Institutional Shaping of Effective Use of Routine Health Data Management in the Context of Global Humanitarian Organizations

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TL; DR

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Abbreviations

AAT	Affordance Actualization Theory
AIDS	Acquired Immune Deficiency Syndrome
CAR	Canonical Action Research
CDC	Centre for Disease Control and Prevention
CPM	Cyclical Process Model
DHIS2	District Health Information Software 2
EHR	Electronic Health Record
H-HMIS	Humanitarian Health Management Information System
HISP	Health Information Systems Programme
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
HQ	Headquarters
ICRC	International Committee of the Red Cross
ICT	Information and Telecommunication Technologies
ICT4D	Information and Telecommunication Technologies for Development
IS	Information Systems
IT	Information Technologies
MSF	Médecins sans Frontières
NAP	Nested Affordance Process
NGO	Non-Governmental Organization
OC	Operational Centre
OCA	Operational Centre Amsterdam
OCB	Operational Centre Brussels
OCBA	Operational Centre Barcelona Athens
OCG	Operational Centre Geneva
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OCP	Operational Centre Paris
PAHO	Pan-American Health Organization
PEPFAR	President's Emergency Plan for AIDS Relief
PoC	Protection of Civilians
PSI	Population Services International
RCA	Researcher-Client Agreement
RT	Representation Theory
SBTF	Standby Volunteer Task Force
TB	Tuberculosis
TEU	Theory for Effective Use
UiO	University of Oslo
UN	United Nations
UNMISS	United Nations Mission South Sudan
WHO	World Health Organization

Abstract

This thesis presents a theoretically informed empirical analysis of the design, implementation, and adoption of a Humanitarian Health Management Information System (H-HMIS) within a global medical humanitarian organization. The central research questions addressed in this thesis is: What constitutes effective use of a health information system in a humanitarian organization? I aim to answer this question by studying what constitutes effective use within the context of a global humanitarian organization, as well as the challenges involved in achieving it. The study of the theory of effective use is based on a two-level analysis: first, a macro-level institutional analysis of the environment in which the system is deployed and used; and second, an affordance-based micro-level analysis of the different uses of the system and the interactions between users and technology at the field level.

The empirical research focuses on the implementation project of the H-HMIS in Médecins Sans Frontières Spain (MSF Spain), as well as the challenges encountered in its adoption and use in the field setting. Despite being globally deployed for a few years, it was felt by the management that the system did not appear to be facilitating meaningful use of information amongst field actors. Instead, it was seen to be mainly geared towards reporting and accountability functions, with rapid decisions and follow-up often still being done using paper or ad-hoc solutions. The research approach followed a Canonical Action Research (CAR) framework to first identify what constitutes effective use in the field and the main challenges encountered, and second, identify the drivers for improving effective use in the defined setting.

The key findings of this research project are the proposal of a (re)definition of the dimension of Transparent Interaction which accounts for the particularities of the context; and the identification of the learning and adaptation actions as potential boundary conditions of effective use when applied in humanitarian settings. Along the process I identified: the institutional logics imposed by the environment and influencing the information system, the characterization of the network of affordances for effective use of the H-HMIS and, the study of the process of affordance actualization.

This research positions the H-HMIS as a critical case of information systems implementation, aiming to provide findings that can be generalised to other environments. From this viewpoint, this project makes several contributions to the field of humanitarian health information systems implementation, as well as to effective use and affordance theory within the broader context of Information Systems research. Key contributions include: *i)* the contextualization of effective use in the humanitarian context and a proposed (re)definition of the dimension of transparent interaction, *ii)* identifying the influence of institutional logics on achieving effective use, *iii)* conceptualizing the network of affordances for the H-HMIS in the field, *iv)* developing a competing affordance potency framework for studying technology use when competing with existing solutions, and *v)* proposing an affordance-based process for measuring effective use in context. Practical contributions include: *i)* building guidelines to strengthen the use of H-HMIS, and *ii)* digitizing the process of manual data collection and aggregation in the field.

In summary, this study provides insights towards understanding how humanitarian organizations can design and implement information systems that are easily adopted and effectively used to attain organizational goals. The lens of effective use holds great promise for the study of information systems in humanitarian organizations and has the potential to be extended to other resource-constrained settings that share similar environmental and institutional conditions.

1 Introduction

Humanitarian organizations operate in complex and unpredictable environments, posing considerable challenges to the design, deployment, and maintenance of information systems. Compared to the commercial sector, technology penetration in the humanitarian field is relatively low (Kabra et al. 2017) and also unique, raising novel and time-consuming challenges in making systems work effectively in field settings (Gavidia 2017). In scenarios marked by rapid shifts, inconsistent and minimal Information Technology (IT) literacy, and a lack of digital infrastructure, many digital solutions are often set aside in favour of simpler, or even non-tech alternatives (Comes and Walle 2016; Harvard-Humanitarian-Initiative 2011).

Health Information Systems play an integral role in addressing information needs and enhancing accountability mechanisms (Lewis and Madon 2004). For humanitarian organizations responding to health crises, interventions rely on routine data collection systems (Mesmar et al. 2016). These systems are increasingly managed by non-state organizations, including those dedicated to humanitarian aid (Braa and Sahay 2017). However, in spite of considerable investments in innovation and emerging technologies, digital systems' significance in the humanitarian sector is still limited, and information management continues to be an enduring challenge (ALNAP 2015; ALNAP 2018; Fast and Waugaman 2016b).

Humanitarian organizations grapple with unique challenges such as limited resources, high turnover rates, and infrastructure constraints (Mesmar et al. 2016; Tafere 2014). The motivations to use particular systems is often driven by the user's perception of the effort required and expected performance outcomes (Kabra et al. 2017). It's vital for users to perceive that a solution will help streamline their daily tasks, not complicate them. If they sense it contributes to additional workload, they might revert to methods they believe to be more efficient. For instance, in field hospitals, users must balance the demands of the information system – encompassing data collection, aggregation, and regular reporting – while simultaneously overseeing hospital ward management and patient care. This balance is particularly challenging, as many hospital workers hail from healthcare backgrounds and possess varied, often limited, IT skills. In the field, users might opt to follow their situated preferences by either selecting a different tool or entirely avoiding digital technology altogether (Kabra and Anbanandam 2016).

Such nuances underscore the necessity to meticulously examine both macro and micro-level processes related to user acceptance or rejection of digital solutions. It's also important to gauge the potential value or lack thereof that these solutions might introduce to their daily routines. A deep understanding of how institutional conditions impact technology-user interaction and the situated processes through which new solutions are either adopted or disregarded is essential. This research domain is relatively nascent, underscoring the importance of accumulating empirical evidence to shed light on the intricate dynamics inherent in such implementations (Kabra et al. 2017).

This project examines the Health Management Information System project of Médecins Sans Frontières Spain (MSF Spain), a prominent humanitarian organization, which has over the years developed and incorporated a web-based information system for data collection and analysis throughout its worldwide interventions. I refer to Humanitarian Health Management Information System as H-HMIS in this thesis. The research delves into this particular H-HMIS project, tracing its evolution from inception at MSF Spain's headquarters to its application by field health workers in the last mile, particularly in an inpatient department within a mission-based field hospital.

The research is anchored in three bodies of theory: Theory of Effective Use (TEU), Institutional Theory, and Affordance Theory. The theory of effective use offers insights into the interplay between the H-HMIS and the organization's informational goals, shedding light on system adoption and utilization processes. Institutional theory provides a higher-level perspective, analysing potential macro-organizational challenges (e.g., those arising from global policies, institutional constraints or contextual limitations) and how these factors influence the pursuit of effective system use. Complementing this is the mid-range Affordance Actualization Theory (AAT), which zeroes in on technology use at the grassroots level, examining how individual actors engage with technology within specific contexts.

I draw upon this theoretical apparatus to answer the central research question posed in this thesis:

> *What constitutes effective use of a health information system in a humanitarian organization?*

This inquiry is addressed through three sub-questions, further elaborated upon in section 1.2 in this chapter.

1.1 Setting the Context: Humanitarian Health Information Systems

Within IS research, the exploration of humanitarian health information systems remains underrepresented, with most existing studies originating from emergency management, public health, and digital health disciplines. The foundational pillars framing my research comprise three distinct attributes: *i)* scope of research; *ii)* types of technologies and data employed; and *iii)* implementation and the challenges that accompany them. The ensuing discussion will delve deeper into these aspects.

1.1.1 Scope of research on humanitarian health information systems

Research on Humanitarian Information Systems predominantly falls into two contextual categories. The first revolves around an “inter-organizational” perspective, emphasizing the coordination of information across multiple agencies engaged in a particular humanitarian crisis. The 2010 Haiti earthquake marked a pivotal moment when digital technology took centre stage in orchestrating response efforts (Meier 2015) , becoming both “essential and inescapable” (Brophy-Williams et al. 2013). Yet, despite the integral role of technology and information, significant challenges in information management arose. The World Health Organization (WHO) even

categorized the information management in the aftermath of this earthquake as subpar in a report evaluating the global response (Goyet et al. 2011). Issues like inadequate information channels, low prioritization of information-related tasks, and challenges in determining source reliability were seen to directly impede coordination and decision-making (Altay and Labonte 2014). Other crises, such as the West Africa Ebola outbreak in 2014, exposed further complications. These included the prevalence of paper-based data collection, overlapping and conflicting information systems, and static information reports that obstructed efficient information sharing for global response coordination (Comes et al. 2015; Fast and Waugaman 2016a).

A considerable portion of literature from this inter-organizational lens gravitates towards public health. Examples include the analysis of public health information's role among Syrian residents (Diggle et al. 2017), and a study underscoring the challenges surrounding health information in the Central African Republic, which highlights that documenting health and humanitarian needs requires innovative approaches (Kuehne and Roberts 2021). Other studies have focused on the exploration of health information sharing in humanitarian contexts (Nair et al. 2022) and the examination of global emergency coordination reporting mechanisms (Chan et al. 2019). While the inter-organizational angle provides valuable insights into collaborative dynamics and global coordination, it overlooks the internal capacities and challenges individual organizations face concerning their information systems. This leads us to the second research context: the “intra-organizational” perspective.

The intra-organizational domain focuses on the examination of health information systems within individual organizations, analysing specific interventions and their impact on health services. Robinson et al. (2019) embarked on a survey of remote communities to measure the effects of augmented integrated community case management on malaria care access. Ortin et al. (2018) probed into the implications of mobilizing technology in health services to refine referral coordination. Jobanputra et al. (2016) scrutinized the introduction of an Electronic Medical Record within an Ebola clinic, and evaluating its influence on data collection methodologies. Their findings accentuated a pronounced organizational culture rift between technological and humanitarian spheres, notably spotlighting the organization's inadequate technical preparedness vis-à-vis the Ebola crisis.

In the absence of robust internal capacities and resilient systems, an organization's aptitude for engaging in inter-organizational activities is severely compromised. To address these challenges an intensive focus on intra-organizational evaluation is imperative — a focus that underpins this research.

1.1.2 Types of technologies and health data operating in humanitarian settings

The humanitarian sector has witnessed a significant surge in the adoption of ICTs, primarily geared towards enhancing the health and social welfare of affected communities. When synergized with broader technological and institutional innovations, ICTs are emerging as pivotal catalysts for improved health outcomes (Walsham 2020).

Diverse technologies bolster the delivery of care within the ambit of humanitarian endeavours. This technological repertoire encompasses electronic health records (EHRs) tailored for clinical care, drones, artificial intelligence, machine learning, and management information systems (Mcguire 2021). Case in point, volunteer networks have initiated mapping systems, enabling both organizations and local communities to register incidents. Moreover, the data shared by civilians via social media platforms has morphed into invaluable information reservoirs (Read et al. 2016). Crisis-mapping platforms, notably Ushahidi and the Standby Volunteer Task Force (SBTF), have championed crisis mapping over the past decade (2010-2020), finding utility among prominent humanitarian entities like NGOs and United Nations (UN) agencies (Meier 2011). Pioneering digital platforms have also been rolled out to facilitate digital identification for vulnerable demographics, potentially amplifying the impact of interventions by facilitating more precise and targeted service deliveries, particularly to refugees (Madon and Schoemaker 2021).

The collection and analysis of large amounts of data potentially enables timely responses in humanitarian contexts (Mesmar et al. 2016). Such information is critical to understanding the current health status of affected populations, their location and demographics, immediate and long-term risks, available resources, needed supplies, and prioritizing urgent needs (Thieren 2005). The organization's information systems play a crucial role in meeting these needs (Lewis and Madon 2004; Read et al. 2016), but presents unique challenges and approaches to engage with them. Some key domains of health data that are relevant in a humanitarian crisis include estimates of affected population size and composition, information about health risk factors, information about health services and outcomes, and pre-crisis disparate information. Figure 1 represents a mapping of public health data relevant for assisting crisis-affected populations (Checchi et al. 2017).

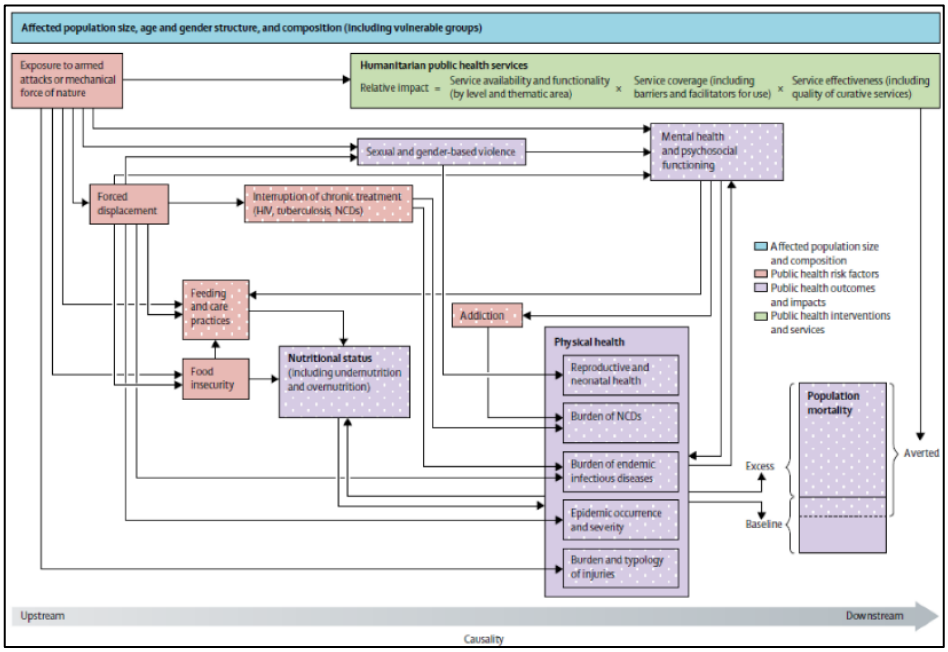

Figure 1 - Public health information in crisis-affected populations: a review of methods and their use for advocacy and action (Checchi et al., 2017)

While numerous health information systems are deployed in humanitarian contexts, my research zeroes in on H-HMIS, which concern the routine collection and reporting of aggregated healthcare data and indicators (Magnuson and Dixon 2020). Primarily, they manage data pertinent to health outcomes and impacts, functioning as surveillance or monitoring sources that guide real-time interventions. Routine health information from H-HMIS is used as well to evaluate intervention effectiveness and reinforce accountability mechanisms in relation to the organizational mission and objectives (Mesmar et al. 2016). It is important for strengthening advocacy and documentation processes and plays a key role in contributing to the overall emergency coordination. At higher coordination levels, routine health data is shared across different organizations engaged in the humanitarian intervention and used in combination with other contextual information, such as conflict and security status, agricultural production and, service availability reports. For example, through the 4Ws (Who does What, When and Where) tool formulated by WHO/OCHA.

Centrally focusing on H-HMIS as the technological backbone of a humanitarian organization's care provision for those in dire need (Mesmar et al. 2016), my research delves into how digital undertakings in these contexts can refine routine health data management practices, the distinct challenges faced, and the strategies to address them.

1.1.3 Information systems implementation and adoption in humanitarian settings

The implementation of H-HMIS related systems is fundamental to managing information flows in operations but represents a complex undertaking (Gavidia 2017; Kabra et al. 2017; Sigala et al. 2020). Building understanding of how to navigate through these challenges represents an urgent subject of future research (Harvard-Humanitarian-Initiative 2011). Studies in IS and ICT4D domains have primarily focused on systems instituted by Ministries of Health (MoH) in LMICs. Challenges spanning system design, software development, technology implementation and use, and sustainability concerns have been discerned (Alwan et al. 2016; Braa and Hedberg 2002). Oftentimes, appropriate technology in relation to health information systems is either inaccessible or ineffectively operational in numerous developing nations, consequently not supporting the enhancement of public healthcare services (Heeks 2006; Walsham 2020). While H-HMIS systems bear similarities with MoH-driven frameworks, pivotal distinctions exist. As such, present research serves as both a source of valuable insights and a conduit to enrich this field of study.

System integration and data quality emerge as shared challenges across both the MoH and humanitarian setting domains. In developing countries, projects lean heavily on donor methodologies and finances (Ali and Bailur 2007), leading to ambiguities in actor responsibilities and diverse interests steering projects in disparate directions (Kimaro and Nhampossa 2005). This climate fosters a predilection for pilot projects (Sanner et al. 2012). Partial implementations are common, engendering system fragmentation (Braa et al. 2004; Sahay and Walsham 2006) —a predominant hurdle in IS deployments (Stansfield et al. 2008; Sæbø et al. 2011). Consequences include

health data being scattered or absent, resulting in data duplication, redundancy, and inconsistencies (AbouZahr and Boerma 2005). While humanitarian organizations typically uphold centralized information systems governance, geographical disparities between headquarters and field operations can engender similar misalignments. It's not rare to encounter bespoke solutions crafted by field personnel to address unfulfilled needs or oversee sudden activities. Notably, these solutions might not be incorporated into the official H-HMIS data collection frameworks. The fragmented nature of disaster response, coupled with nascent and diverse information management paradigms, represents core challenges in amplifying the efficacy of digital interventions in these contexts (Comes et al. 2015; Fast and Waugaman 2016a). A comprehensive study examining health information practices in humanitarian settings over two decades highlighted that obstacles in data collection, the absence of data-sharing frameworks, and logistical impediments stand out as significant barriers (Nair et al. 2022). Likewise, difficulties in identifying reliable data sources hamper both data sharing and emergency response coordination (Day et al. 2009).

Other challenges in implementing information systems in developing countries often stem from technology solutions conceived and developed in the north-western regions—a markedly different environment from where they are ultimately deployed. This discrepancy between design intent and actual usage context, known as design-reality gaps, introduces friction when technology is deployed in the field (Heeks 2006; Suchman 2002). Similarly, humanitarian organizations grapple with bridging the gap between their headquarters and field operations. Typically, projects are managed from headquarters predominantly situated in Europe and North America. This centralization exacerbates issues with data collection and logistical hurdles, which have been identified as significant barriers in a comprehensive study on health information practices across two decades in humanitarian contexts (Nair et al. 2022).

Furthermore, institutional disparities and resource constraints impede implementation processes in the public health sector (Sood et al. 2008). Organizational challenges, cultural divergences, and inconsistent IT literacy levels amplify the barriers impeding technology adoption in emergency scenarios (Maiers et al. 2005). Common challenges include sparse information streams, diminished priority to information tasks (Day et al. 2009). Factors like environmental conditions, limited resources, and infrastructure challenges mould the deployment of information systems in both developing countries and humanitarian environments (Mesmar et al. 2016; Tafere 2014). Further impediments, such as prevalence of paper-based data collection, parallel information systems, and rigid informational reports, obstruct the seamless sharing of data for emergency coordination (Comes et al. 2015; Fast and Waugaman 2016a).

Despite these parallels, distinct differences characterize humanitarian organizations, rendering their H-HMIS an intriguing subject of study. Many of the aforementioned challenges are often countered at grassroots levels through innovative improvisations and local adaptations (Heeks 2006; Li and Nielsen 2019; Suchman 2002). This phenomenon of design-use gaps occurs not only with solutions that transition from

developed to developing regions. Any technology created in one context and employed in another, will necessitate some extent of local appropriation. However, the wider the gap- whether it be geographical, economic or cultural- the more extensive the need for adaptations becomes (Suchman 2002). This is where the unique landscape of a humanitarian backdrop becomes evident. Introducing routine information systems becomes exponentially intricate, taking into account the user profiles in emergency scenarios, which are defined by the rapid and ever-evolving nature of their work and environments (Mesmar et al. 2016; Tafere 2014).

The humanitarian workspace diverges considerably from conventional office environments. As articulated by Suchman (2002) in the context of difficult reworkings and local adjustments to technology, one plausible course of action when "*prospective users are powerful enough is its rejection*", a scenario notably applicable to humanitarian workers. Users exhibit high autonomy and a robust problem-solving mindset. Professionals, grounded in their experiences, often avoid unproven and risky methodologies, leaning instead on time-tested, reliable alternatives. Professionals, seasoned by their experiences in challenging terrains, tend to be averse to embracing new risks. Contemporary solutions are frequently dismissed in the field, with a preference for low-tech or even non-technical methods like paper (Harvard-Humanitarian-Initiative 2011). Moreover, systems are often deployed to remote, decentralized locations with scant infrastructure, complicating the provision of technical support and diminishing the potency of digital interventions (Tusiime and Byrne 2011). All these issues are intensified by and high rates of staff turnover, making continuous retraining difficult to achieve (Tafere 2014).

Implementing IS in such context presents a different nature which brings potential to contribute to IS research. Implementers and users experience challenges for system adoption and use at a higher intensity than other technology users. Infrastructure is limited, environment is challenging, field user rotations are constant, and their expectations are high. To make all conditions more critical: user level of tolerance to bad performance is really low.

Positioning my research

Summarizing from these three areas introduced to contextualize my work, research on humanitarian health information systems represents a somewhat fragmented and nascent body of research. Theoretical underpinnings have largely been overlooked, restricting the scope for broader generalizations. Given the escalating frequency of humanitarian health crises and the rising prevalence of digital interventions for their management, there is an urgent need to develop theoretical concepts, which are contextually tailored to serve as guiding posts for interventions across diverse settings. For instance, delving into the dynamics of implementation, system design, and development processes can afford a more intricate understanding of the essential conditions for sustainability and scalability when incorporating technology into humanitarian efforts.

The parallels and distinctions drawn between H-HMIS and routine health information systems, often commissioned by Ministries of Health, and the challenges that the

humanitarian environment poses into the implementation and use of technology, provide the foundational basis for conceptualizing this H-HMIS study as a "critical case". A critical case facilitates generalizations from single case studies, offering insights that enable logical deductions along the lines of, "If it is valid for this case, it is valid for all (or many) cases." (Flyvbjerg 2006, p. 230). Working from this viewpoint, I work with the assumption that a system successfully implemented and utilized in a humanitarian context, considering the stringent user conditions, would likely be seamlessly used in a regular or resource-limited settings with analogous information needs.

Centring on the intricacies of deploying functional and effective health information systems—bridging the data flow from grassroots field operations to top-tier coordination—my research aspires to delve deep into the H-HMIS within a singular medical humanitarian organization. Aiming for a deeper understanding of the micro-level dynamics—how users embrace or reject novel digital solutions and the perceived value these tools bring to their routine tasks—I intend to scrutinize the organization from a global perspective right down to the field-level operatives, all the while crafting an empirically-grounded theory. Drawing from Organization Studies and Information Systems, my goal is to forge a conceptual framework that resonates across diverse humanitarian health landscapes and comparable resource-limited scenarios.

1.2 Research Phenomenon, Research Question and Theoretical Underpinnings

Research phenomenon: This study centres on the digital intervention of Médecins Sans Frontières Spain (MSF Spain) to strengthen its routine health information system and introduce a new H-HMIS. The initiative sought to transition from an Excel-based health information system to a web platform, enhancing data integration and field analysis. Spearheaded and housed within the organization, the intervention received strategic backing from three pivotal departments at the organization's headquarters: the General Direction, Medical, and Operations departments.

Research question: The following research question is addressed in this thesis:

> *What constitutes effective use of a health information system in a humanitarian organization?*

This inquiry is addressed through the following sub-questions:

1. *What are the specificities of the institutional context and what is their impact on effective use?*
2. *What are the operating affordances and how the institutional context shapes the process of actualization?*
3. *How can the theoretical model for effective use be made relevant for humanitarian settings and diverse context?*

The theoretical foundations that guide this research project in addressing the research questions are presented next.

Theoretical underpinnings: The theoretical framework guiding this research comprises three bodies of theory: Theory of Effective Use (TEU), Institutional Theory, and Affordances Theory. The role of each one of the theories and their contribution to the overall analysis are explained next individually and summarised at the end as a combined analytical process.

1.2.1 Effective use, the desired outcome of the organization

The crux of this research centres on contextualizing the theory of effective use within the humanitarian setting under exploration (Burton-Jones and Grange 2013) This theory suggests that individuals can engage in specific actions to amplify their system utilization, thereby enhancing performance outcomes. Central to this theory is the notion that several factors — ranging from individual to organizational to environmental — can influence the effective employment of systems. By addressing these determinants, users can bolster their competence in utilizing systems effectively, which in turn can result in improved performance outcomes. The emphasis of the "effective use" concept rests on individuals proactively fine-tuning their system use to achieve optimal results. On an organizational scale, this theoretical model furnishes a blueprint through which the latent potential of information systems can be fully attained.

The proposed theoretical model outlines three dimensions pivotal to effective use: transparent interaction, representational fidelity, and informed decisions. Attaining these dimensions can spur organizational performance by refining individual efficacy and efficiency. Driving this effective use are the learning and adaptation actions that users employ to enhance these three core dimensions.

In the context of this research, the objective is to discern what embodies "effective use" within a humanitarian context and assess its relevance in such an environment. To this end, the theoretical model is contrasted with the prevalent environmental and organizational traits. Such a comparative analysis is instrumental in spotlighting the salient challenges in achieving effective use and pinpointing the crucial facets for refining system implementation.

1.2.2 Institutional theory as a lens to untangle the macro-level

This research employs concepts from institutional theory to scrutinize the role of institutions and their impact on H-HMIS from a global perspective. Within this framework, H-HMIS is considered an institution, since technology can function as an institution, shaping organized activities within society (Avgerou 2002). This examination is based on two pivotal concepts: the organizational field and institutional logics.

The organizational field (DiMaggio 1983) is delineated as a dynamic network of interrelated organizations, where key participants both react to and engender environmental pressures tied to implementation processes (Orlikowski and Barley 2001). This encompasses the roles played by Information and Communication Technologies (ICT) and the associated practices, both formal and informal. It also takes into account potential contradictions that might emerge (Piotti et al. 2006). In

contrast, institutional logics serve as guiding principles that offer directives to participants within the field, steering the strategies and objectives of individual behaviour (Friedland and Alford 1991).

Viewed through this lens, the information system is conceptualized as an institution with users as independent actors impacting organizational dynamics. The organizational field signifies the spectrum of users, each with their distinct contexts and requirements, and it recognizes the potential influence of informal practices on institutional formation. This top-down analysis endeavours to identify these formal rules and informal practices that act as either facilitators or barriers. It also seeks to discern how these elements translate into institutional logics that shape the effective use of the system.

1.2.3 Affordance actualization theory as a lens to zoom-in on user adoption

Affordance actualization theory, as proposed by Strong et al. (2014), delves into the influence of individual practices on technology use, while simultaneously considering the impact of organizational structures on transformation processes. Through the lens of affordance actualization theory, this research examines how users in humanitarian organizations realize the potential of IS interventions, emphasizing user-technology interaction. Central to the analytical endeavour are the concepts of affordance actualization, affordance potency, and the network of affordances.

Affordance actualization is the process by which users harness the potential uses of technology to derive immediate concrete outcomes (Strong et al. 2014). This theory identifies three critical components that shape affordance actualization: context, technology features, and the user. The interplay among these elements determines whether an affordance is actualized. This holistic perspective allows for an in-depth evaluation of the technology's nuances, the diverse capabilities of users, and the myriad contextual conditions. The goal is to determine the factors that facilitate or hinder affordance actualization and the challenges therein.

Affordance potency, introduced by Anderson & Robey (Anderson and Robey 2017), provides a framework to scrutinize the affordance actualization process within a contextual backdrop. Potency is defined as the likelihood that affordances will be actualized, a result of the synergy among the three key components of affordance actualization. Within this research, potency is approached from an ensemble perspective (Orlikowski and Iacono 2001), juxtaposing digital methods with traditional paper-based solutions and practices crafted by users.

Lastly, the concept of the affordance network facilitates an exploration of the intended outcomes of system utilization. This network comprises individual affordances that, when effectively actualized, work toward achieving organizational objectives. By constructing an affordance network, this study seeks to define and promote effective use within the organization's framework.

1.2.4 Overall analytical process

My research's analytical process adheres to the methodology for crafting context-specific theories of effective use as outlined by Burton-Jones and Volkoff (2017) These authors advocate for a bottom-up inductive approach, blending tenets from both the theories of effective use and affordance actualization. I have further extended their method by integrating institutional theory, providing for a more expansive contextual analysis.

As a result, my research is guided by an analytical process that combines the theory of effective use with:

- Institutional theory, used to identify drivers and stressors for effective use from a global perspective through institutional analysis.
- Affordance actualization theory to contextualize effective use and analyse the challenges that field users face when using technology.
- Affordance potency is used to analyse the factors that increase the likelihood of actualizing affordances.

1.3 Empirical Setting and Research Methods

1.3.1 Researcher positionality

From 2013 to 2017, I was employed at the MSF headquarters in Barcelona, where I was part of the team heading the implementation and deployment of the new H-HMIS. During my tenure, I observed first-hand the organization's initiatives to equip MSF field staff with digital information access. I recognized that the varied and evolving nature of field settings produced a range of needs, often challenging for a singular system to address. The constrained infrastructure and formidable working conditions consistently posed barriers. Moreover, actively involving stakeholders in the design process proved challenging, especially when they were preoccupied with emergency interventions. Consequently, the system's adoption did not necessarily lead to its meaningful use in the field.

Both MSF and I were keen to comprehend these less-than-optimal project outcomes and explore avenues for improvement. Intent on refining the H-HMIS and making it more attuned to user needs, we jointly decided to pursue this challenge as a research endeavour. By stepping back from the organization's routines and logic, our aim was to delve deeper into the challenges faced and decisions taken, drawing insights from the IS research domain and its theoretical frameworks.

In March 2017, my role within the organization shifted. I transitioned from overseeing the system's design and deployment to undertaking this PhD. Subsequently, a formal research agreement was forged between MSF and the HISP Centre at the University of Oslo, Norway. HISP is a global action research initiative that has, for over two decades, engaged in the design, development, implementation, and scaling of the District Health Information Software (DHIS2). This has been done within the context of an action research framework, primarily targeting the public health sector in developing nations.

Having spent years both in the field and at the headquarters, I developed strong relationships that fostered trust with key stakeholders and users of the H-HMIS. The organization's endorsement of this research further granted me unparalleled access, legitimizing my investigative endeavours in an environment that is, by nature, restrictive due to potential security threats.

This research serves to broaden the intellectual horizons of the Health Information Systems Programme (HISP) Centre, which has traditionally centred its focus on the public health sector in developing regions. As the inaugural study examining a humanitarian organization and considering MSF's pioneering role in using DHIS2 for humanitarian responses, this research holds significant value for both scholarly and practical spheres.

1.3.2 Empirical setting

Doctors Without Borders, known in French as *Médecins sans Frontières*, is a worldwide organization made up of five independent Operational Centres (OCs). One such centre is MSF Spain, also referred to as OCBA (Operational Centre Barcelona-Athens). While each OC operates autonomously across various countries, there isn't a specific territorial distribution assigned to any OC. In the field, MSF offices coordinate their activities as missions. For the sake of crafting a manageable research project that would yield in-depth insights into the phenomenon being explored, a subset of missions and projects from MSF Spain's interventions was chosen. The South Sudan Mission emerged as the chosen setting—a regular long-term intervention that MSF Spain has operated with since 2013.

On the ground, the primary emphasis was placed on Malakal, South Sudan's fourth-largest city. The Malakal project operated two hospitals, four mobile clinics, and oversaw community health and promotional activities. While there were field trips and data collection efforts in other parts of the country, Malakal was the one consistent technical intervention site for the entire research period. At the headquarters, three key departments collaborated during various phases of the research: the medical department, the operations department, and the general direction, facilitated through the eHealth team.

Multiple visits to both the headquarters and the field, paired with analytical exercises, led to the identification of unique challenges and user practices tied to facility-based data collection. These practices were steered by two primary forces: the overarching institutional context, which prescribed the data to be reported to upper tiers, and the specific role of technology within the local setting. The research focused on deciphering the impact of the humanitarian environment and its core principles on the technological aspects of data management practices in the field. It also explored how such technology could be optimized for greater benefit of the field workers. As part of the solution, a mobile platform was rolled out in healthcare facilities. This system facilitated daily patient data collection, executed closely alongside medical procedures. The accumulated patient data was subsequently used to auto-generate weekly aggregate reports, providing a snapshot of facility performance and broader health

trends. These insights were drawn from patient profiles, diagnoses, and outcomes. The creation and continuous enhancement of this solution remained a pivotal component of the research undertaking. Alongside the research objectives and activities, my role in building this mobile application was very central. MSF dedicated part of their e-health team, concretely a project manager, an epidemiologist, and a e-health technician to this technical intervention. Working with that team, I led the conceptualization, design, configuration and implementation of the solution, as it provided the analytical focus of my empirical work.

1.3.3 Research design

The objective of this study was to comprehend the challenges and potentialities of adopting an H-HMIS within the organization, focusing on users' perspectives and interpretations. This interpretive study aims to discern the social contexts that influence an actor's decisions and actions. Interpretive methods posit that our understanding of reality is a human-constructed perception, emphasizing the processes through which shared understanding or inter-subjectivity is crafted (Walsham 1993). Employing this interpretive approach offers insights into the H-HMIS by encompassing the viewpoints of varied stakeholders.

This endeavour aligns with the tenets of Canonical Action Research (CAR) (Davidson et al. 2014). Abiding by CAR principles was both a facilitator and an outcome of the need to formalize a research agreement with MSF Spain. This agreement solidified the research's focus, outlined the commitments and roles for each participant, and clarified mutual goals. Decisions regarding data collection and analysis techniques were collaboratively made, involving MSF, myself, and my PhD supervisor. Action Research, in general, and CAR as a specific form of it, combine theory and practice with the dual intention of improving practice and contributing to theory and knowledge through change and reflection. This approach is particularly suitable for conducting research in a humanitarian organization where practical actions and contributions are of utmost importance for the organization to accept the research and justify access to field settings.

The specific cyclical CAR phases were preceded by an exploratory phase and culminated in a comprehensive analysis, leading to the thesis writing. A synopsis of these distinct stages and intervals is provided in Table 1. The timelines and periods here presented are delineated for analytical purposes. In reality, there was some overlap and back-and-forth among the stages, which is reflected in the significant time difference among them. For instance, an unplanned sub cycle of action-intervention-evaluation occurred in parallel with and complemented the reflection stage. Findings from this sub cycle were integrated with the insights from the preceding stages for final the analysis. More detailed information about this and another unforeseen events can be found on Chapter 4 - Research Methods.

CAR cycle stage	Duration	Years
Exploratory phase	4 years	2013 - 2016
Diagnosis	1 year and 9 months	2017 - 2018
Action planning	1 year	2018 - 2019
Intervention	6 months	2019 - 2020
Evaluation	3 months	2020
Reflection	1 year and 6 months	2020 - 2021
Overall analysis and writing	1 year and 4 months	2022 - 2023

Table 1 - The action research cycles and time periods

Data collection

This study predominantly utilizes qualitative methods grounded in an interpretive mode of inquiry (Walsham 1993). Data was collected through semi-structured interviews, focus group discussions, and participatory observations during visits to both the headquarters and field sites. In total, thirty-one interviews and three focus group discussions took place. Observational techniques were employed at both the headquarters and field locations.

Detailed notes from interviews and observations were documented during field visits and subsequently logged in the research diary. Participant observation in workplaces offered insights into system utilization, user feedback, and problem-solving approaches. Additionally, attending meetings shed light on how challenges were identified, negotiated, and resolved, and what was the role of data and information on that process.

This information was then deliberated with my supervisor. Serving as an unbiased, "know-nothing" figure, he ensured an absence of assumptions and promoted continual reflection. This external viewpoint was particularly invaluable, considering my intimate knowledge of the organization from four years of involvement.

Archival research acted as secondary data source. Pertinent documents, such as legacy materials from various H-HMIS project phases, activity reports, and other internal documentation, were scrutinized. Relevant data collection and analysis tools used alongside the standard H-HMIS, including specific Excel files, routine reports, and paper-based methods, were also examined when relevant.

1.4 Expected contributions

By situating the theory of effective use within a specific context and leveraging a combined theoretical framework, this study enriches the evolving landscape of IS research within humanitarian organizations. Additionally, it advances knowledge in the broader field of humanitarian action, especially regarding the role of ICTs. On a practical level, the project aims to enhance the implementation of H-HMIS and bolster

the use of health data to guide humanitarian interventions by field users within MSF Spain.

1.4.1 Theoretical Contributions

The pivotal contribution of this thesis is the adaptation of the original theory of effective use to humanitarian contexts. The research emphasizes broadening the theory to encompass the backdrop of a humanitarian field intervention, specifically evaluating the resilience of the digital intervention associated with the H-HMIS. This is set within a distinct context that merges managerial and operational elements in a fluid environment. The contextualization of the theory of effective use in the humanitarian setting is achieved through three means:

i) Bringing in the role of the environment through the lens of institutional logics.

ii) Studying the micro-level network of affordances and its process of actualization.

iii) Revisiting the dimension of transparent interaction and defining a process for measuring effective use in context.

The specific theoretical contributions that stem from this analytical work are:

Contextualizing the theory effective use to a Humanitarian Context: Defining potential boundary conditions of the humanitarian context and reporting on the contextualization and test of the theory of effective use in contrast with them, and offering an empirically based definition of transparent interaction.

Identifying environmental influences on Effective Use: Extending the approach for contextualising the theory of effective use by incorporating an additional step to study the influence of the operational environment through the lens of institutional logics.

Developing a framework to study Competing Affordances: Developing a theoretical framework of competing affordance potency for analysing effective utilisation of technology when in contest with existing solutions.

Proposing an affordance-based process for assessing of Effective Use in context: Defining a mixed-methods process that builds upon existing measurement tools (Eden et al. 2020) in combination with the concept of network of affordances (Burton-Jones and Volkoff 2017).

1.4.2 Practical contributions

Gleaning insights from users' experiences in the most remote and demanding settings is instrumental in crafting compelling use cases for various user groups. This study sheds light on the challenges IS professionals encounter, encompassing both the research and practice aspects of humanitarian organizations.

Building a foundation for strengthening H-HMIS in the field: This research provided MSF with nuanced insights into their operational environment and the potential conflicts influencing the deployment and utilization of the H-HMIS system. Throughout the project's progression, the findings were synthesized into comprehensive reports, lucidly presenting the results while proffering actionable

recommendations. This endeavour enriched the organization's knowledge base on technological interventions aimed at enhancing data collection and use processes.

Digitalizing individual data collection in the field: The primary objective behind the mobile data collection initiative was to seamlessly aggregate weekly data into the routine reporting system (H-HMIS), which resulted in multiple pronounced benefits. Users experienced a time-saving advantage in data collection, which, in turn, granted them additional time for patient care and administrative duties related to ward management. Tangible enhancements in data quality were noted, especially in managerial metrics deriving from hospital wards.

The digitalization journey has seen progressive success. The organization rolled out a second iteration of mobile data collection, imbibing refinements informed by this research—such as the integration of individual patient data and streamlined filtering and search functionalities. The tech solution rests on an open-source mobile application platform, and there are deliberations within the organization about the feasibility of broadening the solution across their global missions, projects, and healthcare services. The endeavour to promote the use of the individual patient information to support clinical care wasn't encapsulated within the goals of this intervention, however. Evaluating the advantages of possessing individual data from hospital wards at the coordination and headquarters tiers wasn't encompassed within the scope of this study.

1.5 Papers included in the Kappa

The publications included in this thesis are:

1) Humanitarian Health Information Systems: Different challenges and responses. Vila-Pozo, M. M. & Sahay, S. (2018). *ECIS 2018*.
2) Institutional Shaping of Affordances: Implications on Information Use in Global Humanitarian Organizations. Vila-Pozo, M. M. & Sahay, S. (2019). *IFIP 9.4 2019*.
3) Competing Affordance Potencies Shaping Data Collection: Case of Humanitarian Organizations. Vila-Pozo, M. M.; Martínez, R.; & Sahay, S. (2022). *ICIS 2022*.
4) Contextualizing Effective Use of Health Information Systems in Humanitarian Setting: The role of Transparent Interaction. Vila-Pozo, M. M *ISCRAM 2024 (submitted)*
5) An Affordance-based Process for Assessing Effective Use of Health Management Information Systems in Low-Resources Context. Kuika Watat, J.; Vila-Pozo, M. M. ACIS 2023 *(accepted)*

1.6 Structure of the Thesis

The rest of the thesis is structured in the following manner:

In Chapter 2 – Conceptual Framework, I first outline the different bodies of theory used in this thesis, with particular emphasis on the different concepts underpinning the analysis. I then explain the theory-guided analytical process which I follow to contextualize effective use, which I later use to describe my findings in Chapter 5.

In Chapter 3 – Research Context, I introduce the context of my research. I first introduce my academic and institutional context, HISP and the University of Oslo (UiO), followed by the technological context, the DHIS2 Software. I conclude by introducing the empirical setting, where I describe the humanitarian organization at headquarters and field setting, and the technical intervention performed within this research project.

In Chapter 4 – Research Methods, I describe the research methodology of this thesis. The chapter includes the research design, data collection and analysis methods, and my positioning in the research, concluding with an analysis of the ethical challenges encountered.

In Chapter 5 – Research Analysis and Findings, I present the publications that form this thesis, followed by a phased description of the analytical process explaining the findings from each step and how they contribute to answering the research questions. I conclude with a synthesis of findings and their unified relevance to address the research questions posed in this thesis.

In Chapter 6 – Research Contributions, I first discuss the overall contextualization of effective use into the humanitarian setting, to frame the individual contributions which are later described individually. The chapter concludes by introducing the practical contributions to the organization.

In Chapter 7 – Concluding Remarks, I conclude the thesis with a recap of the research problem and findings identified. I explain the potential generalization of my work, its limitations, and include suggestions for future research.

2 Theoretical Framework

In this chapter, I outline the primary theoretical concepts that form the foundation of my analytical framework. My research delves into the challenges and obstacles encountered during the global deployment and adoption of the H-HMIS system, a digital tool employed for humanitarian interventions. The objective of my analysis is to determine how IS theories can illuminate these challenges and obstacles. More precisely, my study examines the interaction between users and technology within a specific humanitarian intervention and its ramifications on the overarching organization's information management objectives.

In striving for these goals, I emphasize the significance of the information system as an integral organizational instrument and its pivotal role in bolstering humanitarian initiatives. My theoretical base amalgamates three research domains: the theory of effective use, institutional theory, and affordance actualization theory. Together, they offer a lens to discern how the H-HMIS system functions in a humanitarian intervention context and the determinants shaping its integration.

Central to my investigation is the application and adaptation of the theory of effective use in the examined scenario. To cultivate theories pertinent to this context, I juxtapose these three sets of theoretical ideas and employ inductive methodologies to develop a comprehensive analytical perspective. Through this strategy, I aspire to unveil both specific and universally relevant insights regarding the hurdles encountered during the H-HMIS system's rollout in humanitarian interventions.

Following Agverou's (2019) review of contextual research in the IS literature, I focus on three set of dimensions:

1. My contextualization aims to extend the theory of effective use model by incorporating context-specific relevant factors.
2. The contextual factors provided are a combination of institutional and material conditions found in the environment of the H-HMIS being studied.
3. The explanatory mechanisms mainly examine the socio-technical influences of the contextual conditions.

The theory of effective use serves as the foundational framework for interpreting the connection between the H-HMIS system and the organization's information objectives. To deepen this comprehension, I integrate insights from institutional and affordance actualization theories. I employ institutional theory as a meta-theory to discern how environmental characteristics influence technology usage processes in field settings. On a granular scale, the affordance actualization theory aids in examining data collection and utilization practices on the ground. I will discuss these three research pillars separately in the ensuing sub-sections and meld them into a cohesive conceptual framework in Section 2.4.

2.1 Effective Use. Organizationally Desired Outcomes

The theory of effective use asserts that organizations deploy information systems to fulfil specific objectives. Consequently, the effective utilization of the H-HMIS system is tied to the goals the humanitarian organization aims to realize through this digital initiative. This theoretical framework elucidates the mechanisms by which proficient use of information systems culminates in enhanced organizational performance. Additionally, it introduces models delineating the primary dimensions and critical determinants of effective use. The theory acts as a foundation, examining how information systems are (or could be) employed to achieve desired results and amplify the benefits of information system enhancement projects.

Originating from Representation Theory (RT) and the perception of information systems as semantic entities (Wand and Weber 1995), the theory of effective use views systems as tools capable of mirroring real-world occurrences. This allows users to engage with digital manifestations of these phenomena. Thus, an information system conveys significance through a coordinated set of symbols. Representation Theory suggests that information systems consist of three interconnected structures:

- Deep structure: This refers to the definition of data structures and their specifications to represent the domain. It implies the design prompted on the database and configuration of the H-HMIS system for defining the data that will be collected by the system.
- Surface structure: This is the structure that enables the user to access the deep structure. The user interface allows for data collection and analysis. It enables the selection of data to be retrieved from the deep structure to generate a representation.
- Physical structure: This component connects the deep and surface structures. The H-HMIS system requires material components to allow users access to interact with the surface structure to access the deep structure. This refers to the IT infrastructure and hardware that supports the H-HMIS system.

Individuals rely on digital representations to acquire insights about specific real-world scenarios, which subsequently guide their actions (Burton-Jones et al. 2017b). The shift from mere use to effective use can be viewed as progressing from utilizing a system for a specific task (system use) to deploying it in a way that advances the achievement of organizational goals (effective use). The primary objective isn't simply to use the information system but to employ it as a tool for achieving the broader organizational aims. Effective use is characterized as "using a system in a manner that facilitates the realization of the system's intended goals" (Burton-Jones and Grange 2013, p. 633).

The theory of effective use seeks to identify the catalysts that lead to its achievement. It establishes an overarching framework, grounded in the idea that the development and application of information systems are susceptible to errors but can be refined over time. Users possess a continuous ability to introduce rectifications, enhancing both the system's usage and its overall efficiency.

Effective use is modelled across the following three dimensions, as described by Burton-Jones and Grange (2013, p. 642):

- 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 dimensions interrelate in a hierarchical manner. Within this hierarchical structure, transparent interaction catalyses information potential, subsequently facilitating representational fidelity. This fidelity can then be harnessed for informed action (Burton-Jones and Grange 2013). It's essential to actualize all three dimensions to achieve effective use. While each dimension is vital, alone it is not enough to progress to the next level. This interrelation is graphically depicted in Figure 2 (pg. 22).

These dimensions don't pertain solely to the user or the system, but rather to the act of system utilization. For example, representational fidelity might hinge on the user's method of information extraction, while informed action depends on the user's ability to utilize the derived representation. Transparent interaction, being the pivotal dimension for effective use in humanitarian scenarios, is now elaborated upon in greater depth.

I present some ongoing critiques of effective use theory and my responses to it in Section 2.4 of this chapter.

2.1.1 Transparent interaction and its role in effective use

Transparent interaction aims for enhanced performance and focus (Burton-Jones and Grange 2013). By fostering this interaction, users should experience improved performance, feeling more adept and empowered. Transparent interaction diminishes barriers related to the system's functional components, offering more fluid engagement. Challenges at this juncture can stem from the system's physical (hardware) or surface structures (software).

Transparent interaction is recognized as the key dimension in achieving effective use (Eden et al. 2019), serving as the primary step on its hierarchical ladder. Its significance is accentuated in emergency contexts, where humanitarian workers' digital tool use ties directly to performance expectations and the anticipated effort level (Kabra et al. 2017). If the system interaction isn't seamless and fails to augment day-to-day tasks, field operators might switch to alternate software or abstain from digital solutions altogether (Kabra and Anbanandam 2016). Compromised transparent interaction can hinder task performance and its repercussions can be magnified in humanitarian contexts. Inadequate transparent interaction might curtail efficacy,

potentially prompting system abandonment. Consequently, transparent interaction stands as a central concept in this research.

Recent investigations have introduced measurement tools to evaluate effective use's dimensions from assorted angles. Haake et al. (2018) unveiled a measurement model for a Loan Management System, spotlighting the dimensions' hierarchical nature. Eden et al. (2019) executed effective use and rolled out a measurement instrument for hospitals, underlining a robust link between effective use and both individual and organizational gains. Crafting apt measurement tools for effective use's constructs can yield prescriptive insights, equipping researchers to assess the model and practitioners to gauge system benefits (Burton-Jones and Grange 2013). Within the H-HMIS realm, such metrics would help empower humanitarian entities to maximize their information system deployments by emphasizing heightened effectiveness and barrier reduction, thus curtailing risks of system neglect or misuse.

2.1.2 Theory of effective use in emergency contexts

The theory of effective use has guided research on IS implementations across diverse domains, including hospitals (Eden et al. 2018; Eden et al. 2019), educational institutions (Eden et al. 2020), enterprises (Trieu 2013; Trieu et al. 2022), and banking (Haake et al. 2018). Its applications have also extended to emergency management (Bonaretti and Fischer-Preßler 2021; Bonaretti and Piccoli 2018; Bonaretti and Piccoli 2019).

The deployment of the theory of effective use in emergency management pivots on its contextual adaptation to chaotic environments. This application underscores the pivotal role of ISs in bolstering inter-agency coordination. While this focus diverges from my research's emphasis on intra-agency information systems, foundational similarities substantiate its application within the H-HMIS context. Bonaretti and Piccoli (2019) advocated for adjustments to the theory of effective use model, tailoring it for emergency management scenarios. Their primary alteration replaced the 'Informed Action' dimension with 'Situational Awareness' as the third effective use dimension. Situational awareness recognizes that an information system might not encapsulate all necessary data (Endsley 1995). Instead, the emphasis shifts to the adequacy of information as a cornerstone of effective use.

The context-dependent nature of humanitarian information systems is underscored by the aforementioned considerations. The value of timely information or informed action deeply intertwines with the surrounding circumstances and specific events. Factors such as geographic locale, crisis nature, and emergent population needs play integral roles. This accentuates the significance of all effective use dimensions (transparent interaction, representational fidelity, and situational awareness) as sculpted by the interplay of user, system, task, and environment. The original model for the theory of effective use overlooked the environmental aspect, marking the second amendment suggested by the authors.

Bonaretti and Piccoli (2018) aim to address the lack of prescriptive indications that IS theories often present, which limits the capacity of practitioners to evaluate the

effectiveness of initiatives for emergency management. They propose a framework that embeds goal-oriented principles to increase the practical relevance of IS scholarship by examining the effective use of IT in emergency management. The resulting model for effective use adapted for emergency management contexts can be found in Figure 2.

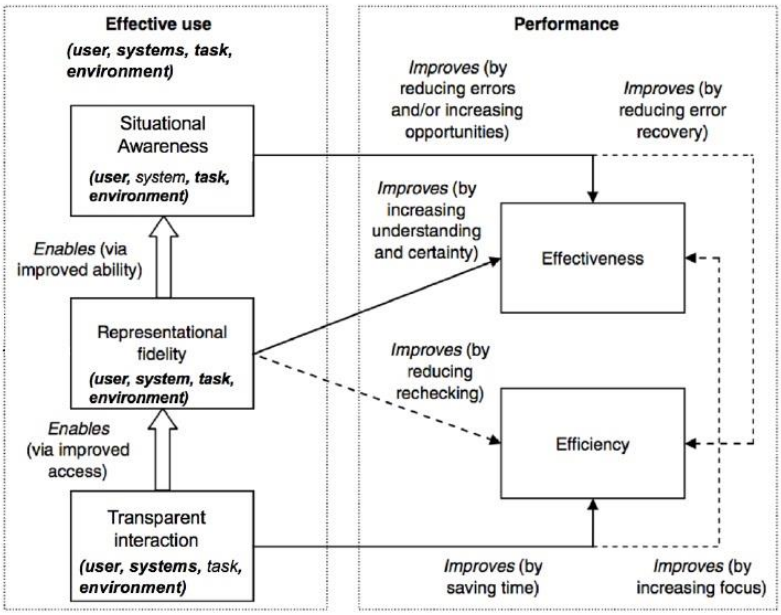

Figure 2 - Effective Use model adapted for emergency management contexts

In this thesis, when examining the dimensions of effective use, I will take as my point of departure this revised that incorporates 'situational awareness' as the third dimension and factors in the environment's role in effective use. My utilization of the theory of effective use centres on its tailoring for the humanitarian sector, with a particular focus on the construct of transparent interaction. The ultimate objective is to guide humanitarian organizations in optimizing system access in the field. To enrich this analysis with a broader perspective, I will draw upon selected concepts from institutional theory, which I now introduce.

2.2 Institutional Theory as a Global Framework

Originally, institutionalism focused on high-level social structures and changes, as well as the impact of institutional rules and forces (Zheng 2015). Institutional theory has informed IS research by examining how ICTs function within organizations, notably within the healthcare sector in low and middle-income countries (Hayes and Rajão 2011; Sahay et al. 2010).

Though institutional theory represents a vast and diverse body of research, specific key concepts stand out as particularly relevant to this study. The evolution of the definition of an institution from being "the rules of the game" (North 1990) to "the outcome of human activity, not necessarily a conscious design" (Friedland and Alford 1991) allows for the exploration of users in information systems as independent actors and the potential for unintended consequences. These actors might employ the system for intended purposes or for uses that emerged organically without prior system design.

Significantly, this definition encompasses both intentional and unintentional human behaviours, particularly relevant for the dynamic field of humanitarian users and information systems.

Building on North's depiction of institutions as “the rules of the game,” organizations emerge as the players. Collectively, interrelated organizations form an organizational field, defined as “a collective of organizations recognized as a specific domain of institutional life” (DiMaggio 1983). DiMaggio (1986) views this perspective as spanning organizational and societal levels to study societal changes. Within this field, organizations are not mere passive entities; they actively respond to and even generate environmental influences (Orlikowski and Barley 2001).

The concept of institutional logics has been pivotal in IS research, particularly in explaining discrepancies arising from IS implementations. Stratton et al. (2016) argue that every instance of adaptive tech use in ICT for Development (ICT4D) projects underscores competing logics born from institutional contrasts. Such contrasts can result in change, coexist, or even initiate other events. Meanwhile, studies such as those by Silva and Hirschheim (2007) or Sahay et al. (2010) shed light on the implications of conflicting institutional logics in various settings. Hayes and Rajão (2011) emphasized the critical nature of recognizing contrasting institutional logics when deploying technology to achieve sustainable development goals.

Institutional logics prescribe principles that guide individuals within a field, influencing the motives and methods of their behaviour (Friedland and Alford 1991) and determining the operational procedures of a societal entity (Thornton and Ocasio 2008). Alford and Friedland (1985) recognize the emergence of conflicting practices from specific institutional logics within organizations. These dominant logics can vary, sometimes coexisting in discord, leading to institutional contradictions (Friedland and Alford 1991).

This logics perspective informs my analysis, particularly when discerning the occasionally contradictory practices related to digital solutions in humanitarian contexts, specifically the deployment of the H-HMIS. Given that an H-HMIS operates within a fluid and dynamic environment, contradictions are inherent. To grasp how the characteristics of the humanitarian context influence technology use and its impact on effective use, I subsequently engage in a detailed analysis of technology utilization, leveraging affordance actualization theory.

2.3 Affordance Theory as a lens to study the field user’s engagement with technology

The concept of affordances originated from the study of how animals perceive their interactions with their natural environment. In ecological psychology, James J. Gibson (1979) described affordances as the opportunities or benefits an object provides to an individual or entity. This suggests that an actor, driven by a specific goal, perceives an object based on its utility, rather than solely on its attributes. Affordances are understood without necessitating an explicit cognitive process from the observer to recognize the object's characteristics.

The ensuing dialogue among researchers led to the evolution of the affordance theory. Some considered it as a quality inherent in the object or environment (Turvey 1992), while others saw it as a relational property between the animal and its surroundings (Stoffregen 2003). Yet another perspective, presented by Chemero (2003), argued that it's not a property but the very relationship between animals and their environment under specific conditions. The discourse eventually converged with Chemero & Turvey (2007) agreeing on affordances as "emergent, relational properties of animal-environment systems." This viewpoint was then applied in technology domains, highlighting that affordances don't solely stem from the technology but from the relationship between the technology and its users in situated contexts.

2.1.3 Affordance actualization theory and affordance potency

Strong et al. (2014) advanced the theory of affordances by introducing the affordance actualization theory, designed to study organizational change processes linked with the implementation of an EHR system. Their objective was to understand change that takes into account individual practices and the IT artifact, harmonizing individual actions with the impact of organizational structures on the change process. They felt a need for a theory that would analyse the processes leading to the actualization of affordances in organizational contexts, derived from a group of interrelated affordances.

Affordance actualization theory (AAT) rests on several foundational principles from its original ecological psychology formulation:

i) Affordances are relational, acting as "links between the abilities of animals and environmental features" (Chemero 2003).

ii) Affordances signify "possibilities for action" (Stoffregen 2003) and exist whether perceived or actualized.

iii) Action possibilities are finite.

iv) An actor's behaviours are always goal-driven.

Affordances are commonly defined as "potential behaviours linked to achieving an immediate outcome, emerging from the relationship between an artifact and a goal-driven actor" (Strong et al. 2014, p. 4). Actualization means that a user transforms this potential into tangible action. AAT identifies three pivotal factors guiding individuals in the affordance actualization process: *i)* their inherent abilities, *ii)* the characteristics of the technology, and *iii)* the working environment. Researchers in information systems have sought to comprehend the conditions that enhance the actualization of affordances in specific contexts (Chatterjee et al. 2015; Hausvik and Thapa 2016). Similarly, this study delves into the process of actualization of affordances, complementing it with the concept of Affordance Actualization Potency.

Affordance potency (Anderson and Robey 2017) is an extension of the idea of affordance actualization and its factors, as defined by AAT. The concept of potency is defined as "the strength of the relationship between the abilities of the individual and the features of the system at the time of actualization" (Anderson and Robey 2017, p.

103). The potency of the affordance determines the probability of users engaging with it. This potency emerges "at the time of actualization" in a situated context, which includes the actual workplace environment, the actual abilities of the user, and their actual goals. The notion of *situated affordances* emerges from this contextualization to encapsulate all operating affordances, including those unexpected uses or outcomes that were not planned or intentionally included in the design of the system. Situated affordances and their potencies only emerge at the time the system is being used by the actual users, in the actual conditions. Figure 3 schematically presents this model.

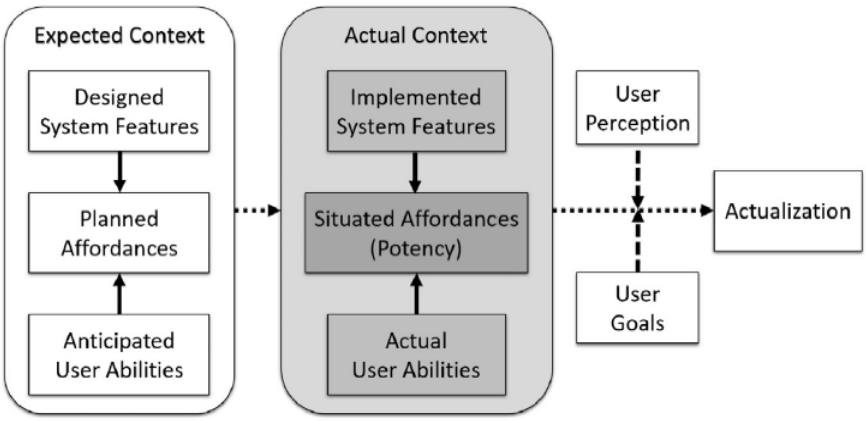

Figure 3 - The model of affordance potency (Anderson & Robey, 2017)

The concept of affordance potency has been used in empirical information system intervention settings (Anderson et al. 2019). This approach is particularly relevant in unpredictable humanitarian workplaces, where assessing the potency of situated affordances can provide valuable insights for understanding the likelihood of adoption in complex settings.

The concept of affordance potency has been used in empirical information system intervention settings (Anderson et al. 2019). This approach is particularly relevant in unpredictable humanitarian workplaces, where assessing the potency of situated affordances can provide valuable insights for understanding the likelihood of adoption in complex settings.

2.4 The combined analytical process

This research analysis responds to the call by Burton-Jones and Volkoff (2017) to develop contextualized theories of effective use. However, when tailoring research to humanitarian settings, there's a heightened need to grasp the unique aspects of the context, especially when juxtaposed against standard office and desktop-centric organizational environments. Thus, my analysis weaves together contextual factors, viewing them as an amalgamation of institutional and material conditions (Avgerou 2019).

To emphasize the importance of contextual analysis, I incorporate an initial step to scrutinize the environment in which users' function before delving into the interactions and objectives of the digital system. This refined method comprises four stages: the

preliminary step (Step 0) is my contribution, followed by the trio of steps suggested by Burton-Jones and Volkoff (2017) to contextualize EUT:

0. *Understanding how the environment affects the organization and system goals.*
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.

2.1.4 Division of labour: which theory does what?

The theories presented herein facilitate a comprehensive understanding of the phenomenon by integrating various frameworks, each aptly suited for dissecting different project stages and levels—ranging from broad organizational perspectives to specific end-user processes. The theory of effective use serves as the primary scaffold for this research. It is synergistically paired with both institutional theory and affordance actualization theory to enrich distinct phases of the analysis. In essence, this research melds the theory of effective use with:

- Institutional theory, to identify drivers and stressors for effective use from a global perspective through a lens of institutional logics.
- Affordance actualization theory, to contextualize effective use and analyse the concrete challenges of field users when using technology.
- Affordance potency, to analyse the factors for high likelihood of actualization of affordances.

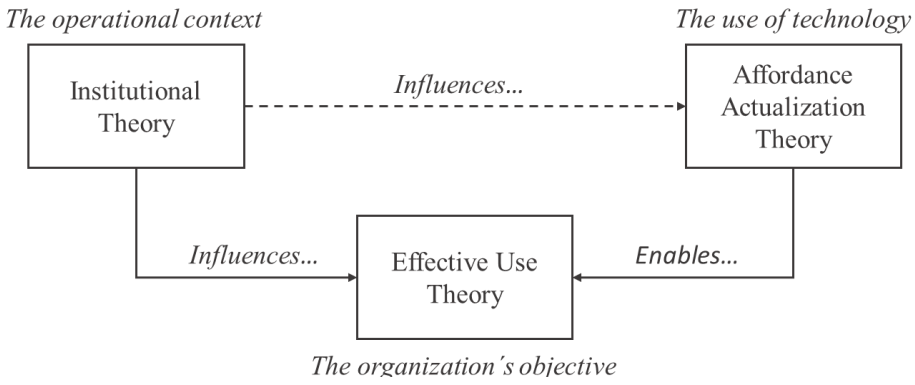

Figure 4 - Overall analytical process

The analytical framework is illustrated by the diagram above. On the left, institutional theory is depicted as the overarching theory employed to dissect both organization and context. This investigation aids in elucidating the catalysts and external stressors pertinent to effective use. On the right, Affordance Theory is leveraged to a) conceptualize effective use within field settings, and b) scrutinize the nuanced processes of technology utilization within the humanitarian context. At the core,

'effective use' acts as the theoretical nexus, seamlessly bridging both theories and their respective applications.

This combination of institutional theory and affordance actualization theory forms the analytical lens through which I explore the broader question of:

> *What constitutes effective use of a health information system in a humanitarian organization?*

And its sub questions guiding the enquiry:

1. *What are the specificities of the institutional context and what is their impact on effective use?*
2. *What are the operating affordances and how the institutional context shapes the process of actualization?*
3. *How can the theoretical model for effective use be made relevant for humanitarian settings and diverse context?*

The argument is that environmental stressors can hinder the realization of affordances, which directly impacts effective use. This argument is based on the following assumptions:

- The environmental stressors of the humanitarian setting can impact system use, which is conceptualized as affordance actualization.
- Institutional conditions have the potential to affect affordance actualization.
- Effective use can be conceptualized through affordances, which implies that effective use requires affordance actualization (Burton-Jones and Volkoff 2017).

The theoretical underpinnings for these assumptions guiding each of the analytical steps, are developed next.

0. Understanding how the environment influences system use (Institutional theory)

The contextual elements in this study encompass both institutional and material conditions. Institutional factors pertain to the organization's social orders, norms, values, and practices that influence the dynamics of the information system. Conversely, material factors allude to the technological infrastructures, the tangible conditions of existence, and the physical attributes of the geographic locale surrounding the IS (Avgerou 2019).

Avgerou (2002) suggests that technology can serve as an institution, influencing the transformation of organized activities within society. Elaborating on this, Piotti et al. (2006) incorporates the roles of information and communication technologies along with the formal and informal practices that shape their utilization. By extending this perspective to organizational behaviour and transformation, the information system can be perceived as an institution where users are autonomous entities capable of impacting organizational conduct. This viewpoint acknowledges their agency and

potential to sway the institution. The concepts used in this theoretical framework are outlined Figure 5.

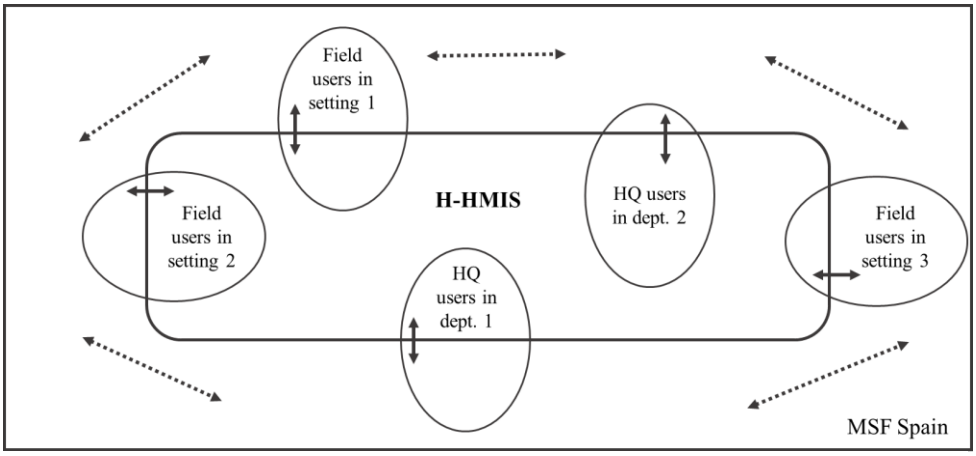

Figure 5 - An institutional conceptualization of the H-HMIS

The primary rectangle that encircles the figure symbolizes the organizational field, where each one of the ellipses represent an organization, understood as a specific type of users in every different setting and level of operation. Each one of the organizations is a use case, with individual agency and capability for action. The central rounded rectangle represents the H-HMIS understood as the institution, and its intersection with the ellipses -organizations- represents the use of the system, the interaction between the users and the H-HMIS. The H-HMIS possesses specific functionalities and constraints which might not adequately cater to every use case. In their daily operations, users who deem the system unfit will seek alternative methods and push for modifications. This represents the conflicting logics between each organization and the institution, leading to institutional contradictions—depicted by the arrows inside each ellipse.

The alignment between the H-HMIS functionalities and the requirements of the varied use cases is uneven. This disparity in alignment between the institution and the different organizations is depicted graphically: an ellipse almost outside the rounded rectangle symbolizes an organization where the system does not meet its needs well. In contrast, an ellipse largely inside indicates a strong alignment between user needs and system features. However, these needs might diverge across use cases. Therefore, potential institutional alterations introduced by one organization, may, or may not, benefit the others. When discrepancies arise, users might tailor the system to their needs, potentially clashing with the logics of other users. To summarize, user groups interact with the system within the organizational field's domain. This interaction of clashing logics can reshape the institution, resulting in changes either beneficial or detrimental to other users. The figure indicates these contradictions with discontinued dashed arrows.

The conceptual framework rooted in institutional theory is apt for deciphering the intricacies of this case study. It offers concepts to comprehend and dissect the potential impact on effective use of the information system. The research issue is embedded

within the broader actions of the humanitarian organization. Yet, the research's unit of analysis centres on information management processes in the field. Here, a spectrum of users, each with distinct skills, information needs, and work environments, profoundly influences the phenomena being examined.

A global perspective helps pinpoint the primary challenges impacting system usage in a worldwide humanitarian organization. Analysis outcomes will guide the identification and role of stressors when situated in the field in later stages. Upon identifying institutional logics that could shape system usage, my focus shifts to the field setting. Initially, the research design aimed to study multiple field settings to gauge institutional contradictions' interplay within the institution and among organizations from a broad standpoint.

However, the realities of humanitarian fieldwork combined with the constraints of the COVID-19 pandemic curtailed the scope, confining the project to a single setting. The Methods chapter provides a detailed explanation. From a theoretical stance, this restricted the study to the preliminary phase, concentrating on deciphering global institutional logics and their impact on system usage. Nevertheless, the analysis yielded insightful findings, shedding light not just on system usage determinants but also on environmental factors influencing system components for effective use. Therefore, institutional theory remained an integral part of this thesis.

Having explored the organization's broader framework, I now narrow my focus to a singular field setting for the empirical contextualization of effective use. Specifically, I centre my analysis on the processes surrounding field data management using the H-HMIS.

1. ***Understanding how a network of affordances supports the achievement of organisational goals (TEU and AAT)***

In line with the methodology proposed by Burton-Jones and Volkoff (2017) for contextualizing IS theories, the foundation of this analysis is built upon concepts from the affordance actualization theory. This theory zeroes in on the user-system interaction within the workplace, pinpointing how affordances culminate in effective use. To discern how a network of affordances aligns with organizational goals, two steps are paramount: first, identifying the affordances within the workplace, and second, correlating them to the organizational objectives. This analytical approach leans on the concept of situated affordances, derived from the potency framework (Anderson and Robey 2017). The goal is to recognize not just the system's intended uses but also those unintended ones that manifest within specific contexts. Through this lens, I craft a model of effective use for the humanitarian field setting, which integrates the network of affordances geared towards achieving organizational goals.

With this rationale, the concept of actualization—defined as the actions undertaken by actors—equates to the real-world usage of the H-HMIS. Hence, the effective use of H-HMIS translates to the heightened actualization of affordances across as many settings as possible. The challenge inherent in this analysis is pinpointing those specific affordances and gauging their degree of actualization within the chosen study setting.

2. ***Understanding how the affordances are actualised in context (Institutional theory and AAT)***

The mechanisms explaining how environmental conditions correlate with the studied phenomena predominantly concentrate on the behavioural influence of these contextual conditions on all stakeholders within the system, which includes system developers, managers, and users (Avgerou 2019). The influence of the work environment on the actualization process is derived from the preceding institutional analysis. For the field user level analysis, I explore the actualization process and its susceptibility to the institutional conditions defining the context. I adopt an institutional shaping perspective to investigate the affordance actualization process and the unique challenges that the humanitarian context introduces.

At this juncture, I introduce the concept of affordance potency, as defined by Anderson & Robey (2017), which denotes the probability of an affordance of being actualized or not in a given context. In a humanitarian environment, systems ought to offer pronounced affordance potency, signifying a strong likelihood of affordance actualization. The significance of affordance potency in achieving effective use is straightforward. As per the proposed theory of the effective use model, actualizing a hierarchy of affordances culminates in meeting organizational goals, thereby achieving effective use. Elevated affordance potency equates to a higher actualization probability, which translates into improved effective use.

The theoretical model for effective use earmarks learning, adaptive actions, and feedback as catalysts for enhancing effective use. This suggests that both learning and adaptive actions amplify affordance potency, thereby raising the likelihood of actualization. Nevertheless, the humanitarian context tests these tenets. Deciphering how to ensure high affordance potency without heavy reliance on training or modifications is central to my analysis. This emphasis establishes affordance potency as a pivotal concept when unpacking the dimensions of effective use.

3. ***Using inductive theorizing to analyse the principles for effective use in a given context***

The analytical process for theorizing the principles of effective use within a humanitarian context is detailed in Chapter 5 - Research Analysis and Findings. This study integrates various inductive theorizing methods across the four described analytical phases. It initiates a retrospective examination at the organizational level, which shapes the positioning of the IS as an institution and delves into factors influencing the system's design, implementation, and adoption. Subsequently, a more granular analysis examines users and their technological interactions. Drawing insights from prior phases, a sharper focus then centres on a specific user group: health workers in hospitals performing routine data collection tasks. In this study's culmination, insights from the field-based analysis elucidate the prerequisites for effective H-HMIS use and the extent to which the existing theory can guide organizational improvements in field systems.

It could be contended that my approach doesn't align strictly with the pure inductive theorizing as described by the Grounded Theory Method (GTM) (Glaser et al. 1968). While I didn't develop a theory exclusively explaining the observed phenomenon, I did employ my theoretical lens as a sensitizing device to identify issues of importance. Issues that arose inductively from empirical data collected during distinct analytical exercises, such as identifying environmental logics, the situated affordances at varying operational levels, and analysing the actualization process with its contextual challenges. Ultimately, I formulated principles defining effective use in humanitarian contexts, aiming not for theory validation but for its expansion to include novel settings of humanitarian organizations.

Thus, my approach can be considered a hybrid, steered by inductive theorizing principles. Theory served as a bridge in enabling conversations between the theoretical constructs I held and the empirical realities under investigation (Maanen et al. 2007) to contextualize effective use.

2.1.5 Combination of theories: A map is not the territory

The synthesized theories here originate from seemingly contrasting ontological bases, which might prompt reader reservations. While 'effective use' is often anchored in largely positivist research principles and quantitative methods, both institutional and affordance theories predominantly thrive within the interpretive realm, underpinned by qualitative methods. Effective use, rooted in Representation Theory, emphasizes representational fidelity as crucial. Understood as "the truth, the whole truth, and nothing but the truth" (Burton-Jones and Volkoff 2017, p. 475), this notion operates on the premise of a singular truth awaiting representation. This sharply contrasts with this study's interpretivist stance, which perceives reality as malleable and shaped by collective human beliefs and behaviours (Walsham 1993).

This research recognizes and builds on the idea that Information Systems (IS) represent reality, and that users respond to these representations. However, I align with the notion articulated by philosopher Korzybski (1931): "A map is not a territory." This emphasizes the need for critical thinking about the discrepancies between reality and its representations. Similarly, surrealist artist René Magritte, discussing his 1929 painting "The Treachery of Images" (often referred to as "This is not a pipe"), remarked, "Perception always intercedes between reality and ourselves." Within the context of information systems, this perspective aligns with the idea that data is inherently partial. The processes of data collection, conceptualization, and utilization contribute to its divergence from tangible reality (Jones, 2018), thereby challenging the concept of a singular, absolute truth.

In my research, this philosophy applies at two distinct levels. Firstly, my data and findings, anchored in the interpretivist approach, are crafted from both participant insights and my own interpretations (Walsham 1993). Secondly, the data curated, and representations generated by the information system—presented to targeted users—are, as previously noted, intrinsically partial due to both humans and digital processing (Jones 2018). In both contexts, I contend that these representations aren't exact

reflections of reality but rather individual interpretations of it. These representations can spotlight certain facets while inevitably obscuring others. For example, when examining my results, the theory of effective use provides insights on optimizing system usage to enhance organizational performance. Yet, in my observations, it doesn't address the system's potential to better clinical patient care. Similarly, while an information system might adeptly depict aspects of a health scenario, such as epidemiological outbreak trends, it might overlook cultural elements influencing disease transmission, such as local burial rituals.

Revisiting the map metaphor, Korzybski posited, "A map is not the territory it represents, but, if correct, it has a similar structure to the territory, which accounts for its usefulness"(Korzybski 1931). This utility is precisely what Bonaretti and Piccoli (2019) aimed to achieve when they introduced situational awareness as a substitute for representational fidelity, adding a third dimension to effective use (Bonaretti and Piccoli 2019). In emergency contexts, which these authors describe as chaotic environments, the domain an information system strives to represent is frequently ambiguous. Determining what qualifies as informed action becomes challenging, and expectations of representational accuracy wane (Bonaretti and Piccoli 2019). I view this as a pivotal move in approximating the theory of effective use to interpretive research.

The theory of effective use has faced criticism for its primary focus on individual users, often neglecting the broader social context of information system utilization. Furthermore, it lacks specificity in guiding enhancements to the effective use of such systems. While the theory provides overarching insights on user-system interaction optimization, it falls short of detailed directives for refining system design or execution. I believe the amalgamation of the theories presented here holds promise in addressing these shortcomings. The triad of the theory of effective use, institutional theory, and affordance theory furnishes holistic views on information system analysis. By intertwining these theories, I achieve a richer grasp of this multifaceted phenomenon under study. This encompasses understanding system usage and the tangible interplay between users and technology (affordance theory and effective use theory), discerning how they shape individual behaviour, identifying the external factors that mould the systems (institutional theory), and recognizing the personal and organizational mechanics driving performance (effective use theory and affordance theory).

Monteiro et al. (2022) advocate for the research community to retain flexibility in comprehending emerging phenomena. They underscore the value of using theories as temporary "scaffolds" while useful, emphasizing that no single theory reigns supreme but rather various lenses can co-exist to provide richer interpretations of the world (Walsham 1993). They further highlight the benefits of employing diverse theoretical bases and frameworks, which can offer myriad perspectives and bolster a range of concepts (Markus 1997). Integrating non-neutral and notably distinct approaches might introduce challenges and discord, but such synergy also holds the potential to unlock new vistas and enrich academic understanding (Monteiro et al. 2022).

This work responds to the authors' compelling call for innovative approaches in two significant ways. First, it synthesizes theories that, at their core, have differing ontological assumptions, yet it aligns them without inherent contradiction. Second, while this research is not plural methodologically and maintains an interpretivist approach, predominantly employing qualitative methods, its concluding contributions advocate for a mixed-method analytical process. This approach leverages the strengths of each theoretical perspective, guiding both researchers and practitioners in their pursuit of effective information systems.

This chapter has introduced the analytical process and theories employed in this research project. It takes into account the limitations of both the approach and theories proposed, as well as their amalgamation. In summary, the analytical process and the combination of theories offer a sensitizing lens to studying the H-HMIS within its contextual framework. This perspective spans both a broad, high-level environmental viewpoint that encompasses organizational and environmental characteristics, and a granular, low-level perspective that delves into user interaction with the technology, influenced by environmental conditions. The practical implementation of this lens within the context of a humanitarian intervention is a question that will be addressed in the subsequent chapters of this thesis: the research context, followed by research methods.

3 Research Context

The empirical setting for this thesis is the humanitarian organization called MSF Spain, and their global health management information systems. The academic context is the Health Information Systems Programme (HISP) group at the University of Oslo, and the technological context is provided by the DHIS2 software. To provide an initial introduction and understanding of the setting, I will first introduce HISP and the DHIS2 software. Then, I will shed light on the humanitarian organization and the specific field mission that formed my empirical core. I will wrap up with a synopsis of the information system in question and the technical intervention undertaken in this project.

3.1 HISP and DHIS2

3.1.1 The HISP Programme

The Health Information Systems Programme (HISP) is a research group based at the University of Oslo, Norway. It began in the mid-1990s as a joint effort between the University of Cape Town in South Africa and the University of Oslo, set against the backdrop of post-apartheid South Africa. HISP's core mission revolves around fortifying health information systems in developing countries. This mission advances along three parallel paths: the creation of the DHIS2 software, the orchestration of the HISP community and capacity-building centred on DHIS2 software implementations, and research and education that enrich both technological advancements and field implementations.

From its early days, HISP adopted action research as its guiding methodology, aiming to enhance health information systems through research initiatives. As a research entity, HISP's commitment to Action Research is foundational. These roots emerge from Scandinavian critical research projects that emerged with the Norwegian Iron and Metal Workers Union. Central to these project efforts was an emphasis on user participation and emancipation, as seen in Bødker et al.'s work (1988). This critical approach was instrumental in moulding the evolution of health information systems in post-Apartheid South Africa, setting HISP on its trajectory as a transformative force. Over the years, HISP launched a series of educational programs at the Masters and PhD levels, weaving in insights from prior action research initiatives. It integrated professionals from these research settings into research roles, forging a nexus between scholarly inquiry and practical HIS endeavours. This synthesis has deeply informed HISP's action research methodology. Today, the HISP research team is a diverse cohort of medical doctors, informaticians, and experts deeply rooted in their respective nations' contexts. Together, they champion the development and deployment of health information systems, fostering a holistic understanding of systems development.

Emphasizing capacity building and strengthening of south-south collaborations, paired with the imperative to build operational capability in developing countries, led to the inception of the HISP network. This locally-rooted network encompasses HISP groups predominantly situated in Sub-Saharan Africa and Southeast Asia, with recent

extensions to Latin America and the Caribbean. Currently, twenty HISP groups1 operate globally, facilitating DHIS2 deployments across over 100 countries2. These groups, embedded within Ministries of Health, universities, or functioning as standalone entities, meld academic and operational dimensions. The academic facet features researchers and scholars, while the operational side houses information systems implementers, software developers, and public health experts (Adu-Gyamfi et al. 2019). Collectively, they converge on the shared ambition of strengthening health information systems via open-source technology and nurturing DHIS2's evolution as a digital global good.

The central HISP UiO group is responsible for coordinating the development of the DHIS2 technology and overseeing the HISP community. The primary objective of the HISP community is to enhance capacity building centred on the DHIS2 software and to assist with its implementation. The HISP UiO group plays a crucial role in coordinating HISP groups and fostering collaborations with other global health organizations. Technical assistance and research and education programs are provided at the country-level DHIS2 implementation, within a framework of action research. Currently, HISP UiO has over 150 employees (HISP-Centre 2022), including academic members, and its academic and research programs have produced over 500 master's degree graduates and over 60 PhDs2.

3.1.2 The DHIS2 Software

The guiding principle of DHIS2 is its open-source and community-driven approach. It is a generic software adopted by Ministries of Health and NGOs to support health management and various other activities (Adu-Gyamfi et al. 2019; Nicholson et al. 2019). DHIS2 offers a comprehensive suite of functionalities for information management, streamlining the processes of data collection, storage, validation, analysis, and presentation. It functions as a data warehouse and can be tailored to integrated health data management systems (Braa and Sahay 2017) as well as specific data collection needs like immunization, surveillance, or maternal health programs.

Over the past decade, DHIS2 has gained global recognition, with its application extending beyond Ministries of Health. It's now utilized by global entities such as the World Health Organization (WHO), the Pan American Health Organization (PAHO), UNICEF, and the Centre for Disease Control and Prevention (CDC). Moreover, governmental development initiatives like the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) have adopted DHIS2 for reporting purposes. Its reach has also encompassed international non-governmental organizations (NGOs) like Médecins Sans Frontières (MSF), the International Committee for the Red Cross (ICRC), and

[1] https://dhis2.org/hisp-network

[2] https://www.mn.uio.no/hisp/english/about/facts

Population Services International (PSI), all of which have integrated DHIS2 into their programs.

This research project develops around the routine information system of MSF, which employs DHIS2 across both its web and mobile platforms. Consequently, DHIS2 constitutes a pivotal aspect of the technological context of my research. Detailed descriptions of the organization, the information system, and the technical interventions will follow in subsequent sections.

3.2 The Humanitarian Organization

3.2.1 Médecins sans Frontières

Doctors Without Borders (MSF) is an international medical humanitarian organization offering emergency aid to "people affected by armed conflict, epidemics, and natural disasters, based on needs irrespective of race, religion, gender, or political affiliation"[3]. MSF provides assistance to field operations globally. Spanning all five continents and has been engaged in these efforts for over five decades.

The international MSF movement comprises 25 sections of associations worldwide[4], each functioning as an autonomous entity with its elected president and board of directors. The current MSF associations are located in Australia, Austria, Belgium, Brazil, Canada, Denmark, France, Germany, Greece, the Netherlands, Hong Kong, Japan, Italy, Luxembourg, Norway, Southern Africa, Spain, Sweden, Switzerland, the United Kingdom, and the USA.

Each MSF association is linked to an Operational Centre responsible for managing field interventions and determining the necessary interventions and medical assistance. The current operational centres include Belgium (OCB), France (OCP), the Netherlands (OCA), Spain (OCBA), Switzerland (OCG), and West and Central Africa. Each Operational Centre functions independently and has a global reach, without specific distribution of regions or countries. This project is associated with the MSF Spain section, specifically the Operational Centre Barcelona-Athens, which I will refer to as MSF Spain – OCBA.

MSF International safeguards the identity of the movement and consists of all MSF associations. Its highest authority is the International General Assembly, which includes the International President, representatives from the associations, and individual members. The general assembly holds responsibility for MSF's medical missions and provides strategic guidance to all MSF entities. Figure 6[5] depicts the

[3] The Médecins Sans Frontières Charter https://www.msf.org/msf-charter

[4] https://www.msf.org/

[5] https://www.msf.org/sites/default/files/2022-06/msf-governance.pdf

governance structure of MSF, from MSF International, to the Operational Centres and associated sections.

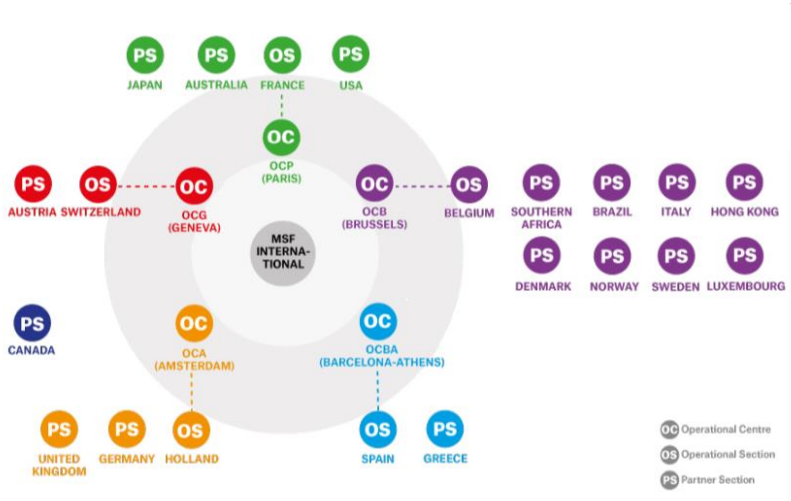

Figure 6 - MSF International Governance Structure

In 2022, MSF International delivered humanitarian aid in over 77 countries: 55% of the interventions took place in Africa, 13.7% in the Middle East, 13.1% in the Asia-Pacific region, 9.1% in the Americas, and the remaining 8.9% in Europe. The contexts of these interventions were categorized as 39% stable, 30.1% in armed conflict, 27.2% in situations of internal instability, and 3.7% in post-conflict or other situations (MSF International 2022). MSF Spain has contributed to this global response by deploying interventions in 26 countries facing emergencies caused by armed conflicts, epidemics, nutritional crisis, natural disasters, social violence and exclusion from health care shown in Figure 7. The map displays all MSF interventions in black and those where there are interventions managed by MSF Spain in red (MSF Spain 2022).

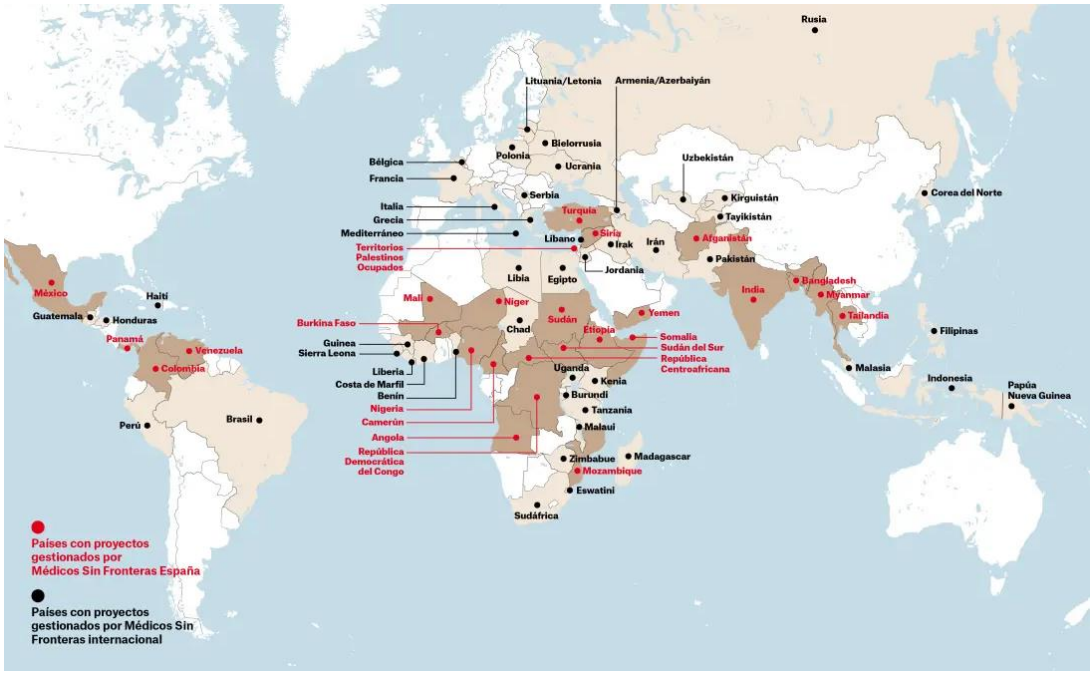

Figure 7 - Operational map MSF International - MSF Spain

MSF Spain – Operational Centre Barcelona-Athens

At the headquarters, each operational centre oversees its interventions through specific operational cells and a single emergency unit. While the operational cells handle a set of long-term interventions, the emergency unit is tasked with managing the initial response teams for global humanitarian emergencies. Essentially, they handle the most immediate crises within larger emergencies. Projects within the emergency unit can either open and close based on the urgency or evolve into long-term interventions, at which point they are transferred to an operational cell. Table 2 summarises the distribution of interventions into Operational Cells and the Emergency Unit.

Operational Cell 1	**Operational Cell 2**	**Operational Cell 3**	**Operational Cell 4**	**Operational Cell 5**	**Emergency Unit**
Palestine Syria Yemen	Burkina Faso Mali Nigeria Niger	Cameroon Democratic Republic of Congo Central African Republic Thailand Myanmar	Colombia México	South Sudan Sudan Somalia	Mozambique Ukraine Turkey Angola

Table 2 - Operational Cells in MSF Spain OCBA

Within MSF, field interventions are referred to as 'missions', which typically align with specific countries. Each mission maintains a coordinating office, usually located in the capital city of the respective country. These coordination offices serve as the hub for directing field projects. Furthermore, field projects function with their own sub-coordination teams, who oversee both the projects and the associated healthcare facilities. A simplified diagram of the structure of field operations can be found in Figure 8.

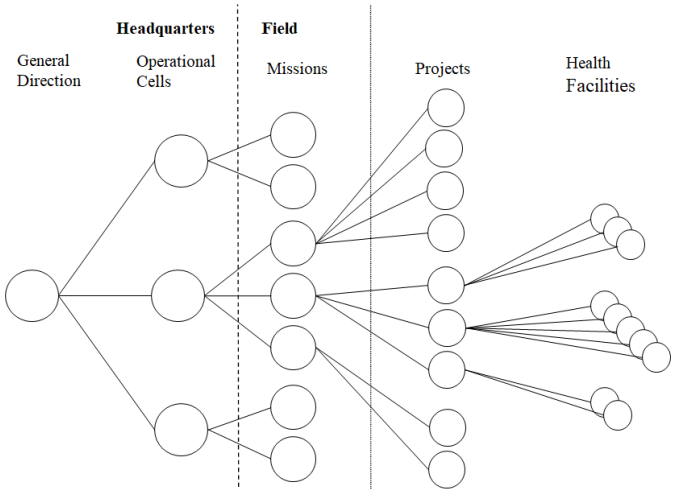

Figure 8 - Simplified diagram of field operations structure

This research project was conducted at both the headquarters and field operations of the operational centre in Barcelona, Spain. At the headquarters, three departments participated in the H-HMIS project, each becoming involved at distinct phases of the research study.

- Medical department: The Medical department requires health data to ensure adherence to standards and to maintain the quality of medical operations, among other purposes.
- Operations department: This department serves as the bridge between the field and headquarters, requiring real-time access to cross-sectional information to support the management of interventions.
- e-health unit (General Direction): This team provides technical solutions to operations and the medical department. The HMIS team is a multidisciplinary team inside the e-health group.

The main part of my work in the field developed in one mission and one project. Both are introduced in the following section.

3.2.2 The Field Setting

At the beginning of the project, the selection of the research field from among all the missions and projects of MSF Spain was conducted in collaboration with the organization. The primary aim was to design a research initiative that was both operationally viable and insightful regarding the phenomenon being studied. All missions of MSF Spain were considered, with the exception of francophone settings due to my language constraints. The criteria used in the setting selection process is summarized in Table 3. The resulting selected mission was South Sudan.

Criteria	**South Sudan Mission**
Stability of mission context	Internal conflict and instability
Variety of projects	Regular projects and short-term in-country emergency interventions
Type of health facilities	Hospitals, health centres, outreach mobile clinics
Services provided	Vertical programs, primary and secondary health care, community, and outreach activities,
Volume of activity	Relatively stable facilities and health services were not overloaded on a regular basis
Status of HMIS	HMIS remotely deployed in 2015.
Operational strategy	Long-term mission

Table 3 - Criteria for field setting selection

The South Sudan Mission

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). MSF International has been present in the areas that now constitute South Sudan since 1983. MSF Spain has been active there since 2004, and four other Operational Centres (OCs) are also currently engaged in the country.

In September 2018, key factions in the conflict came together to sign a peace agreement, outlining crucial conditions to be realized by 2019. Unfortunately, the stipulated terms went unfulfilled, leaving the country's situation largely unchanged. The displaced masses remain in camps, grappling with inadequate services and a stark lack of primary and secondary healthcare. Another agreement in 2019, however, did succeed in halting the hostilities. However, intercommunal violence, revenge killings, and cattle rustling continued, causing many victims across the country[6].

In 2021, South Sudan grappled with a confluence of crises, from widespread flooding and surges in violence to food shortages and disease outbreaks. It was estimated that 8.9 million individuals — representing over two-thirds of the nation's population — were in dire need of humanitarian aid[7]. Throughout the year, MSF Spain concentrated its efforts on enhancing its emergency response capabilities. This involved meticulous preparation, vigilant monitoring, comprehensive evaluation, and timely intervention. MSF Spain also committed to bridging healthcare gaps and amplifying the efficacy of its operations. A particular emphasis was placed on secondary care, chronic diseases such as HIV, TB, and kala azar, and support for trauma and sexual violence victims in conflict zones. The organization also championed innovative community health strategies and prioritized preventive measures against leading fatal illnesses like malaria, respiratory tract infections, and diarrhoea (MSF Spain 2021).

The following field projects were active in South Sudan during the duration of this research (2017-2023) and involved on the study:

- Yambio [Closed 2018]: Testing, diagnose, and treatment of chronic diseases (HIV).
- Aburoj [Closed 2019]: Provided medical care for the population affected by the conflict.
- Malakal [Active]: Provided free and quality healthcare to victims of the conflict.
- Ulang [Active]: Provided medical care for the population affected by the conflict.
- Emergency team [Active]: Internal team for local emergencies.

[6] https://www.msf.org/south-sudan

[7] https://news.un.org/en/story/2022/03/1115212

My involvement with the South Sudan mission remained consistent throughout the duration of this project, though the extent of my engagement with specific projects fluctuated. Initially, my attention was centred on two projects in the northern Greater Upper Nile Region, as well as the coordination office in Juba. The first project, in Malakal, was a long-standing operation that oversaw activities in two hospitals and four mobile clinics. In contrast, the second project in Aburoj was an emergency response, managing one hospital and two mobile clinics. Another project in the Western Equatoria state, Yambio, was initially within the research's scope. However, due to operational instability during the planned field visit timeframe, it became infeasible to visit, and the project eventually closed in 2018. Figure 9 shows a map with the locations of the projects and the country coordination office in Juba.

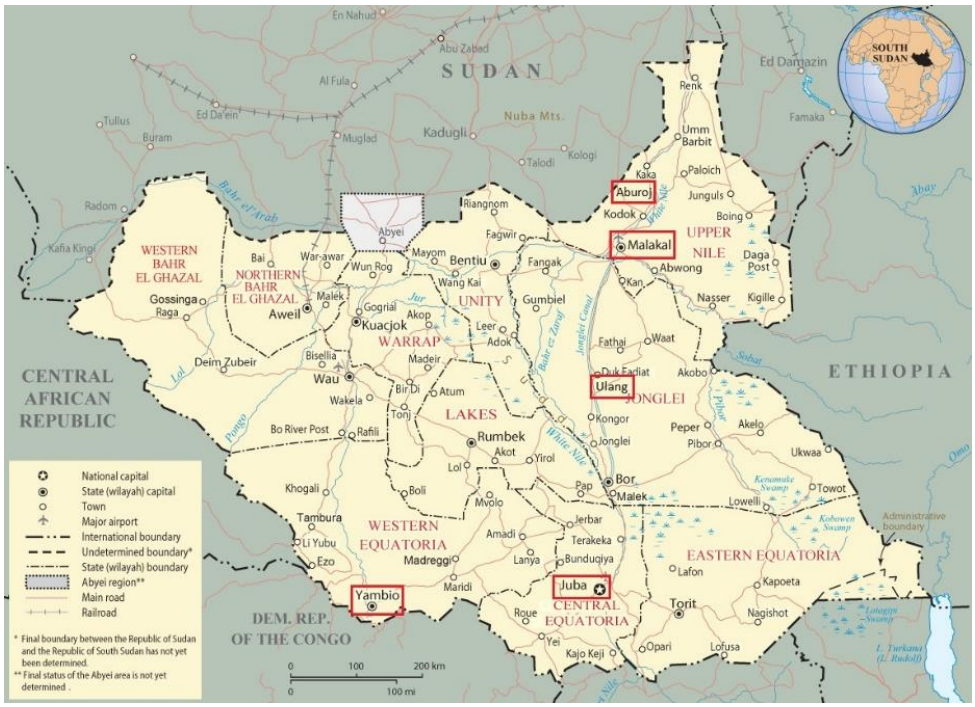

Figure 9 - Operational map MSF Spain South Sudan mission

Both the Aburoj and Malakal projects were included in my initial field visit. However, Aburoj closed shortly after that visit, leading to the opening of a new emergency project in Ulang. My second visit encompassed both the Ulang and Malakal projects. Of these, Malakal has maintained its operations most consistently, even though its facilities and services underwent changes over the past four years. Consequently, Malakal serves as the primary research setting, and it was there that the specific technical intervention took place.

Beyond the South Sudan mission and its projects, there was an agreement to incorporate at least one emergency response intervention into the study. In this intervention, my role would be dual: to support the response team with data collection and analysis, while simultaneously gathering data for my own research. The specifics of this emergency response intervention were left open-ended at the project's onset, given the unpredictable nature of emergencies. Regrettably, due to conflicts between emerging opportunities in the project's early years and my personal availability, this

intervention did not materialize. My commitments during the development of this PhD project, combined with the unpredictability of the intervention, precluded participation in the few emergency opportunities that arose. These challenges were further exacerbated post-2020 by the COVID-19 pandemic, resulting in the exclusion of an acute emergency context from the study.

The Project in Malakal

Malakal is capital city of the Upper Nile State, and the fourth largest city in South Sudan with an estimate of 160,765 population[8]. Initiated in 2013, this project aims to reduce morbidity, mortality, and suffering among vulnerable populations in the counties of Malakal, Akoka, and Balliet.

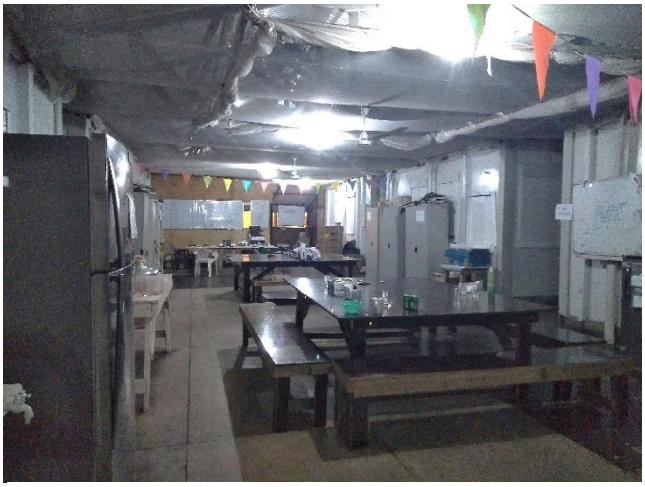

Figure 11 - MSF Project office and staff house in Malakal PoC

Figure 10 - Malakal UNMISS PoC Layout (IOM 2021)

The project office and staff house (Figure 10) is located in the humanitarian hub of the UN Mission in South Sudan (UNMISS) base in Malakal which hosts a Protection of Civilians Camp (PoC) since 2013 (Figure 11). The population of the camp are 34.056 civilians[9]. In a context of internal instability, the project targets a diverse population, including both the general public and those internally displaced, as well as victims of armed conflict. The intervention addresses humanitarian needs that arise from continuous internal displacements, a deteriorating humanitarian situation stemming from a prolonged reliance on external aid, the population's limited adaptive and coping mechanisms, and ongoing local violence.

In Malakal, MSF Spain oversees health activities in two secondary healthcare hospitals: one within the Protection of Civilians (PoC) site and another in Malakal Town. These facilities offer emergency room services as well as inpatient care, catering

[8] https://www.geonames.org/

[9] Danish Refugee Council headcount 2021

to adults, paediatrics, neonates, and nutrition needs. Additionally, they deliver primary healthcare services, covering programs related to tuberculosis, HIV, Hepatitis B, and kala azar, as well as support for victims of sexual violence and mental health patients. The team also spearheads community initiatives focused on preventive and curative measures for malaria, respiratory tract infections, and acute watery diarrhoea– the predominant life-threatening diseases in the region.

Figure 12 - Malakal Town and Malakal PoC Hospitals

Figure 13 - The Adults and Paediatric Wards in Malakal PoC Hospital

3.2.3 The H-HMIS Project and the Mobile Data Collection Intervention

The move to digitize traditional paper-based reporting in humanitarian systems seeks to improve the data efficiency and accuracy. Presently, health information, along with the technical tools that support its collection, processing, and analysis, play an integral role in humanitarian healthcare (Van Velthoven et al. 2019). MSF Spain's H-HMIS is at the forefront of this digitization effort, streamlining its routine health data. This system is pivotal in enhancing the organization's health activities, promoting data-driven decision-making and management.

H-HMIS Project

In 2013, MSF Spain launched a project to create their new H-HMIS, built on the DHIS2 Software. By 2015, this system was implemented across all global missions. Today, the H-HMIS is functional in twenty countries, namely Angola, Burkina Faso, Central African Republic, Colombia, Democratic Republic of Congo, India, Mali, Mexico,

Mozambique, Niger, Nigeria, Palestine, Somalia, South Sudan, Sudan, Syria, Thailand, Turkey, Ukraine, and Yemen. The system has a total of 3,086 users combining headquarters, missions, and projects, and collects an average of 250,085 data values per week[10].

The system collects information from thirty-three domains, including:

- Health services/programs: mental health, antenatal care, postnatal care, external consultations, sexual violence, community activities, emergency room, observation room, inpatient wards (gynaecology and obstetrics, adults, paediatric, neonatology, surgical), intensive care units (adults, paediatric, neonatal), operating theatre, nutrition programs (ambulatory and inpatient), immunization, HIV/AIDS, tuberculosis, nutrition ambulatory, and viral haemorrhagic fever.
- Outbreak response: cholera, dengue, measles, meningitis, covid-19.
- Hospital services: infection and prevention control, laboratory/diagnostic services, medical imaging.
- Demographics and health structure information.

Most data are collected as aggregated datasets. However, certain health modules, such as mental health, sexual violence, and outbreak response programs, collect data at the individual patient level. As an outcome of this research project, the inpatient wards in the two hospitals in Malakal transitioned from digitizing data in weekly aggregated segments to individual patient records.

Though the system was globally deployed across all countries and projects by 2015, by 2017 MSF encountered challenges in its adoption at the field level. The deployment didn't fully achieve its goal of enhancing data usage and facilitating informed decision-making in the field. Feedback from field users indicated that the H-HMIS data primarily supported upstream reporting and accountability, rather than bolstering on-ground interventions. Consequently, field operations often persisted with paper-based and low-tech parallel solutions for activity monitoring and decision-making.

This scenario set the stage for the initiation of this PhD research project. It started with a broad objective to enhance the field users' experience with the H-HMIS. Through in-depth analyses and multiple visits to both the headquarters and field projects in 2017 and 2018, a diagnostic exercise was undertaken to pinpoint the challenges faced by field staff in using the H-HMIS.

Beyond challenges linked to system and infrastructure constraints, the data collection process emerged as a particularly cumbersome activity, hampering both user acceptance and data quality. Field data management was shaped by two pivotal aspects: the overarching institutional context, which set the data reporting standards for higher tiers, and the role of technology in the local field environment. The research

[10] HMIS usage statistics from April 2023

aimed to discern how the humanitarian context and its foundational principles influenced technology's role in field data management. Additionally, it explored ways in which technology could be better harnessed for value addition.

With this in mind, the decision was made to craft a mobile solution, serving as an extension to the existing DHIS2-based H-HMIS application. This solution would facilitate the daily collection of individual patient data. The conception, development, and fine-tuning of this intervention became a central part of my research project, which is elucidated in the subsequent sections.

The Mobile Data Collection (MDC) intervention

During the technical intervention, I collaborated closely with part of the H-HMIS team, which comprised a project manager, an epidemiologist, and an e-health technician. Together, we devised an intervention to pilot mobile technologies (tablets) with the aim of enhancing the data collection processes within the health facility. I lead the conceptualization, design, configuration, and implementation plan, as this formed the analytical crux of my empirical work.

The solution we proposed centred on deploying the DHIS2 Android application for individual patient data collection within the hospital wards. This individual patient data would then automatically generate the weekly aggregated information needed by the H-HMIS. This aggregated data provided insights into the facility's performance and the health status of the population, based on the profiles, diagnoses, and outcomes of admitted patients.

The existing data workflow in the facility was rooted in paper-based systems and spanned four stages. Upon a patient's admission to a ward, their clinical file was filled out (step 1), and an entry was made in the register book (step 2). It's important to note that the register book, also paper-based, was distinct from the clinical file. While the clinical file served medical care purposes, the register book offered a concise record, capturing essential information in a single line for each patient.

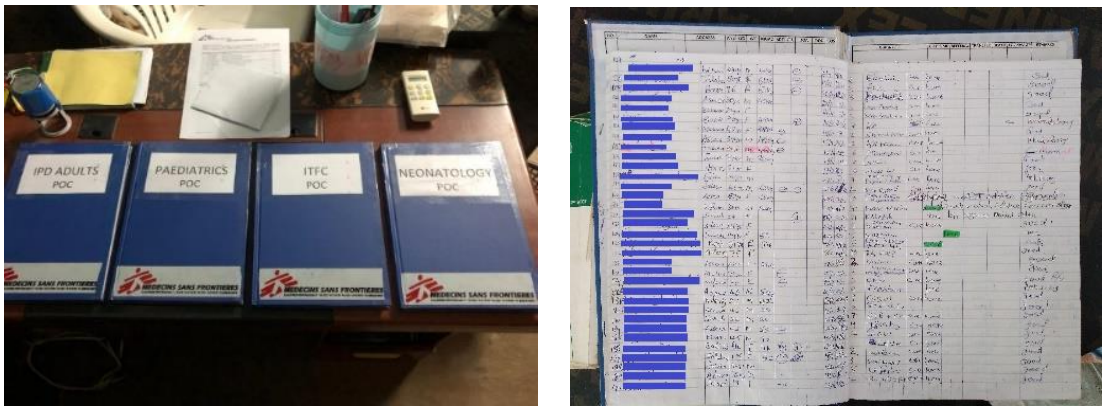

Figure 14 - The paper registry books

The subsequent stage was weekly data aggregation (step 3), sourced from the register book, typically conducted on Monday mornings to compile the previous week's data. Factors like age, gender, diagnosis, exit type, causes of death, and diagnostic test

results were aggregated. This task fell under the responsibilities of nurse supervisors, with support from a data collector when available. After the weekly data had been compiled, the tally sheets were submitted to the project for review and approval by the project medical referent. Only at this point was the data input into the H-HMIS system (step 4). This fourth step marked the initial interaction with the digital technology.

This four-step manual procedure was pinpointed by staff as notably cumbersome and difficult to integrate with their daily tasks. Described as repetitive, time-intensive, and susceptible to human error, the main challenge was the manual data aggregation process.

In response to these challenges, we designed a new tablet-based system to evaluate its potential in enhancing the data collection process. The solution sought to streamline the number of steps and reduce the time spent on data aggregation through two primary measures:

1) bringing digital data collection more proximal the medical activities,
2) integrating automatic aggregation of information from the patient records into the H-HMIS reporting system.

The data entry form on the tablets mirrored the registry book, featuring identical data entry fields. Figure 15 showcases the interface of the DHIS2 Android App on a tablet, placed alongside the registry book.

Figure 15 - The paper based and digital registry forms

The subsequent data collection process, when compared with the previous method, is illustrated in Figure 16. As depicted, the new system retains the initial steps: the manual completion of both the clinical file and the registry book.

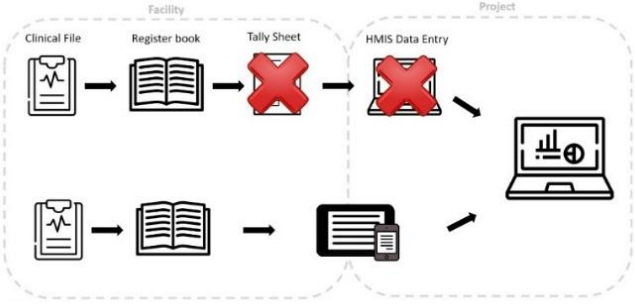

Figure 16 - The old and new data collection flows

The clinical file is inherently localized and challenging to standardize. Medical doctors frequently amend these files and carry them throughout the ward. Transitioning them to a digital platform would necessitate considerable effort and substantial alterations in the caregiving processes. The registry books were comparatively straightforward and their utilization systematic, the tablets could have fully replaced them. However, given the deep reliance of health workers on these registers, it was decided to phase them out in subsequent stages once users gained confidence in the new solution.

The new data collection was implemented in the inpatient services of the hospitals managed by the project, including:

- Malakal PoC Hospital: Neonatology, Paediatric Ward, Inpatient Therapeutic Feeding Centre (ITFC), Adults Ward.
- Malakal Town Hospital: Neonatology, Paediatric Ward, Inpatient Therapeutic Feeding Centre (ITFC).

In some cases, two services shared one physical ward but operated independently. The technology deployment was planned as represented in the images below:

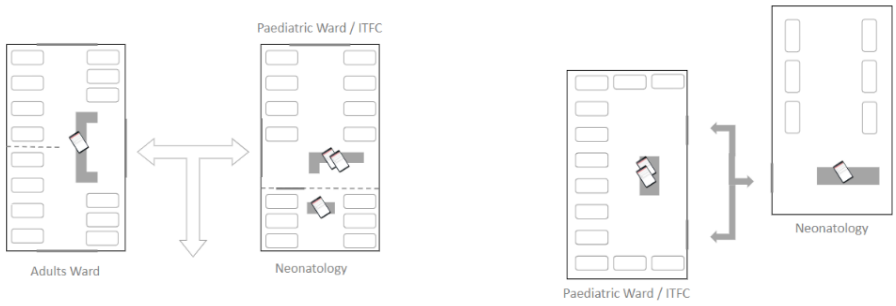

Figure 17 - Layout of the deployment of the mobile devices in the inpatient wards

From a research standpoint, the goal was to theoretically analyse the interaction between the user and the technology upon its introduction to the medical ward, comparing it to paper-based solutions. The mobile solution was successfully rolled out and is now in use in the Malakal project. More specifics regarding the implementation process and its alignment with the research project are detailed in the subsequent chapter, which outlines the methodologies.

Figure 18 - Health staff entering data in the ward

4 Research Methods

The humanitarian health field has a research tradition that spans both positivist and interpretivist approaches. MSF has its own Research and Reflection Centre11, aimed at fostering debate and critical reflection on field practices to enhance the added value from their field interventions. Operational Research in MSF aims at enhancing healthcare delivery and policy through the dissemination of research-based knowledge. Examples of such research include an analysis of interventions post-discharge in children treated for nutrition-related conditions (Niyonzima et al. 2023) and an examination of the growing challenges concerning the accuracy of malaria rapid diagnostic tests (Molina-de la Fuente et al. 2023). Focused on medical interventions, MSF's field research predominantly adopts a positivist approach, akin to that found in the natural sciences. This method posits that phenomena should be defined by objectively measurable variables and operates under pre-established hypotheses about the relations between independent and dependent variables. Such research is valued for its repeatability, refutability, and generalizability. However, my research addresses a different form of operational research, applying an interpretive lens to analyse the health information systems within the field interventions. A novel research domain for the organization.

The interpretive tradition steers interventions that engage directly with the groups benefiting from the research outcomes. Here, the phenomena are assessed through individuals' interpretations and perceptions, aiming for a more relativistic shared understanding since different individuals might perceive the same situation differently (Orlikowski and Baroudi 1991). Interpretive methods embrace the idea that our grasp of the world is socially constructed through the collective beliefs and actions of individuals (Walsham 1993). These techniques aim to comprehend how inter-subjectivity forms, with research uncovering the various perceptions of reality held by individuals and highlighting how these interpretations shape group behaviour (Orlikowski and Baroudi 1991; Walliman 2011).

Information systems can be conceptualized as social systems, with technology intermingled with social and contextual elements (Angell and Smithson 1991; Lippeveld et al. 2000). As a result, the outcomes of information system projects are as influenced by the social context as by the digital system itself. Health information systems in the humanitarian sector exemplify this; they operate in a domain replete with variables and are heavily reliant on the context and users. This setting accentuates the challenges inherent to technology implementation and adoption.

The primary objective of this study is to understand the constraints and opportunities associated with the adoption of an H-HMIS within the organizational framework, as viewed through users' perspectives and subjective interpretations. Consequently, I embraced an interpretive approach and employed qualitative research methods. From this standpoint, my goal is to grasp the social context of the information system,

[11] https://www.msf.org/analysis-reflection-and-evaluation

intending to examine how the system can either influence or be shaped by this context (Walsham 1993). Using qualitative methods, the research phenomena are discerned through users' interpretations, which are acquired through document analysis, observations and discussions with the actors themselves (Orlikowski and Baroudi 1991; Walsham 1995).

4.1 Research Design

This project's design adheres to the Canonical Action Research (CAR) principles (Davidson et al. 2014). Committing to these principles was both a facilitating factor and an outcome of formalizing a research agreement between MSF Spain and the University of Oslo. This pact laid the foundation for the Researcher-Client agreement (Davidson et al. 2014), outlining the project's focus, commitments, roles and responsibilities of both parties, and objectives. Data collection and analysis methods were determined in close cooperation between MSF, myself, and my supervisor.

CAR represents a strand of action research that synergizes theory and practice. It aims to amplify the quality of practical applications and simultaneously contributes to theoretical and knowledge advancement by catalysing transformative changes and reflection. My research sought to forge new theoretical insights by examining the dynamics of the H-HMIS implementation from both contextual and organizational viewpoints, along with the challenges encountered in system use and adoption at the field user level. On a practical plane, the objective was to glean insights on enhancing the organization's ability to undertake digital interventions that add value to field operations while minimizing disruption to field workers' tasks.

This methodology was appropriate for research within a humanitarian organization, where the value and outcomes of practical actions are pivotal for the institution to endorse the research and validate access to field contexts. Even more for an organization that has a research tradition different from the IS research domain. Consequently, the insights derived from this research emerged collaboratively, shaped by interactions between the researcher, organization at the HQ, and participants from the field sites, all within the comprehensive structure of the CAR approach. The CAR framework is operationalized through five principles (Davidson et al. 2014) summarized in Table 4.

CAR principle	**Application in this research project**
The principle of the Researcher-Client Agreement	Research agreement was established between MSF Spain and the University of Oslo at the beginning of the project and renewed annually after expiration.
The principle of the Cyclical Process Model	One research cycle comprised of a smaller sub-cycle was completed. Each cycle contributed to the following in both the theoretical and practical evolution of the project.

CAR principle	Application in this research project
The principle of Theory	Theoretical concepts framed the analysis in all stages of the cyclical process guiding diagnosis, action planning, evaluation, and reflection. Institutional theory guided the contextual analysis at a higher level, Affordance Actualization theory informed the study of the user-technology interaction in context as well as the analysis of the use of the information system at organizational level and its challenges and contribution to the performance of the organization. The latter studied with Theory of Effective Use.
The principle of Change through Action	A new mobile technology was implemented in the field settings that was *i)* inspired by the diagnosis stage and *ii)* enabled reflection and learning. It represented a significant step forward digitizing data collection in the field.
The principle of Learning through Reflection	Research papers were published as outputs from the different stages of the cyclical model.

Table 4 - CAR principles applied in this research

The research design centred on a case study, chosen because the issue under scrutiny was deeply rooted in practical application and located within a specific context. This context, where actors' experiences were paramount and the setting crucial, demanded a case study approach based on building intimate situated understandings of the phenomenon. The case study method equips researchers with the ability to engage with qualitative questions, particularly the "how" and "why", while also accounting for the contextual factors influencing the phenomenon in question (Baxter and Jack 2008).

The project was longitudinal, tracing the phenomena from its inception and observing its development over six years post-implementation (2015-2021). The unit of analysis centred on the processes of health data management in the field project associated with the H-HMIS. To understand and generalize challenges in the field, emphasis was placed on the institutional context and its impact on the design, implementation, and uptake of the information system. Interactions and influences from higher levels were integral to understand daily field operations. Data collection and analysis spanned multiple levels, from the headquarters and country coordination office to the project coordination office and health facilities and the individuals involved there.

The journey resulted in outcomes that addressed both the organization's defined problem and my academic interests as a researcher. The theoretical framework that directed the analysis evolved alongside the stages, with each process reciprocally influencing the other. Hence, I will elucidate each stage and its parallel theoretical advancement.

4.1.1 The CAR stages and project development

As a CAR project, the cyclical principle was at the core of the activities and work plan. In that sense, this project constituted one broad cycle represented in Figure 19 with detail of the activities and timeline.

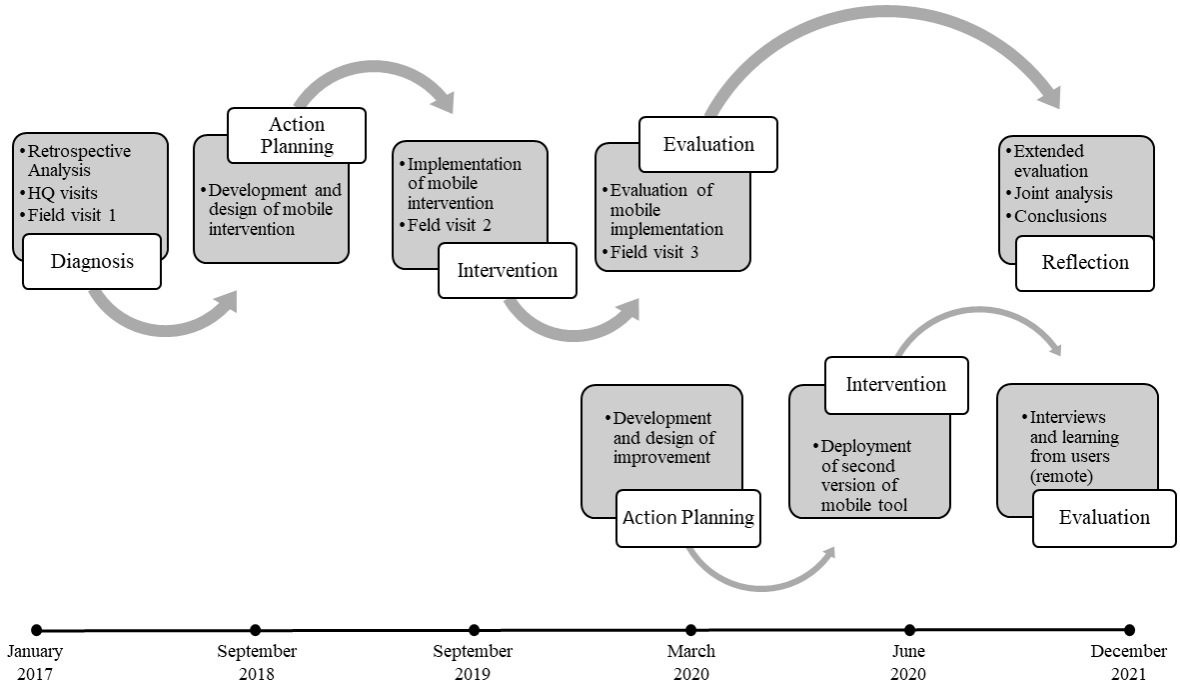

Figure 19 - The CAR cycle, stages, and activities with timeline

Exploratory phase Pre-PhD (2013 – 2016)

Before embarking on the research project, my engagement with the organization served as an exploratory phase. Data collection during this phase was informal, stemming from information gleaned through my regular duties as an MSF staff member engaged in the project. Activities during this period covered various levels of the organization. In the project's design phase, semi-structured interviews involving all pertinent stakeholders were carried out, with meticulous notes taken and subsequently shared with interviewees for verification. To study the system's users at the headquarters, my project-related tasks included semi-structured and unstructured interviews, and participant observations during meetings. I also actively participated in coordination meetings, system design workshops, internal team gatherings, and facilitated capacity-building sessions. Subsequently, I managed the global implementation of the H-HMIS, and directly participated on its deployment in four filed missions, engaging with twelve projects. This foundational experience set the stage for the research project, bestowing a profound understanding of both the organization and its context, which was instrumental at the onset of my work.

Diagnosis (January 2017 – September 2018)

The diagnostic stage unfolded on two fronts. A macro-level analysis leaned on documents and insights from the exploratory period, which enriched my experience in both the field and headquarters. Collaborative reflections with my supervisor helped develop a retrospective analysis of the H-HMIS project. In preparation for the research intervention, I made three visits to the headquarters office in July and November 2017, and again in February 2018. Alongside these in-person meetings, continuous communication was upheld via email and Skype to discuss and oversee various facets of the research project. On a micro-scale, an initial diagnostic field visit in February-March 2018) which helped grasp the users' challenges related to data management processes.

In this retrospective analysis phase, an institutional framework was developed to dissect and comprehend the various actors, logics, and potential contradictions influencing the H-HMIS. The system's conceptualization as an 'ensemble view' emerged from these preliminary analytical endeavours, influenced by the realization of the multiple elements involved in the data management process surrounding the digital H-HMIS, including paper records, alternative solutions, and user-specific practices.

Identifying the affordance actualization perspective occurred slightly later but still within the diagnostic phase. It was apt for examining user-technology interactions within a specific context, leading to future research informed by the concept of "institutional shaping of affordance actualization.

Action Planning (September 2018 – September 2019)

The action plan focused on designing, configuring, and strategizing the deployment of the mobile solution in field hospitals to alleviate and streamline data collection practices. These practices had been identified as the main sources of challenges. This endeavour was pragmatically driven and executed in tight collaboration with the organization. Drawing from the diagnosis stage, I integrated findings into the proposed intervention. In my capacity as a researcher, I also acted as the primary technician responsible for configuring the system. The organization supplied medical feedback for system configuration, essential technical assistance to ensure seamless integration of the solution with the routine H-HMIS, and support in coordinating logistics and preparing training materials for field deployment.

Intervention (October 2019 - March 2020)

This phase saw the rollout of the mobile solution in the field. Once launched, this solution operated concurrently with the existing paper-based methods. The goal was to glean insights by comparing both approaches when integrated into the routine tasks of healthcare professionals. As the intervention progressed, the final set of theoretical concepts was introduced. Learning from this comparison led to the formulation of the "potency of situated affordances" concept, designed to evaluate and contrast the different solutions in their operational context. Subsequently, the "competing situated

affordances" concept was adopted as an instructive tool that steered both the data collection and ensuing analysis. This comprehensive framework then informed the next evaluation and reflection phases.

Evaluation (April 2020 – June 2020)

Four months post-deployment, an evaluative exercise was conducted through a field visit. During the visit, feedback from users and the data they produced were scrutinized to comprehend the new solution's effect on healthcare staff's daily operations and the quality of the resulting data. This assessment was made in combination with baseline data gathered during the initial deployment.

The insights garnered from the evaluation informed enhancements to the technical solution. Feedback from the field was harnessed to refine the mobile tool, culminating in the rollout of an updated version. This generated a sub-iteration in the AR cycles, consisting of the following steps:

- A new action planning phase (June 2020 – May 2021), during which a new version of the system was built.
- A new intervention phase (May 2021), consisting of the deployment of the new version.
- Evaluation (June 2021): The new intervention was assessed remotely through Skype call interviews after it was implemented. In this case, there was no follow-up after some months, as was done in the first intervention.

The technical team from MSF spearheaded this second intervention. They managed the development and rollout of the new version. Meanwhile, I assumed a supportive role, offering insights and recommendations but not overseeing the development or being present in the field for its deployment. This second version of the solution remains in active use in the field. Following this intervention, a second evaluation phase was conducted, and fresh insights were incorporated into the ultimate evaluation. The combined findings from both evaluations informed the reflection stage.

Reflection (July 2020 - December 2021)

The reflection phase entailed a collaborative analysis with the organization to distil insights from the entire intervention. Practically, we delved into the potential advantages of incorporating the solution into their service offerings for the field. Additionally, we evaluated the impact and resources needed by the headquarters teams and any field missions opting for its adoption.

Challenges and Unexpected events

As delineated in the preceding chapter, the initial blueprint envisaged deploying interventions in, at a minimum, a rapid response to emergencies as a secondary setting. This would have represented a parallel cycle of the same solution in a distinct environment. Such an intervention wasn't definitively planned from the outset, as it was contingent on the dynamics of a humanitarian crisis. While the number of cycles

for the overarching project remained undefined, we also anticipated at least one more cycle, replicating the intervention in a setting akin to the first, drawing from its insights.

Research endeavours in 2020 and 2021 faced considerable setbacks due to the COVID-19 pandemic, impacting both the involvement in an emergency response and in a second regular intervention. Aligning opportunities for a swift response field deployment with my availability proved challenging in the early years, a situation exacerbated by the pandemic.

The declaration of a global pandemic on March 11th, 2020, brought my final scheduled field visit to a halt. I departed from the project in South Sudan, returning to Spain as the initial lockdown began. The resultant spike in workload meant that DHIS2 teams, which include me, assisted countries in bolstering their surveillance and reporting systems. This nearly halted my research activities from March 2020 till year's end, and they were markedly reduced in 2021 as we further aided countries with the implementation of systems to manage their vaccination campaigns. Concurrently, access to MSF's field operations became heavily restricted, and the organization and its field teams channelled their energies into the pandemic response and mitigating its impact on healthcare systems.

Overall analysis and Kappa writing (January 2022 – April 2023)

This culminating phase involved a comprehensive review of my research and publications, marking the commencement of my kappa writing. My third publication underwent multiple submissions and rejections before its eventual presentation at the International Conference for Information Systems (ICIS 2022). Concurrently, my focus was drawn to writing the Kappa. However, progress was limited due to two factors: clashing professional responsibilities as the product manager of DHIS2's mobile team (my role in the HISP team) and struggles with focus and concentration. These impediments surfaced in 2021 and persisted into the first half of 2022. By the latter half of 2022, I began to regain my capacity for reading and writing. The complete chronology, encapsulating field activities, publications, and kappa writing, is detailed in Figure 20.

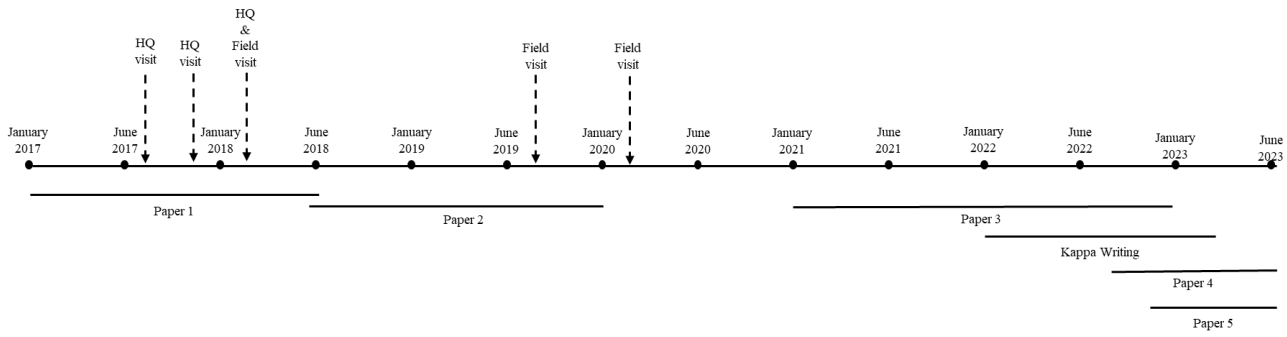

Figure 20 - Research field activities and writing timeline

During this final analytical phase, the theory of effective use (Burton-Jones and Grange 2013) was introduced. Consequently, it wasn't an integral part of my rationale during the development of the CAR stages. Over time, its incorporation assisted in creating a framework that cohesively integrated various findings and theoretical concepts. Bringing in the theory of effective opened a new space for theorising the context opening new avenues for further research on the domain and acted as a catalyser to structure the knowledge gained in the form of recommendations for improving the efficiency and effectiveness of information systems. Given the challenging and restrictive environments in which humanitarian organizations operate, there is a need to maximize the impact of their technical interventions. Therefore, effective use was identified as an ideal theoretical model to integrate the findings and provide contextualized and practical feedback to the organization.

4.1.2 Data Collection

The study predominantly used qualitative methods grounded in an interpretive mode of inquiry (Walsham 1993). Interviews were conducted both online and in-person, following a semi-structured format, and participatory observations took place during visits to the headquarters and the field. The study encompassed users of the H-HMIS system from both the headquarters and field interventions, as well as staff who engaged with the system at any stage of the data collection process, information consolidation, and higher-level data use and analysis. Where relevant and feasible, individuals in managerial positions were also included.

The different roles involved in data collection were as follows:

- Managerial positions: Head of mission and field project coordinator.
- Health staff: Medical referents (headquarters), Mission medical coordinator, Mission medical coordinator assistant, project medical referent, nurse activity manager, field doctors, nurse supervisors, field nurses, laboratory technicians, pharmacists, information education and communication officer, medical officers, and data encoders.

Interviews

The primary source of data for this study came from semi-structured interviews. While the overarching theme of the interviews centred on understanding user perceptions of the H-HMIS, the specific scripts varied based on the setting or phase of the project.

During the diagnosis phase, interviews delved into five main areas: *i)* demographic details of the respondent; *ii)* exploration of institutional norms and structures surrounding information systems; *iii)* assessment of practices related to information use; *iv)* examination of the usage of ICTs in daily tasks; and v) the informational capabilities among participants. During the intervention and evaluation phases, the interview topics were: *i)* demographic details of the respondent; *ii)* practices related to data collection and information use within the ward; *iii)* usage of ICTs in daily tasks and challenges faced; and *iv)* participants' experiences interacting with both systems, the pre-existing and the new one.

A total of 31 interviews were conducted during the field visits (see Table 5 for details). With the explicit consent of participants, all interviews were recorded and subsequently transcribed. The majority of the interviews were in English, but a few were in Spanish. These Spanish recordings were translated into English, the shared language for the three authors contributing to various publications.

Phase	Level	Role	Nr.
Diagnosis	Headquarters	HQ Medical Coordinator	1
	Mission Coordination Office	Head of Mission Medical Coordinator Medical Coordinator Assistant	1 1 1
	Project Coordination Offices	Medical Referent Field Doctors Field Nurses Lab. Technician IEC officer	2 5 5 1 1
		Project Coordinator	1
	Health Facility	Medical Officer	2
Intervention	Project Coordination Offices	Nurse Activity Manager	2
	Health Facility	Nurse Supervisor	2
Evaluation	Project Coordination Offices	Project Medical Referent Nurse Activity Manager	1 1
	Health Facility	Medical Doctor Nurse Activity Manager	1 3

Table 5 - Detail of participants in interviews

Participant observation and researcher notes

Participant observation was an ongoing method during my visits, given my immersion within the mission and associated project activities. I took part in routine project meetings and toured all facilities overseen by the different projects. These visits enabled direct observation of data collection processes and facilitated informal conversations with staff about their first-hand experiences. Observations extended to users' daily activities within their hospital wards and project offices, encompassing their use of registry books, various forms, and patient registers.

For the sake of clarity and thoroughness, I appended my interpretations and comments to both interview and observation notes. These notes were either captured in real-time during interviews and observations or recorded for accuracy. All these recordings and notes were later transcribed into my research diary, organizing the raw data in preparation for analysis.

The technical work developed during the intervention also served as a vital part of participant observation. I compiled notes and reflections from my collaboration with the MSF team throughout the conceptualization, configuration, implementation, and evaluation phases of the solution.

Focus Groups

Focus group discussions took place during my visits, either to validate prior findings or uncover new challenges. These group conversations were designed to gauge the suitability of the intervention by contrasting experiences and insights from the participating users. I facilitated these discussions, accompanied by a colleague responsible for notetaking. With the explicit consent of participants, we recorded each session. After every focus group, the note-taker and I would debrief, promptly documenting our observations and key takeaways. These audio recordings, along with the notes and interview transcriptions, were then consolidated for further analysis. All focus group discussions were held at the project coordination office. In total, there were three such discussions: two during my initial visit and one on my second trip. A fourth focus group planned during the intervention phase was unfortunately side-lined due to operational adjustments in light of the COVID-19 pandemic.

Stage	Role	Nr.
Diagnosis	Medical Referent	2
	Field Doctors	5
	Field Nurses	5
	Lab. Technician	1
	IEC officer	1
	Project Coordinator	1
Intervention	Project Medical Referent	1
	Nurse Activity Manager	2
	Medical Doctor	2
	Nurse Supervisor	2
	Data encoder	1
	Laboratory responsible	1
	Pharmacist	1

Table 6 - Detail of participants in focus groups per stage

Short Surveys

During the intervention phase, field-level users completed a concise, self-administered survey. This survey delved into user experiences, the relevance of the Mobile Data Collection tool, the tool's impact on day-to-day operations, and its adoption and application. These findings informed specific areas of inquiry for the subsequent in-depth interviews.

Secondary Data

Relevant documents and reports, when available, were incorporated into the research for detailed study and analysis. This encompassed historical documents from various stages of the H-HMIS projects, activity reports, and any materials shedding light on data practices within the organization. Other tools used in tandem with the standard H-HMIS, such as ad-hoc Excel files, routine reports, and paper-based solutions, were also scrutinized when relevant.

Modes of Field Engagement

Throughout the project, there were three field visits, with each spanning approximately a month. These visits encompassed data collection efforts at the mission coordination office and three separate field projects. Besides research-related activities—like attending meetings, collecting research data, and deploying the technical intervention—other routine tasks were executed. These included the maintenance and technical support of the H-HMIS and training sessions for end-users.

The technical intervention examined existing data flows and processes and introduced the new solution. This introduction was paired with in-service hands-on training for users, in preparation for the official implementation launch. Subsequently, on-site follow-up activities were conducted After this period, four months of remote monitoring and support ensured the continued to use of the new solution.

During this remote support phase, virtual meetings with field workers provided insights into their observations regarding data collection and transmission procedures, both within hospital premises and at the project office.

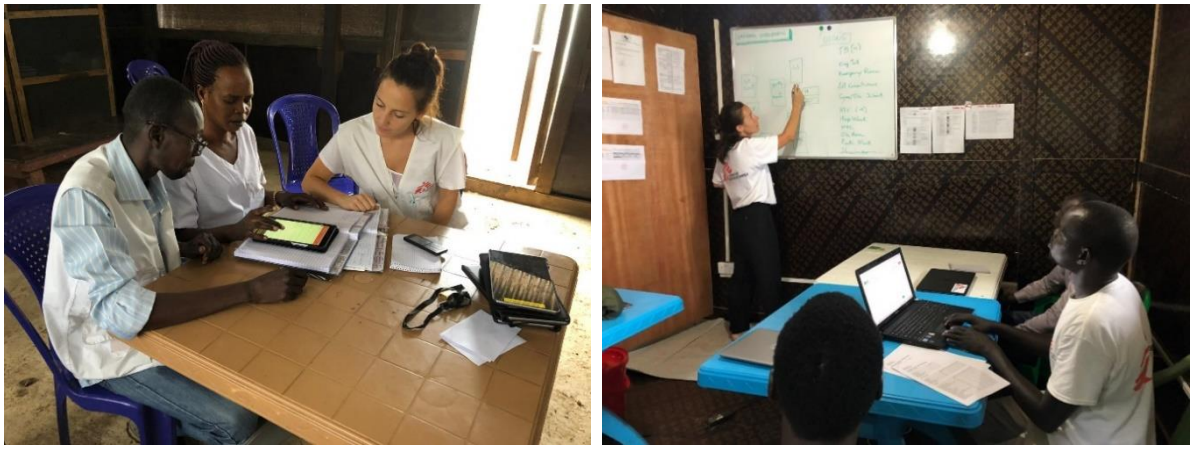

Figure 21 - Training activities in the field

4.1.3 Data Analysis

Data analysis in this study was conducted iteratively in alignment with the different project cycles and field visits, following the CAR approach (Davidson et al. 2014). The analysis informed both actionable steps and the more theoretically focused analysis which formed the basis for writing the research articles. Each cycle in the analytical process contributed to a coherent conceptual whole that addressed the research question.

The overall data analysis approach followed the hermeneutic circle framework (Klein and Myers 1999) and aimed to derive meaning from the textual data, compiled from the interaction with people and their respective contexts. All materials were transcribed and analysed by me, my supervisor, and the other authors when pertinent. The involvement of both an insider and outsider researcher resulted in many conversations that required me, as the "inside" researcher, to reflect on my ideas and provide detailed examples to support my arguments or adjust my statements accordingly.

All publications were based on a thematic content analysis (Miles et al. 2013) of the interviews and focus group discussions. Each publication followed slightly different strategies, briefly described below. In the first publication, I followed a retrospective interpretive process that allowed me to analyse the empirical experiences holistically. This process involved connecting the difficulties encountered during design, configuration, and implementation of the H-HMIS with theoretical concepts. Through iterations between discussions, documentation, and theory, the concepts evolved into more coherent and naturally organized themes, which represented the primary challenges encountered during the project. The image below exemplifies how quotes evolved to codes, themes, and theorising in one of the publications.

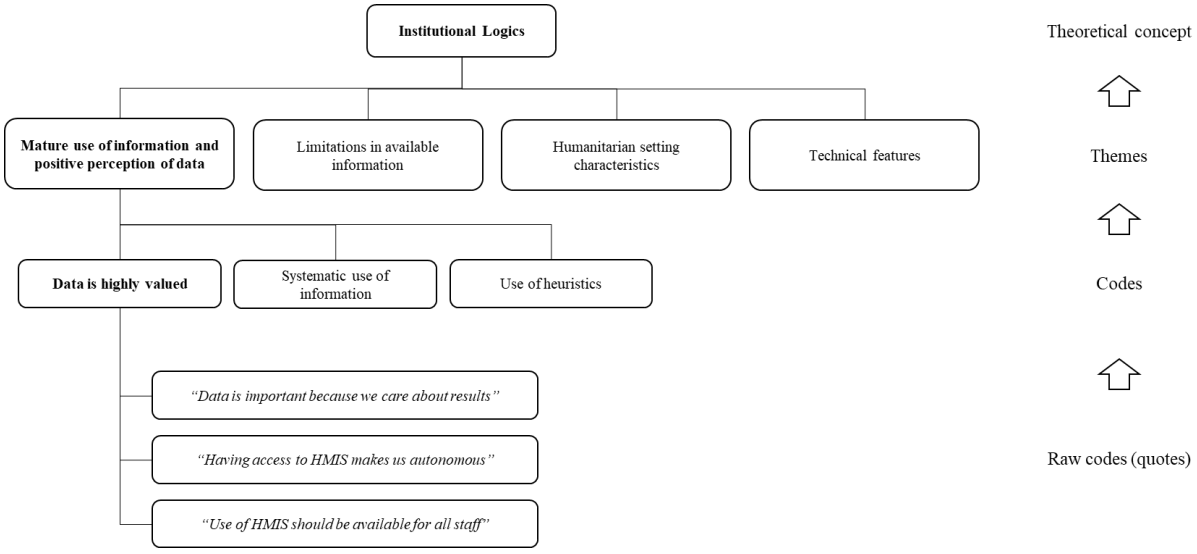

Figure 22 - Example of coding process in data analysis

We engaged in discussions to identify events and generate illustrative examples that effectively illustrated the themes. These themes incorporated vivid examples that organically evolved into vignettes, serving as analytical tool. Vignettes enabled the illustration of significant practices or events related to the case study (Kotlarsky et al. 2014), employing a narrative structure that maintains chronological order and focuses on a limited time period, one or a few actors, or a bounded space, or a combination of all three (Miles et al. 2013).

In the second publication, both quantitative and qualitative methods were employed for data analysis. The qualitative approach utilized an iterative coding process, while

the quantitative method emphasized quantifying code occurrences and ranking them to analyse their prevalence. These codes were further contextualized through qualitative analysis, interpreting the deeper meanings of the text. The interview data was transcribed, and the various authors reviewed it to identify primary-level codes pertinent to the research question. In total, 408 raw codes were identified. A subsequent analysis grouped these codes into broader, higher-level themes. The final analysis aligned these themes with the theoretical concepts of affordances and institutions.

In the third publication, data analysis was conducted using an interpretive approach, focusing on user perceptions about the digital intervention's impact on work practices and shifts in the data collection process. The core analysis and findings were rooted in interpretive methodology, bolstered by a quantitative data quality analysis. This quantitative evaluation assessed data quality from two angles: completeness, defined as "the extent to which all expected and required data (records, attributes) are present or not missing" (ISO 2007), and accuracy, which refers to "the degree of agreement between data and real-life phenomena under study" (ISO 2007).

For the interpretive analysis, each author independently reviewed the entire dataset in two separate phases. These findings were shared among the authors and combined with daily observation notes. In the initial phase, the primary focus was on identifying pivotal themes related to analysis and work practices. As understanding deepened, technology usage was mapped to procedures associated with the paper-based data collection system. System utilization emerged as situated affordances, enabling a more comprehensive analysis of informal practices. Dominant work practices were discerned through collaborative discussions among the authors. During the subsequent data analysis phase, the objective shifted to correlating these themes with our theoretical perspectives on affordances. Recognized practices were labelled as affordances, and based on the proposed potency framework, user responses to both the new and older systems were analysed. This method entailed iterative shifts between data and theory and discussions aimed at interpreting user perspectives on data collection processes. Such interpretations informed the determination of the potency for each identified affordance.

4.1.4 Generalization

Interpretive studies don’t aim for building statistical generalizable knowledge but to create new insights and concepts which can be transferred across contexts. A case study entails an in-depth exploration of a specific topic, aiming to deepen one's grasp of that subject (Ruddin, 2006), and generalization in a case study, as described by Yin (2013), is the attempt to expand insights from a limited number of cases to a broader set of instances. Generalizing from interpretive case studies, however, is challenging. Some argue that qualitative research's strength in terms of generalizability is inherently constrained (Firestone 1993), prompting questions about how methodologies or theoretical insights might be applicable to other cases.

While fresh knowledge might not seamlessly transition from one case to another, theoretical progress can yield "explanations of particular phenomena derived from empirical interpretive research in specific IS settings, potentially valuable in the future in other organizations and contexts." (Walsham 1995, p. 2). Generalizations then, can be perceived as theoretical contributions. The act of theory generation pivots on extending observations or measurements to create new theoretical constructs or broaden the reach of existing ones beyond the observed domain. Yin (2009) elucidates how researchers aim to extend specific findings to wider theories, backing their claims with evidence. Such generalization strives to showcase a theory's expansive relevance across varied phenomena or demarcate its applicability and the circumstances validating its use (Firestone 1993).

Opting for a single case and leveraging it to its full potential serves as an effective strategy for generalizing theory (Patton 1990; Yin 2009). This is the case in the employment of a critical case (Firestone 1993). Such a case is strategically significant in relation to a wider issue, making valuable contributions by fostering knowledge that supports logical deductions. As articulated by Flyvbjerg "If it is valid for this case, it is valid for all (or many) cases", in its opposing formulation, "If it is not valid for this case, then it is not valid for any (or only few) cases" (2006, p. 230). Critical cases stand as one of the more persuasive means of generalization (Wikfeldt 2016) and are instrumental both in refining and expanding theories. They facilitate generalization by demarcating the conditions under which an established theory holds.

However, pinpointing critical cases demands profound domain knowledge and experience, as there's an absence of clear methodological principles guiding this endeavour. It's generally recommended to seek cases which align with the most likely or least likely scenarios, cases that can definitively affirm or refute propositions (Flyvbjerg 2006). In the context of my research, given the unique conditions and challenges the humanitarian landscape introduces to both users and systems, I view the implementation of information systems within a humanitarian intervention as a critical case. Operating from this perspective, I hold the conviction that a routine system, if successfully adopted in a humanitarian organization, would likely thrive in any resource-limited environment, and even more so in conventional settings. Viewing from this meta-level critical case perspective aids the analysis and bolsters the findings' relevance to varied settings and contexts. This is achieved by both validating and adapting extant theories, as well as introducing fresh conceptualizations and methodologies.

4.2 Researcher Positioning and Motivation

This research project is rooted in an exploratory period of four years during which I served on the information systems team at MSF Spain, the organization and system being studied. Due to this involvement, I consider myself an "insider" researcher (Walsham 1995).

While on the information systems team, I took charge of the design and development of the H-HMIS and subsequently oversaw its global implementation. This role granted

me direct access to key figures within MSF, including the project leader, e-health technicians, epidemiologists, and medical officers. I also liaised with the Medical Department, engaging with its director and the medical specialists across various fields such as surgery, paediatrics, sexual and reproductive health, sexual violence, mental health, health promotion, nutrition, HIV/AIDS/TB, non-communicable diseases, and neglected & tropical diseases.

Being stationed at the headquarters provided an invaluable opportunity to comprehend the organization from a macro perspective. This exploratory phase, within the context of this research, was a deep dive into the organization's dynamics. I became intimately familiar with the organizational structure and the roles various departments played. Some departments, like Operations—which orchestrates field activities—were often difficult to engage with, yet they held a significant role in decision-making and operational execution. While the Medical Department was responsible for determining system content, technical considerations required the IT department's concurrence. Positioned under the General Direction department, the H-HMIS team and I endeavoured to synchronize with various stakeholders through different project phases.

On a more granular level, I faced assorted challenges as the project progressed. As the lead system technician for requirements gathering and design, my objective was to refine the existing system by addressing organizational, data source, and informational needs. Gathering this information meant involving individuals from both the field and the headquarters. Engaging these stakeholders in person for analysis or workshops proved difficult, and remote sessions introduced barriers to interpreting the model and soliciting feedback. The system's intricate design added another layer of complexity, as it had to adapt to changing configurations that encompassed a variety of facility types and services, from outpatient departments to labs and reproductive health services. When the system's configuration reached completion and was ready for deployment, I coordinated the next stage: its simultaneous implementation across 16 countries in Africa, Latin America, and Asia, rendered in three languages. The logistical and administrative intricacies of this rollout presented substantial challenges. My deep-seated commitment over these four years garnered trust from the organization. Furthermore, it fuelled my ambition to launch this research project to dissect the challenges encountered. Consequently, a formal research collaboration was stablished between MSF and the University of Oslo. This alliance formalized in my enrolment as a PhD student. In 2017, I embarked on my PhD journey, stepping away from my role at MSF.

Transitioning to a researcher's role, while continuing sporadic interactions with the team, afforded me a chance to introspect on past experiences and observe team dynamics from a more detached perspective. Over time, this association and my sense of belonging to the organization, reciprocated by the organization itself, began to decrease. Almost in tandem with the inception of this PhD project, I joined the University of Oslo as the product manager for the mobile team responsible for developing the DHIS2 Android application. As previously mentioned, the H-HMIS is

built on DHIS2, and the mobile technology utilized in the intervention described in this project is the DHIS2 Android application crafted by my team. This connection raises ethical issues regarding potential conflicts of interest, which are elaborated upon in the subsequent section.

4.3 Ethical Considerations

4.3.1 Research in humanitarian settings & reflections from the field

Research in humanitarian settings is paramount. In these contexts, interventions are rapidly implemented in challenging environments where resources are limited. Decisions grounded in evidence are essential, and concurrently, these scenarios offer unique opportunities to conduct research and accumulate knowledge for future endeavours. Enhancing the efficacy, efficiency, and fair distribution of interventions is fundamental in disaster response efforts (Mežinska et al., 2016). Thus, there's a pressing need to deepen and broaden the scientific knowledge in disaster relief. Nevertheless, undertaking research projects in such contexts demands rigorous adherence to ethical standards (O'Mathuna 2015).

Conscious of belonging to a globally privileged minority, I've dedicated my professional trajectory to assisting those confronted with more challenging realities. My commitment to humanitarian and development projects stems from a deep-seated belief in the innate equality of all humans. Yet, throughout my research journey, I've faced the sensation that I might be the sole beneficiary of my work, a sentiment seemingly in contradiction with my foundational motives.

This awareness compels me to introspectively examine my motivations for pursuing research in humanitarian contexts. Who truly stands to benefit from this work? Is it self-serving or for the greater good? While immersed in the field, thoughts like, "What is my purpose here?", "Am I genuinely making a difference?", and "What drives me?" frequently surfaced, especially during trips to humanitarian regions. After exhausting workdays set against the backdrop of a harsh reality, returning to relative comfort brings a tide of reflections. The overwhelming needs of the environment contrast starkly with the seemingly limited or sometimes negligible impact one individual or even an entire organization can make. This dichotomy is further accentuated when faced with unintended consequences of interventions and when navigating the intricate dynamics that govern humanitarian efforts, which occasionally conflict with its foundational principles.

Working in Information Systems for humanitarian organizations often means limited direct interaction with the communities you serve, especially in settings like those described earlier. Visits to places like hospitals or outreach sites occur as work demands, and even then, one remains somewhat removed from the local context. Interactions with population, when they occur, are filtered through the lens of a humanitarian worker. As an MSF field representative, organizational identifiers like vests or shirts are always visible. While such identification is needed for safety and coordination, it also introduces a subtle but distinct barrier between the "helper" and

the "helped." In these settings, this distinction further amplifies the inherent disparities.

One particular interaction has resonated with me throughout the years. On a morning field visit, I learned that several team members planned to attend the Ash Wednesday mass in the camp. Instead of attending the UN Staff mass, they chose the camp mass, the one attended by the displaced population. Intrigued by this opportunity for community integration, I decided to join. The "church" was an expansive open space, defined by hand-made walls and crowned by corrugated iron roof. Its vastness and the number of attendees struck me as we entered. Over four hundred individuals were present, joined by a North American priest and my two other colleagues. Upon entering the church, we should remove our organizational identifiers and took our places on the benches, assimilating as ordinary members of the congregation, receiving the priest's words just like everyone else. I hadn't anticipated the profound impact this would have on me.

Sitting among the community, participating in the same rituals, I was deeply touched by the palpable sense of unity and equality, reaffirming my belief in the universal connectedness of humanity under a greater force or divinity, be it God, Destiny, Universe, or Nature… as per your more comfortable reading. When you find yourself in such situation, seating next to. In that setting, seated beside a 60-year-old woman whose attire and facial lines spoke of a life hard-lived, yet whose eyes radiated warmth and kindness, I felt a profound dissonance. The modern sunglasses resting against my pristine t-shirt felt out of place. The realization that my field notes would soon find a home on the ergonomic chair and desk in my comfortable Oslo office further magnified this discomfort and prompted introspection.

Our brief exchange, limited by language barriers, was nonetheless rich in genuine connection. Amid our interaction, I was confronted by a pressing question: How would my research directly benefit this woman beside me? Even if my work ultimately contributes meaningful insights that, over time, enhance healthcare provision, the odds of her reaping these benefits seemed slim. While I would walk away from this endeavour with a coveted PhD, signifying both personal growth and professional advancement, she might never see its direct benefits.

However, does this asymmetry diminish the ethical value of my research? I believe not. I've come to understand that there isn't a one-size-fits-all solution to redress the outcome disparities of my PhD journey. Such imbalances are symptomatic of the broader humanitarian action, which, in turn, reflects the inherent structural inequalities of our world. Choosing not to conduct research is not a viable solution. Turning our heads from the harsh realities of the world and neglecting ethically challenging yet profoundly real circumstances is not the answer. The only approach that aligns with my core motivations is to uphold the highest research principles. This means employing the best methodologies and making decisions grounded in rigor and ethics, even if they don't necessarily ease my work.

Personally, I find comfort in adhering strictly to the ethical principles that underpin humanitarian efforts. In my domain—ICT—I have embraced applied frameworks like the MSF research ethics framework (MSF 2020) and the MSF ethical framework for innovation (Sheather et al. 2016). Another pivotal component has been shaping my research according to Canonical Action Research, a method that places the needs of the organization under study at the heart of project design (Davidson et al. 2014). I perceive this synthesis of robust methodology and ethical frameworks as the ultimate safeguard for the interests of the real beneficiaries of my work. These tools not only give structure to my research but also guide decisions that prioritize the beneficiaries. This remains true even when I'm geographically distant, unable to directly evaluate either the final benefits or potential risks of my contributions.

4.3.2 My dual role as researcher and practitioner

My past association with MSF and concurrent engagement with the University of Oslo at the inception of my research presented potential conflicts of interest, which warrant discussion here. My prior involvement with MSF was instrumental in granting me the access needed to study the organization and its stringent environments. Yet, this connection influenced both data collection and analysis. After four years as the project's main contact, many humanitarian workers recognized both my name and face. While MSF is a dynamic entity with frequent staff changes, I still regularly encountered field staff with whom I had collaborated during the H-HMIS project—whether it was for requirements gathering, training, implementation visits, or support inquiries. This recognition was even more pronounced at the headquarters, where staff changes occur less frequently.

During interviews and sessions, I often sensed participants felt they were critiquing "my work" when discussing the challenges of the H-HMIS. To mitigate this, I clarified my evolved role, admitting to the limitations and challenges that remained unaddressed during my tenure with the project. By providing examples and aligning with their perspective, I aimed to create a more open dialogue. However, this approach ran the risk of introducing bias to the conversation, as I found myself emphasizing certain issues to foster trust. Staying true to the pre-planned data collection scripts proved instrumental in navigating these interactions. Having an external perspective during data analysis was also beneficial. As time went on, this challenge diminished, and by the intervention stage, I was primarily seen and recognized as an H-HMIS researcher.

Another complication stemming from both my previous role with MSF and my subsequent position with the DHIS2 team at the University of Oslo was the managerial capacity I held in both organizations. My natural reactions often drove me to seek immediate practical solutions upon hearing about issues. Being involved in the research while also having the ability to influence the mobile application's development presented potential biases for the research. Thankfully, an open collaborative approach for guiding the DHIS2 roadmap acted as a safeguard against undue influence on the technical solution in favour of the project under investigation.

Throughout my research journey, I've committed to a meticulous and professional methodology. I am profoundly conscious of the privilege and responsibility associated with gaining entry to a specialized and restricted research environment and collaborating with two prestigious organizations that I deeply admire and respect: MSF and the HISP Centre. The primary goal of these organizations is to better the lives of the underserved, a mission that ICTs should strengthen and facilitate. In the upcoming chapter, I will present and elaborate on the analysis and findings that have emerged as a result of applying the research design, methodologies and approaches here described.

5 Research Analysis and Findings

This chapter is divided into two sections. The first section (5.1) provides a comprehensive presentation of the individual papers included in the kappa, outlining an overview of their respective research question, key findings, and contributions. The second section (5.2) discusses the interlinkages between the papers and their contributions towards answering the research question posed in this thesis. This second section addresses different aspects of the research question (sections 5.2.2 to 5.2.5) and concludes with a synthesis of the findings and their collective relevance to addressing the overarching research question posed in this thesis (section 5.2.6). This then provides the basis to discuss the theoretical and practical contributions from this thesis which is presented in Chapter 6 - Research Contributions.

5.1 Research Publications

The research publications include three conference papers in the domain of IS research, summarized in the table below.

#	Title
1	Vila-Pozo, M. M. & Sahay, S. (2018). Humanitarian Health Information Systems: Different challenges and responses. European Conference on Information Systems, *ECIS 2018*.
2	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 2019*.
3	Vila-Pozo, M. M.; Martínez, R.; & Sahay, S. (2022). Competing Affordance Potencies Shaping Data Collection: Case of Humanitarian Organizations. International Conference on Information Systems, *ICIS 2022*.
4	Vila-Pozo, M.M. Contextualizing Effective Use of Health Information Systems in Humanitarian Setting: The role of Transparent Interaction. International Conference on Social Implications of Computers in Developing Countries. *ISCRAM 2024 (submitted)*
5	Kuika Watat, J.; Vila-Pozo, M.M. An Affordance-based Process for Assessing Effective Use of Health Management Information Systems in Low-Resources Context. A*CIS 2023 (accepted)*

Table 7 - Summary of publications included in this thesis

5.1.1 Paper 1: Humanitarian Health Information Systems Different Challenges and Responses

Abstract and research question: Humanitarian organizations play an increasingly vital role in a world characterized by conflicts, natural and man-made disasters, and disease epidemics. To respond more effectively to crisis situations, these organizations need robust supporting information systems. However, designing and using these

systems is complex for two reasons. Firstly, the context is unstable, unpredictable, and dynamic. Secondly, the methods for designing these systems typically follow structured processes assuming routine work environments. This mismatch results in emerging contradictions, which may have adverse consequences in the short run, but may provide the potential for positive change in the long run. The paper draws upon selected concepts from institutional theory to understand the emerging contradictions, why they occur, and how to bring about positive change. Empirically, the study analyses a large humanitarian organization (MSF Spain) and its humanitarian health management information system (H-HMIS) to identify contradictions arising from technical, institutional, and contextual conditions and how the potential for change carried in them can be positively leveraged upon.

The research question addressed is:

> *What are the inherent contradictions between routine H-HMIS and the information needs of a humanitarian organization, and what challenges and opportunities come with them?*

Study findings and analysis: The principles of routine information systems, such as an H-HMIS, largely assume stable and homogeneous settings and systematic actions, which are not commonly found in humanitarian interventions. This paper helps identify those logics and principles inscribed in the software that shape the institutional logics around the system implementation and use.

The identified logics pertaining to the information system comprised stability, infrastructure dependency, and homogeneity. These logics suggest an organizational culture that values consistency and uniformity and relies on the underlying systems and processes. However, upon analysis, the work environment exhibited predominantly dynamic, heterogeneous, restrictive, and independent logics, describing an organizational culture that values flexibility and autonomy. These two sets of logics describe contrasting organizational cultures.

Contribution: This paper highlights the challenges of deploying routine H-HMIS in humanitarian organizations, raising the challenge of contradictory underlying logics and principles. This insight helps to better understand challenges associated with technology adoption and use and difficulties in enabling change.

5.1.2 Paper 2: Institutional Shaping of Affordances. Implications on Information Use in Global Humanitarian Organizations

Abstract and research question: In humanitarian interventions, timely and situationally relevant information is critical. While humanitarian organizations are making efforts to strengthen their supporting information systems, these efforts have not always resulted in optimal practical benefits. The design and content of the H-HMIS is shaped by macro-level formal and informal institutional conditions. This paper aims to analyse how the realization of affordances is situationally shaped.

Through our empirical analysis, we identify three key affordances relevant to the use of data in a humanitarian setting: *operationability*, *accountability*, and

contextuability. These affordances are particularly relevant given the challenge of the remote and dynamic nature of the constantly changing setting. Later, we analyse how the actualization of these individual affordances interacts with each other from an ensemble view of the H-HMIS.

In some cases, easy access to paper-based data discourages users from using the computer-based system, while in other cases, the paper printouts are used in conjunction with the computer-generated reports. We also study how the four key institutional influences identified - both formal (technical features and limited availability of information) and informal (existing maturity in the use of information and the unique features of the humanitarian setting) - shape the actualization of affordances towards data use. Keeping the lens of the ensemble view, we see that these formal and informal institutions have influences that can be both enabling and constraining for the actualization of the identified affordances.

The research question addressed is:

> *How do constraining and enabling institutional influences shape the actualization of management health information systems within the context of a global medical humanitarian organization?*

Study findings and analysis: This study firstly identified three fundamental affordances pertinent to the use of data in the domain: operationability, accountability, and contextuability. Operationality refers to the engagement with data as a customary practice for managerial operational work. Accountability encompasses the capacity to showcase the significance of and individual worker´s effort to higher hierarchical levels, and contextuability addresses the faculty of acquiring historical data with the purpose of guiding decisions within an unfamiliar operational context. Each of these affordances holds particular relevance within a humanitarian context due to the reliance on data, the challenge of rendering one's contribution perceptible to higher levels in a decentralised setup, and the inherent dynamism characterising such environments, which creates difficulties in the access and use of historical data.

Secondly, the findings provide insights into the interplay amongst the individual affordances. An ensemble view helps to highlight how paper holds a prominent role, challenging system use in some cases and complementing it in others.

Thirdly, this study discerned four pivotal institutional factors that shape the actualization of affordances related to data use: (1) existing maturity in the use of information, (2) limited availability of information, (3) unique characteristics of the humanitarian setting, and (4) technical features. Some conditions can be seen as formal institutions outlined by project headquarters to be applied at field level, others can be viewed as informal institutional constraints. Both these formal and informal institutions have influences that can enable or constrain the process of affordance actualization.

Contribution: This study identifies the key affordances crucial to data use practices in humanitarian organizations: operationality, accountability, and contextuability. It shows how these affordances interact with each other and how paper-based data is

prevalent and can complement or challenge digital systems. Finally, it identifies the institutional conditions and how their influence on the actualization of affordances pertaining to data use, with the potential to enable or constrain the process.

5.1.3 Paper 3: Competing Affordance Potencies Shaping Data Collection: Case of Humanitarian Organizations

Abstract and research question: In humanitarian settings, individuals' adoption of technology is closely tied to their expectations of performance and effort, often leading them to default to "whatever works." A comprehensive understanding of how field users adopt new technology is crucial for humanitarian organizations. Using the Affordance Potency framework, we compared the competing affordances of a mobile-based solution with existing paper-based processes against four identified affordances. The mobile solution was deployed in seven inpatient wards of two humanitarian field hospitals over a period of four months. Our analysis demonstrated that technology features are important as flexibility is crucial in responding to contextualized work practices. The affordance potency lens helped to understand how competing systems can shape the data collection process. A key contribution of this study is the use of affordances from a "competing" lens perspective within the unique context of a humanitarian organization.

The research question addressed is:

> *How do competing affordances of paper and digital technologies shape practices of data collection in humanitarian settings?*

Study findings and analysis: This work enabled the formulation of theoretical insights concerning the use and perception of digital technology by humanitarian workers when integrated into their daily operational work within healthcare facilities. The scrutiny of information practices revealed four distinct affordances: "*collecting data daily*"; "*aggregating data weekly*"; "*managing ward logistics*"; and "*accessing patient historical data*". The perspective of competing affordance potency in technology adoption highlighted the significance of organic technology use in humanitarian settings, where affordance actualization is shaped by challenging institutional conditions. The analysis consistently showed a preference for the solution that provides a seemingly effortless and user-friendly experience. This preference was only different if users felt that the technology was genuinely useful for their everyday work and helped them save time managing data-related tasks.

Contribution: The work makes a contribution establishing the concept of "competing affordance" through empirical research. This concept holds significance in comprehending the dynamics of how novel digital interventions compete with the functionalities of established systems, whether paper based or otherwise. We provide a theoretical framework rooted in the notion of Affordance Potency for performing the analysis that can help understand which factors are significant in shaping user acceptance and adoption of digital systems. Practically, this research identified the affordances at play in a field health facility of a humanitarian organization facilitated by both, paper-based and mobile systems. It also revealed the key factors for

technology use and adoption in humanitarian organizations through the study of the potencies of affordances in-context as perceived by health staff.

5.1.4 Paper 4: Contextualizing Effective Use of Health Information Systems in Humanitarian Setting: The role of Transparent Interaction

Abstract and research question: Humanitarian organizations need to ensure efficiency and efficacy in their interventions. Information systems are contributing to providing the required information however, organisations have not yet fully succeeded in integrating data collection and integration processes within their operations. Effective use aims at helping information systems contribute to the organisational objectives and holds promises to contribute to improving efficacy of the digital intervention. This paper analyses effective use of a H-HMIS. The analysis reveals a setting that challenges system access and learning processes and identifies the drivers for effective use as a potential boundary condition for the theory. As a consequence, Transparent Interaction is a critical step in shaping effective use in this context. Its nomological definition presents limitations in the sense that it does not consider the importance of the deep structure into facilitating system access and is not explicit about the conditions of non-impeded access. Following an inductive contextualization process, this paper characterizes effective use in the context of humanitarian settings and assesses its validity. Drawing upon the theoretical lenses of institutional theory and affordance actualization theory, the paper contributes to the theory of effective use by *i)* proposing a definition of transparent interaction and identifying its key aspects for humanitarian settings and its assessment and *ii)* extending the approach for contextualization by proposing the study of the operational environment with an institutional lens.

The research question addressed is:

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

Study findings and analysis: This analysis characterises effective use of the H-HMIS by building the network of affordances and making an integrated analysis of the process of actualization. Findings identify learning and adaptation actions, which are the drivers for effective use, arguably not applicable for the humanitarian setting and identities transparent interaction as the key for attaining effective use of the systems. System access for field workers requires *i)* a natural interaction with the technology which minimizes the need of learning and *ii)* a perceived usefulness of the tool which compensates for dedicated time to using the system. This work proposes a definition of transparent interaction that acknowledges that all system structures can influence the dimension and integrates the challenges of system use in the setting under study. It identifies two key aspects of the dimension that can be understood as impeded access: the level of learning required to use the system and the coupling between the system structures and the domain where the work takes action.

Contribution: This work contributes to the domain of information systems in humanitarian organizations by building the network of affordances for effective use of an H-HMIS. It contributes to the theory of effective use by contextualising it in a novel setting and extends its definition of transparent interaction by proposing a new one which account for the influences of the setting and the understanding of unimpeded system access. The new definition highlights two aspects for strengthening the assessment of transparent interaction: learning requirements and system ontology.

5.1.5 Paper 5: An Affordance-based Process for Assessing Effective Use of Health Management Information Systems in Low-Resources Context

Abstract and research question: Assessing effective use of health Management information systems (HMIS) in low-resource settings is critical to improving public health. However, mainstreaming information systems into daily practice can be challenging in dynamic, isolated settings where technology adoption is often not a priority. It is essential to design tools that address user needs and are deemed useful. In this paper, we propose a generic framework that applies effective use theory and affordance actualization theory to assess how HMIS are used efficiently in organizations and identify areas operational vulnerabilities. The proposed study uses a mixed-methods approach to data collection and analysis. This framework contributes to the information systems utilization literature by providing a method for contextualizing the assessment of effective utilization by giving relevance to specific information management tasks. From a practical perspective, it aims to guide information systems practitioners in low-resource environments in strengthening their digital organizational information systems.

The research question addressed is:

> *How can we design an assessment framework for improving effective use in low-resource settings that captures users' perception of usefulness?*

Study description: The proposed study defines the affordance-based method for assessing effective use in context and aims at validating the theoretical model by assessing effective use of a health management information system in a resource constrained setting. The study will focus on all three dimensions for effective use and aims at validating the theoretical approach and provide prescriptive indications to information systems practitioners from two angles, the actualization of the specific affordances identified from the perception of the users, and the role of the three dimensions for effective use in the process of actualization.

Contribution: This framework contributes to the information systems literature by providing a method for contextualizing the assessment of effective utilization by giving relevance to specific information management tasks. From a practical perspective, it aims to guide information systems practitioners in low-resource environments in strengthening their digital organizational information systems.

5.2 Analysis and Findings to Address the Research Question

Drawing from the findings and contributions of the individual research articles, this section offers an integrated analysis to address the central research question and its sub-questions presented in this thesis:

What constitutes effective use of a health information system in a humanitarian organization?

1. *What are the specificities of the institutional context and what is their impact on effective use?*
2. *What are the operating affordances and how the institutional context shapes the process of actualization?*
3. *How can the theoretical model for effective use be made relevant for humanitarian settings and diverse context?*

As discussed in the Theoretical Framework chapter, this work aims to address the research question by extending the approach proposed by Burton-Jones and Volkoff (2017) for the development of contextualized theories of effective use. An additional step has been incorporated to study the operational environment before examining the interactions and functions of the digital system. The modified process includes:

0. *Understanding how the environment affects the organisation and system goals.*
1. Understanding how a network of affordances supports the achievement of organisational goals.
2. Understanding how the affordances are actualised.
3. Using inductive theorizing to elaborate those principles in a given context.

The findings of this work, which address the research question, are presented in three formats within this section.

- First, Table 8 summarizes the overall analytical process and its relevance to the research questions.
- Subsequent sub-sections (5.2.2 to 5.2.4) each discuss a particular step, accompanied by a table that highlights its specific contribution to addressing the research question.
- A concluding section (5.2.5) provides a summary of the findings in relation to the overarching research question.

5.2.1 Overall analytical process and its contribution to the research question

The following table summarises the findings of my work in relation with the research questions.

Contributions to Research Question
Understanding how the environment affects the organisation and system goals
The impact of the institutional context into effective use: Findings from paper 1 contribute to responding the first research sub question of *What are the specificities of the institutional context and what is their impact on effective use* by uncovering the direct impact of the institutional conditions into the system structures, which inevitably shape the effective use of the digital system. This emphasizes the significance of comprehending these logics and how they influence the achievement of effective system use.
Understanding the network of affordances towards the organisational goals
What is Effective Use of an H-HMIS: Findings from papers 2 and 3 provided the list of affordances operating at the different levels of the field interventions. The description of these affordances supported by the perceptions of the users provides the basis for building the network of affordances which conceptualizes what is effective use of a humanitarian routine health information system. These findings contribute to addressing the second sub question: *What are the operating affordances and how the institutional context shapes the process of actualization?*
Understanding how the affordances are actualised
The particularities of the context and the technology shaping effective use: The findings from papers 2 and 3 are analysed to study the process of actualization at both levels, the project management office, and the health facilities. Paper 2 focused on the influence of the institutional conditions in the actualization of affordances. And paper 3 identified the required characteristics of the system for enabling its use under such conditions in the health facilities. These findings complete the analysis of the second sub question and allowed for identifying the three principles for effective use in a humanitarian setting. The principles set the basis for addressing the third sub question: *How can the theoretical model for effective use be made relevant for humanitarian settings and diverse context?*
Using inductive theorizing to elaborate those principles in a given context
The suitability of the theory of effective use for the humanitarian context and how to adapt it: Building upon the findings from the previous publications. Paper 4 makes an analysis for assessing the suitability of the model for effective use for the H-HMIS in a humanitarian setting. Results identify two particularities of the theory of effective use in humanitarian settings: *i)* transparent interaction as a critical dimension for attaining effective use and *ii)* relying on training and adaptation actions as drivers for attaining effective use is arguably not fully applicable in humanitarian settings. This constitutes a limitation for the applicability of the theoretical model for effective use to a humanitarian context. To help humanitarian organisations improve the effective use of their systems, paper 4 proposes a new definition of transparent *interaction* to help account for the particularities of the humanitarian setting.

Assess effective use in context should account for the perceived usefulness offered to the users. An affordance-based method for building measurement tools which introduces the contextual tasks into the measurement items was developed and proposed for validation in paper 5. These analysis and findings address the third research sub question and complete the inquiry to the overall research question of: *What constitutes effective use of a health information system in a humanitarian organization?*

Table 8 - Summary of contributions from the publications

I will now describe each analytical phase in detail, highlighting the findings developed within each step.

5.2.2 Step 0 - Understanding how the environment affects the organisation and system goals

An institutional analysis of operating logics

Humanitarian interventions are dependent on information systems with specific characteristics. Broadly, H-HMIS gather predefined data at intervals ranging from daily to yearly. This data aims to inform about specific situations, monitor them for changes or potential risks, and manage resources. The gathered information is also used retrospectively for assessments, evaluations, and ensuring accountability. To ensure data accuracy and reliability, the H-HMIS must adhere to integration and standardization norms. This means establishing a consistent structure and procedures to decide what data to collect, when, and from where. However, the unpredictable nature of humanitarian interventions often results in a semi-structured or even unstructured environment, challenging this need. The primary assertion here is that routine information systems, including H-HMIS, generally presuppose stability, homogeneity, and systematic actions, which humanitarian interventions typically lack. These contradictions are explored in Paper 1.

Design inscriptions within software reflect the empirical settings' realities and the context's evolving nature. These inscriptions align with the logics formed in everyday work routines. When new technological and work routines are introduced, new institutional norms and logics arise. But due to challenges and conditions within the humanitarian context, these logics might not always mesh with working practices, leading to conflicting logics. This institutional analysis offers insights into the relationship between institutional logics and technology utilization. To ascertain their potential impact on effective use, it is crucial to analyze the operational contradictions next.

Contradicting institutional logics and their implications for effective use

Institutional logics fundamentally influence the entire information system structure, not just isolated parts. To comprehend this impact on effective use, one must scrutinize the contradictions at a granular level, particularly focusing on the information system's core components: deep, surface, and physical structures. The competing logics

between the information system and the context involve stability versus dynamicity, infrastructure dependence versus independence and restrictive infrastructure, and homogeneity versus diversity.

Stability vs Dynamicity: The H-HMIS functions in a context where institutionalized work routines might hinder requirement gathering, leading to suboptimal design configurations. Furthermore, the system's implementation context is fluid, with the population's needs changing as emergencies evolve. This necessitates gathering diverse data, potentially from new locations.

The dynamic logics of humanitarian environments influence all three structures of the information system: deep, surface, and physical. The physical structure might be impacted by the introduction of new health units with varying access to the Internet or electricity networks. The surface structure, which encompasses the user interface, needs to be flexible and capable of accommodating these changes to ensure a user experience that aids data collection and analysis across diverse settings. The deep structure, rooted in design and configurations, establishes the system's inherent adaptability to shifts at the physical and surface levels.

Dependency vs Independency and Restricted Access: Humanitarian operations frequently take place in settings with significant infrastructure limitations. Reliable internet access, consistent electricity, and suitable workstations might be scarce. Introducing an information system resilient in these conditions directly shapes hardware demands, falling under the physical structure. This emphasizes the necessity for features like offline modes, data synchronization, and distributed systems to handle varied data flows. Such requirements could also influence the user interface. The imperative to function in isolated and restricted scenarios can potentially impact both the physical and surface structures of the information system.

Homogeneity vs Heterogeneity: Heterogeneity refers to 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. These raise different information needs, which directly affect both the deep and surface structures of the information system. Figure 23 summarises the conflicting logics between the system and the context, on the left and centre, and how they influence the different structures of the information system, on the right.

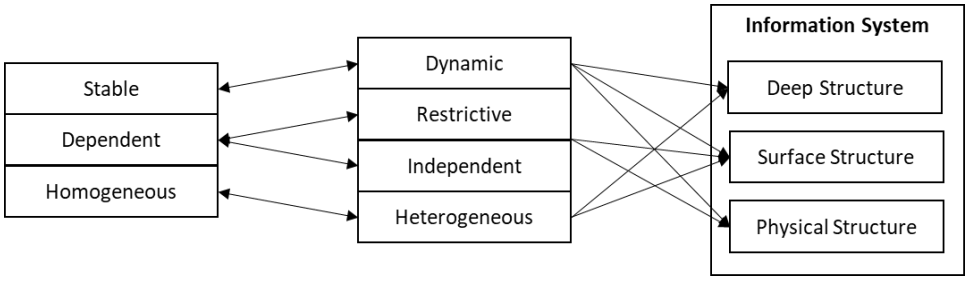

Figure 23 - Conflicting logics and influence on system structures

Addressing the research question

What are the specificities of the institutional context and what is their impact on effective use?
This analysis lays the foundation for understanding how the institutional context of a humanitarian setting shapes effective use. It identifies the peculiarities of the institutional context and their implications for the system structures, emphasizing the significance of comprehending how these logics influence the achievement of effective use. The information system operates under conflicting institutional logics of the context vs the routine nature of the information system: dynamicity vs stability, heterogeneity vs homogeneity, and independence from a restrictive infrastructure vs infrastructure dependency. These contradictions affect the deep, surface, and physical structures of the information system. The institutional logics identified inform the analysis of the process of affordance actualization to identify their impact on shaping the attainment of effective use.

5.2.3 Step 1 - Understanding how a network of affordances supports the achievement of organizational goals

The subsequent section introduces the network of affordances in the humanitarian project, drawing from the individual affordances identified in papers 2 and 3. These affordances pertain to the two operational levels examined: *i)* the project coordination office (highlighted in paper 2) and *ii)* the health facility (discussed in paper 3). Collectively, this analysis illuminates how technology aids in achieving organizational goals related to the system's effective use in field projects.

The naming conventions adopted in the two papers varied. In paper 2, affordance labels utilized a blend of two suffixes: the adjective suffix '-able' combined with the substantive suffix '-ity' (e.g., 'operationability'). Conversely, in paper 3, affordances were denoted by articulating the action more descriptively using continuous tense verbs. Notably, these names seem to emphasize the outcome rather than just naming the affordance. The methodology of paper 2 yielded broader labels (like 'collectability') that were deemed less descriptive for the publication. The names are retained in their published form in this document. However, for consistency, when introducing the affordances from paper 3, I have supplemented the names with suffixes in parentheses, aligning them with the naming patterns across both papers.

Affordances identified at the project coordination office

Three salient affordances were identified at this level:

Operationability denotes the capability to utilize data for monitoring trends, identifying alerts, and consistently adapting operations. This term is influenced by MSF's use of the adjective 'operational,' encompassing all facets linked to field interventions. Both medical and managerial staff found operationability crucial,

especially when working in environments that demanded meticulous daily supervision and coordination of healthcare services across multiple facilities. Such responsibilities spanned decision-making in human resources, capacity development, logistics, and budgetary management.

Accountability pertains to the capacity for data to validate everyday operational activities and decision-making. Medical and management personnel emphasized the significance of documenting operational decisions and communicating them across different tiers, especially at mid-range coordination levels. Health practitioners recognized the necessity to quantify their contributions as a means to validate their actions to their peers. Incomplete records were often seen as a testament to a lack of commitment and precision in their roles. One interview quote encapsulated this sentiment: *"You need your data to prove your work to others," and "If I have empty records, it means that that day I have not worked"*.

Contextuability is defined as the capability to gather insights for context analysis during a new field deployment. The relevance of accessing prior medical data became evident when newcomers joined the project. These members would consult the H-HMIS for contextual updates on the context. As one interviewee stated, *"when I just came to the project, data was my daily bread"*. Building an understanding of the context, these professionals often needed to recalibrate their interpretations of the data.

Affordances identified at the health facility level

The facilities highlighted in this study encompass the inpatient wards where medical services are administered, and data is collected. Workstations are situated within these wards, and they lack internet connectivity. Primarily, data collection takes place here, and, in a few instances, data usage. The central affordances identified pertained to the following work tasks:

Collecting patient data daily (Collectability): Upon each admission, the patient's details are noted in the registry book, which is then updated and finalized at the time of discharge. This documentation takes place within the ward, updated intermittently throughout the day by nurses and medical officers in line with their medical duties. For the users, the registry book primarily facilitated the subsequent data aggregation that was performed weekly. Compared to the detailed patient medical file, which is a two-page document with intricate and less formatted details on the patient's medical trajectory, the registry book was perceived as a streamlined process. *"Objectively, the registry book is to come out with the epidemiological week data collection at the end of the week."*

Aggregating data weekly (Aggregability): Every Monday marks the beginning of a new week when nurse supervisors transport the registry books to the nurse's office. Here, they manually tabulate the patient data from the preceding week to derive the weekly aggregated counts. This procedure, taking approximately four hours, transpires even as the wards remain operational. During particularly busy weeks, this process can be delayed by three to four days – a significant duration considering the context of a weekly report. On reporting days, nurse supervisors find themselves swamped as they

balance their usual ward duties with compiling the previous week's patient data. Discrepancies in the registers are sometimes found during this process, necessitating further inquiry and rectification. Accessing the original source of data for correction becomes increasingly challenging with each passing day. One supervisor articulated this hurdle, *"In the book... on Monday, I don't remember what I recorded..."*.

Managing ward logistics (Manageability): Although primarily intended to maintain a record of admitted patients for weekly H-HMIS reports, the registry book also emerged as essential for day-to-day ward administration. It facilitates a range of activities, such as monitoring patient movements within the ward, verifying bed numbers, acknowledging new admissions, and computing food necessities for both patients and their caretakers. It's also pivotal for managing the bed linen inventory within the ward and the distribution of mosquito nets to departing patients. One participant illustrated the indispensable association between the registry book and the ward's operations: *"They (nurses and clinical officers) follow the ward with the book... and the book with the ward..."*.

Accessing patient historical data (Recordability): While the registry book might be less comprehensive medically than the patient clinical file, it holds considerable value in medical care. It's employed to extract details about any returning patients. More often than not, staff bypassed the clinical file, favoring the registry book for historical information. One participant elaborated, *"it was more difficult to find an old patient file than a registered entry (in the book) ... we go to the book and check the name of the patient... we check the diagnosis..."*.

The organizational objectives and their connection with the affordances

Monitoring the quality of health services stands paramount in the organization's field missions. This involves a persistent assessment and evaluation of the myriad facets of the health services provided. Operationability allows for the customization of field activities and adaptation of health services to the evolving needs of the population, leading to more tailored services. Accountability is crucial, as any enhancement or reallocation of resources requires endorsement and backing from upper coordination tiers. Contextuability becomes especially pertinent when fresh health personnel are inducted into the project, offering them insights that aid in understanding the context.

Minimizing data management workload in the field is geared towards curtailing the time and effort expended on data collection and processing in the field setting. This entails introducing state-of-the-art technologies that refine data management practices at large. The affordance tied to aggregating data on a weekly basis speaks directly to this objective. The most valued facet of the intervention at the facility level was the time users saved due to the automation of this process.

Reducing reporting and data integration times at managerial levels tiers in a strategy to tackle the lags between data collection and its readiness for integrated analysis across various organizational levels. Such delays commonly stem from the manual processes involved, with these lags being more pronounced at higher levels of the data analysis pyramid. The affordance related to weekly data aggregation gravitates towards

process automation, playing a pivotal role in trimming the time to make data accessible at both field and headquarters. It eliminates the manual steps of aggregating data at the facility, followed by its input into the integrated database at the project office. Centralizing data also eliminates the necessity to manually integrate data from different projects at varying organizational layers, a routine prior to the H-HMIS inception.

Improving data use and informed decision-making is aimed at ensuring easier data and information accessibility for decision-making. Leveraging data to inform decisions serves as a foundational move towards delivering a suitable and adaptive response from the diverse coordination offices. Furthermore, it paves the way for resource optimization by ensuring accurate resource and service allocation. Operationability pertains to the affordance that most directly supports operational-level choices, like orchestrating logistics, budget planning, strategizing capacity building, and human resource management, ensuring that services adeptly cater to the population's needs. Accountability paves the way for more agile coordination, enhancing the approval dynamics in decision-making for more streamlined resource allocation to field projects. Contextuability augments the learning curve and eases the decision-making for new project personnel, an essential feature given the frequent staff transitions.

The network of affordances of H-HMIS

To build the network of affordances, I start by identifying each affordance alongside its anticipated outcome, forming a singular unit. Burton-Jones and Volkoff (2017) term these as outcome-units, denoting the manifestation of a specific affordance combined with its immediate individual outcome. Each outcome-unit plays a role in realizing overarching organizational aims. The affordance network is formed by these outcome-units and their ties to the organizational objectives. This methodology enhances the scrutiny of the interplay among affordances, illustrating the interdependence, sequence, and participation of affordances and outcomes across organizational levels.

Figure 24 visually presents the outcome-units and the resultant affordance network. For clarity, outcome-units are distinguished by colours based on the level of their operation – green for the facility level and blue for the project coordination level. Inter-level connections are symbolized with arrows, adopting the colour of the lower tier. This visual format illustrates the manifestation of effective use via the affordance network, shedding light on the interrelationships between affordances and their pivotal roles in achieving organizational targets.

I discuss now the affordance outcome-units, their interwoven relationships, and their contributions to the organizational goals. In health information system, data collection marks the commencement. This research inspected four in-patient wards: adults, paediatrics, neonatology, and the therapeutic feeding program. A consistent data collection approach is evident across these wards. Upon admission, each patient's details are documented in a registry, with health professionals recording basic information (Unit 1) daily. Drawing from this data, nurses and clinical officers oversee the ward, ensuring the provision of food, medicines, and essentials like bed linen and

mosquito nets (Unit 2). They also reference patient records for details on re-admissions (Unit 3). Culminating the reporting interval, data is consolidated weekly, producing the data required for project monitoring (Unit 4).

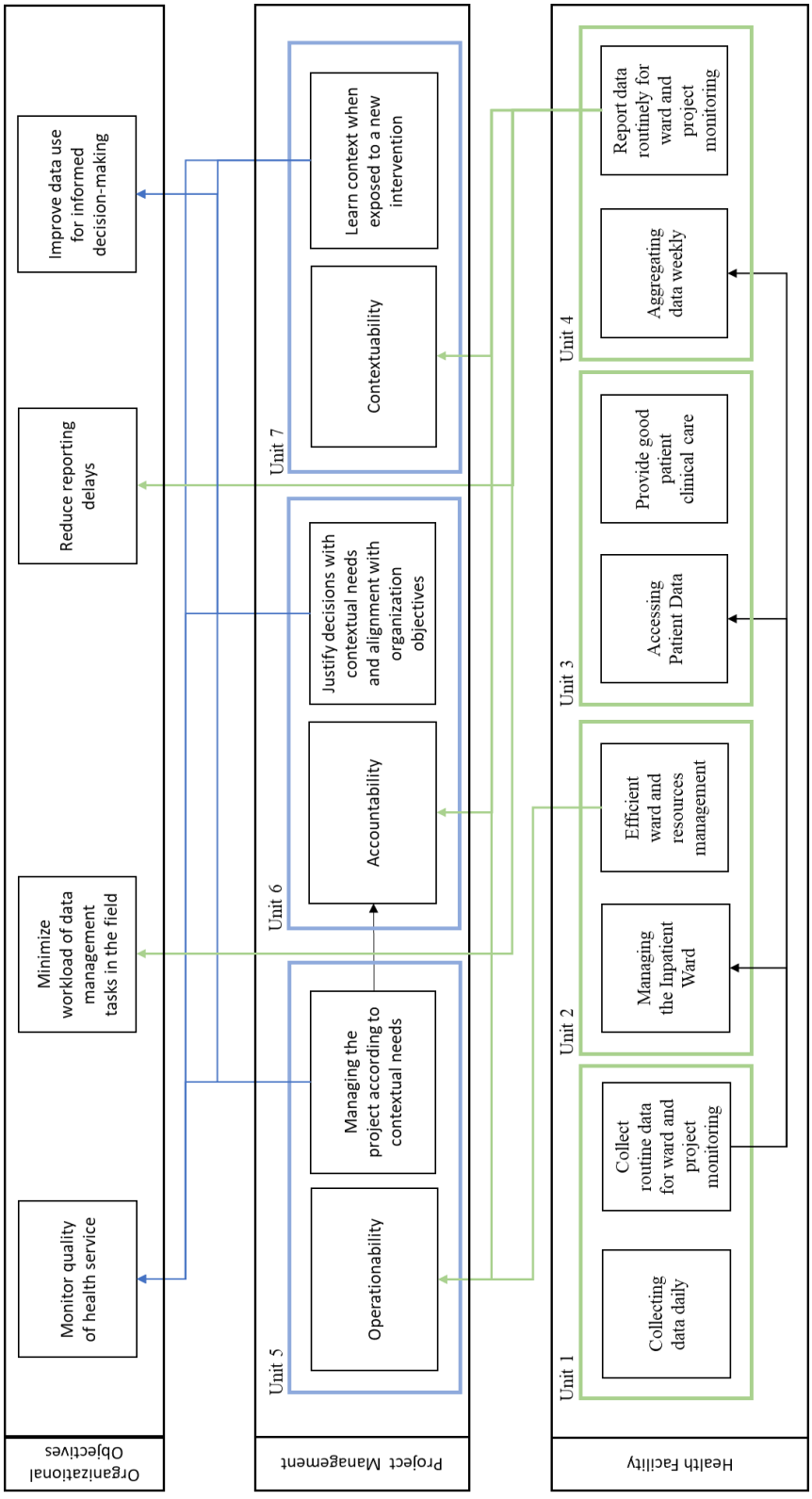

Figure 24 - The Network of Affordances of the H-HMIS in the field

At the project coordination tier, project operational management (Unit 5) is achieved by aligning the project with the contextual needs. Data-informed decisions trigger the affordance of accountability (Unit 6). Contextuability translates to an avenue for the onboarding staff to become familiar with their novel operational environment (Unit 7).

A thorough examination of the interconnections across both levels singles out Aggregating data weekly (Unit 4) as the pivotal affordance. Consolidating ward data (Unit 4) is the linchpin for all managerial affordances: steering the project operationally (Unit 5), validating decisions or operational demands (Unit 6), and easing the transition for new employees into their fresh deployments (Unit 7). Efficient ward management, enriched with detailed insights on patient demographics or categorizations (Unit 2), also enhances the general operational management of the project (Unit 5).

Addressing the research question

What are the operating affordances *and how the institutional context shapes the process of actualization?*
This analysis seeks to elucidate the nature of effective use of an information system within a humanitarian context, addressing the initial facet of our research question: What are the operating affordances? The affordance network delineates the connection between the H-HMIS usage by healthcare professionals and the realization of organizational aims. This underscores the significance of examining the affordance network when assessing effective use. Effective use of the H-HMIS encompasses the manifestation of context-specific affordances and their inherent capacity to further organizational objectives. These affordances encompassing collecting data daily, managing the ward, accessing patient information, aggregating data weekly, operationability, accountability, and context sensitivity—sequentially bolster several goals: monitoring the quality of the health service, minimizing data management workload, reducing reporting times for integrated analysis, and facilitating informed decision making. The subsequent phase delves into the mechanisms through which affordances are actualized, pinpointing the primary challenges faced by users. This exploration couples the process of actualizing the discerned affordances with the institutional logics rooted in the given context.

5.2.4 Step 2 - Understanding how the affordances are actualized.

As initially outlined, affordances are the potential pathways for actions. For a system to be used effectively, these pathways must be realized. To comprehend the process of affordance actualization in this particular setting and under these working conditions, it is essential to elaborate on the network of affordances that underpins effective use. Following this, I delve into the institutional conditions and how they shape system use.

The institutional conditions

Mature use of information and positive perceptions of data: The team leaned on pragmatic problem-solving techniques to analyse data, ensuring the success of the intervention. Habitual processes encouraged a collective analysis of data within the group. For instance, medical teams convened weekly, discussing significant events of the week for each service, grounding their discussions in data. Comments from the field included: *"Data is important because we care about results", "Having access to HMIS makes us autonomous", "...use of HMIS should be available for all staff"*.

Limitations in available information: These limitations are tied to the technology's configuration concerning content availability. The setup had to remain adaptable to each project yet adhere to certain standardization levels set by the headquarters across various contexts. Users acknowledged the value of standardized systems but were also cognizant of the inherent restriction: *"Using standard systems is needed but it will not work for those in the extremes", "...too much data, but yet important data not collected"*. This represented a paradoxical situation of data being overwhelming in volume yet missing critical pieces.

Characteristics of the humanitarian setting: Humanitarian environments are marked by high-intensity operations, prolonged working hours, and limited personnel for rotational shifts, often leading to an overlap of professional and personal boundaries. Depending on the season, the climate could be extremely hot and/or with torrential downpours. A unanimous sentiment among users was the scarcity of time for data management. Even after dedicating extensive hours to data collection, a common refrain was, *"I don't have time to sit and look at the data"*.

Technical features of the system: The project's technical framework includes an offline server, which collects data and syncs with a central online hub when there is internet connectivity. This method reaped numerous benefits. Those in coordination roles particularly appreciated the ability to conduct time-based analysis with data consolidated from various organizational tiers. Despite the existence of certain data in external tools and parallel reporting platforms, users consistently leaned towards the H-HMIS when feasible.

Having identified these conditions at both the project coordination and health facility level, I will next unpack how they shaped the affordance actualization process.

The institutional shaping of affordance actualization at the project office

In the analysis of affordance actualization (addressed in Paper 2), we discerned that distinct affordances were variably influenced by institutional conditions. The findings also unveiled interacting effects—both enabling and constraining—that shaped the actualization of these affordances. A comprehensive summary detailing how different logics either constrain or facilitate various affordances can be found in Table 9, which I will expound upon subsequently.

Institutional conditions	Operationability	Accountability	Contextuability
Mature use of data	(+) fuel of all affordances. (-) Results in use of paper or parallel tools		(+) fuel of all affordances.
Information limitations	(-) increases use of paper and parallel tools	(-) increases use parallel tools	(-) limits retrospective analysis
Humanitarian Setting	(-) challenges all affordances: continuous loss of capacities combined with lack of time for training		
Technical features	(+) increases data quality, facilitates analysis, enhances ownership of data, accelerates access to information. (-) rigid data model, complex analytic tools.		(+) integrated and retrospective analysis. (-) complex analytic tools.

Table 9 - Summary of analysis of affordance actualization in the field project office (Vila-Pozo and Sahay 2019)

The mature use of data typically served as a catalyst for affordance actualization. However, when confronted with challenges like limited available information or complications stemming from the setting or system characteristics, users often reverted to paper or alternative tools. A positive perception and the high valuation of data sometimes led to the negative actualization of affordances. If the H-HMIS appeared limited, users preferred other solutions.

The system's inability to address local specificities hindered the actualization of affordances. When certain data was not available, users resorted to collecting it on paper or using parallel Excel files, undermining the utility of the H-HMIS. Such practices often led to data quality issues (due to multiple sources and double reporting) and information loss, especially if data on paper went unreported. Consequently, users questioned the system's usefulness and became demotivated, feeling that the data collected was not put to use: *"Time dedicated to data collection does not compensate if you don't use the data"*.

Characteristics inherent to humanitarian settings posed challenges to the actualization of all affordances. With a high turnover rate, the deployment period for expatriate medical staff can range from 2 to 12 months, though it's typically 6 to 9 months. The work environment isn't conducive to efficiently onboard and train new members, as one user commented: *"...high turnover and high intensity make you rely on the ones who know instead of teaching the newcomers"*. Users often lead to reliance on those familiar with processes rather than training newcomers. Many felt they couldn't allocate adequate time for training tasks, which sometimes prompted them to use temporary

workarounds and local adaptations. As one user put it, *"Paper is always there, and you don't need to learn"*.

The system's technical features, designed for a centralized offline-online architecture, allowed data modification only at its source, increasing data ownership. Nonetheless, this architecture came with their own challenges, such as limiting maintenance tasks and updates. Such restrictions, coupled with sometimes insufficient information, exacerbated the challenges. Users described the process of data collection and aggregation at the facility level as iterative, tedious, and prone to errors. For monthly reporting and analysis, the prevalent method was to extract data from the H-HMIS and generate tables or charts using Excel. The rationale? *"I already know it"*. Therefore, the technical aspects of the system were both beneficial and limiting; advantageous for integrating data into a centralized database, but restrictive for field-level data collection and analysis.

The subsequent phase of the analysis delves one level deeper, focusing on the users within the health facility in light of these findings.

The role of potency in the actualization of affordances at the health facilities

To understand the popularity of paper-based systems and to investigate the viability of a digital solution mirroring manual processes, a mobile device-based system for data collection was introduced in the inpatient wards. This technical intervention is detailed in the Research Context chapter. The analysis drew inspiration from the concept of affordance potency (Anderson and Robey 2017) and was steered by the Potency of Competing Affordances theoretical framework, as elaborated in the third publication. Affordance potency delves deeper into the idea of affordance actualization, aiming to comprehend "the strength of the relationship between abilities of the individual and the features of the system at the time of actualization" (Anderson and Robey 2017, p. 103). A higher potency of an affordance indicates a greater probability of its actualization. By juxtaposing both systems, the analysis discerned the potency of the competing affordances in the context of identical purpose-driven tasks. The findings from Paper 3 are succinctly outlined in Table 10.

Results showed that the introduction of digital technology was positively received, and it enhanced data completeness. Nonetheless, concerns emerged about training staff who possess diverse levels of IT literacy. For tasks related to patient identification and determining patient volume, paper was favored over digital tools, stemming from users' comfort and familiarity with paper records. Moreover, the preference leaned towards paper when reading and analyzing data, as it obviated the need to learn new digital features. In essence, while the digital solution was embraced for data collection, the predilection for paper persisted for certain tasks, owing to users' ingrained expertise and comfort with it. The universality of reading and writing on paper proved a formidable contender for digital adoption. Yet, for tasks like aggregating weekly data, the mobile solution was preferred over paper, offering time savings and efficiency over

manual methods. Gathering data digitally was seen as beneficial, even if it meant a parallel registration process[12].

Affordance	Potency Factor	Paper- based System	Mobile-based System
Collecting data daily	System Features	Weak	Strong
	User Abilities	Strong	Weak
	Context	Equal	
Aggregating data weekly	System Features	Weak	Strong
	User Abilities	Weak	Strong
	Context	Weak	Strong
Managing ward logistics	System Features	Strong	Weak
	User Abilities	Strong	Weak
	Context	Equal	
Accessing patient historical data	System Features	Strong	Weak
	User Abilities	Strong	Weak
	Context	Equal	

Table 10 - Summary of analysis of affordance actualization in the field facilities (Vila-Pozo et al. 2022)

In the demanding institutional backdrop of humanitarian environments, inherent views about technology use and its perceived usefulness mold the actualization of technological affordances. Recognizing how a strong potency can boost the chances of its actualization is crucial for achieving effective actualization (effective use). The analysis highlighted a consistent user inclination towards technology solutions that were friction-free, easy to use, and demanded minimal training. This trend shifted only when the technology conveyed an immediate sense of value, like a marked reduction in data management time.

[12] The organization and I decided to phase the process and introduce the new digital technology in parallel with the previous paper based- records instead of replacing it.

Addressing the Research Question

What are the operating affordances and ***how the institutional context shapes the process of actualization?***
This analysis complements answering the second part of the research question by showing understanding of how the particularities of technology and the institutional context shape the actualization of affordances. Findings identified how institutional conditions affect affordance actualization differently, both individually and through their interplay, either enabling or constraining factors that collectively influence the actualization of the affordances. Overall, affordances that provide a friction-free user experience are preferred over others, and the need for such natural use can be compensated by perceived usefulness.

5.2.5 Step 3 - Using inductive theorizing to elaborate on these principles in a given context.

The final phase of this study aims to theoretically define effective use within a humanitarian context. I posited earlier that the introduction of an information system in such a setting stands out as a critical case, given the environmental and operational challenges tied to the roll-out of digital solutions. To thoroughly examine the theoretical model of effective use and assess its applicability within this context, it's essential to highlight the distinct features of this critical case, which will then inform the subsequent analysis.

Informed by conclusions from prior analyses, I present a definition of the critical case anchored on three guiding principles for 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.

An analysis of the theory of effective use applied in a humanitarian setting

In this section, I contrast the overarching theoretical model of effective use with the three distinct principles for information system in humanitarian settings. I present a schematic representation of effective use (Figure 25) to illustrate the subsequent

analysis. The discussion begins with a focus on performance, transitions to effective use and its dimensions, and concludes by discussing the actions to improve effective use.

Performance (effectiveness and efficacy): According to the theory of effective use, all three dimensions converge to augment performance. Performance amplification is achieved through both effectiveness—defined as "the extent to which a user has attained the goals of the task for which the system was used"—and efficiency, which characterizes "the extent of goal attainment for a given input" *(Burton-Jones and Grange 2013, p. 654)*.

Transparent interaction reduces the time spent on data collection and aggregation, leading to increased user focus. Similarly, in my study, performance was perceived by users as a reduction in time spent on information system-related tasks and an increase in the feeling of usefulness. Representational fidelity contributes to performance as it reduces the need for data re-checking and enhances understanding of information, which the system users confirmed by valuing the proximity of technology to the source of data. Situational awareness enhances performance by reducing errors in decision-making, including for managerial tasks that require information-based decisions.

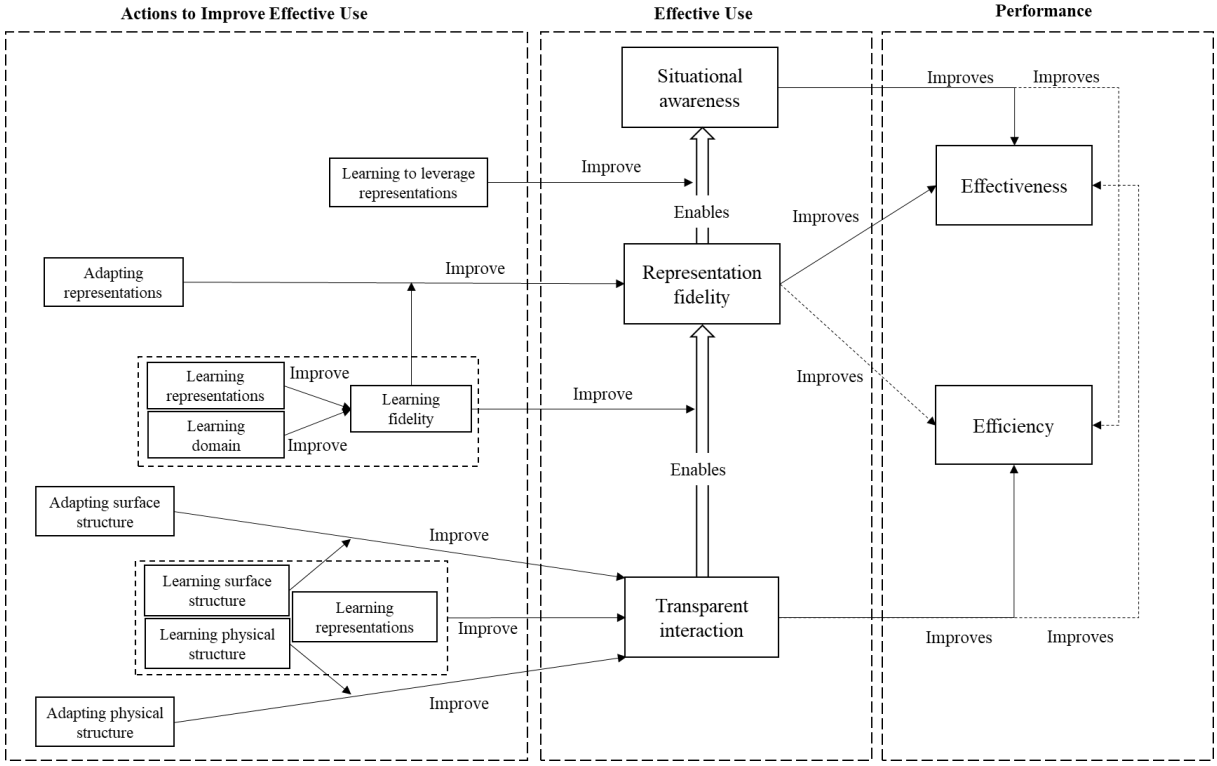

Figure 25 - Simplified representation of the TEU model (Burton-Jones and Grange 2013) adapted for emergency management (Bonaretti and Piccoli 2018)

Consistent with the model for effective use, performance holds paramount importance in humanitarian settings. This is underscored by the third principle for information systems in a humanitarian context, which posits that "humanitarian workers have to juggle multiple priorities constantly, optimizing time and perceived usefulness are critical factors for effective system use within this context".

Subsequently, I explore how the dimensions of effective use contribute to improved performance.

Effective use (through effective actualization): The theory of effective use is agnostic to specific technologies, making its dimensions applicable across varied information systems. The contextualization strategy in this study, rooted in the works of Burton-Jones & Volkoff (2017), suggests that the dimensions of effective use should be shaped to resonate with the specific context at hand. Yet, my analysis refrains from spotlighting contextual dimensions tailored for humanitarian settings. Instead, it delves into the existing dimensions within the theory—namely, transparent interaction, representational fidelity, and situational awareness (Bonaretti and Piccoli 2018; Burton-Jones and Grange 2013) — and assess and evaluates their applicability and relevance to the users and the context of the H-HMIS.

The dimensions of effective use are constructed upon pillars of use, encompassing users, systems, tasks, and the surrounding environment (Bonaretti and Piccoli 2018; Burton-Jones and Grange 2013). These pillars combine to shape the dimensions of effective use, resulting in varied degrees of transparent interaction, representational fidelity, and situational awareness—elements deemed essential for the actualization of affordances (Burton-Jones and Volkoff 2017). This is illustrated in Figure 26.

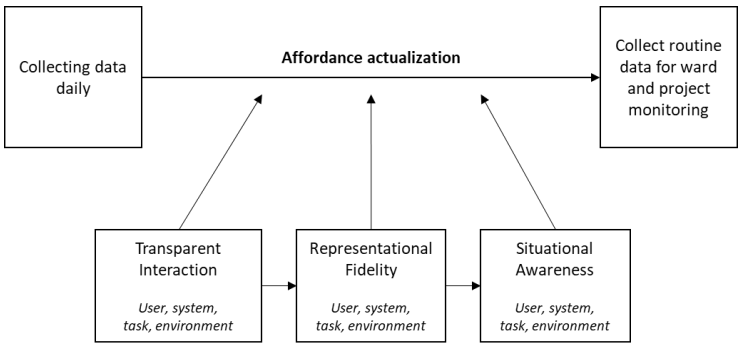

Figure 26 - Instantiation of image from Burton-Jones and Volkoff (2017)

Similarly, affordance actualization theory defines three factors for affordance actualization: system features, user abilities, and context (Strong et al. 2014). The task is represented by the affordance itself, which is understood as a potential goal-oriented action. Based on the parallelism between effective use and affordance actualization (Table 11), this section analyses the role of three dimensions for effective use building upon the findings from the analysis of affordance actualization. I will next analyse the three dimensions for effective use for the case under study.

Transparent Interaction is defined as "the extent to which a user is accessing the system's representations unimpeded by its surface and physical structures" (Burton-Jones and Grange 2013, p. 642). This dimension primarily enhances efficiency by minimizing the time users allocate to the system. A system that offers clear representations provides smoother interactions, potentially heightening user concentration, which is pivotal for efficacy. Positioned at the forefront of technology utilization, transparent interaction focuses on system

accessibility and is foundational in the ladder for attaining effective use. In the context of this study, the prerequisites for optimal affordance actualization emerge when users effortlessly perceive the system's affordances and recognize its utility in task execution. This is reflected in all guiding principles but is particularly evident in the second: "Humanitarian work develops in non-structured and fast-paced environments, an intuitive user experience is considered imperative to ensure use of the system."

Elements of use (TEU[13])	**Factors for actualization (AAT)**
User	User abilities
System	System Features
Environment	Context
Task	The affordance itself

Table 11 - Elements of use in TEU and Factors for Affordance Actualization

The facets of system access are also addressed by the other principles. The statement, "Humanitarian workers have to juggle multiple priorities constantly, optimizing time and perceived usefulness are critical factors for effective system use within this context.", underscores the role of perceived usefulness in influencing a user's choice between the system and alternative solutions. Furthermore, the principle, "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." underscores the importance of a flat learning curve. Training becomes indispensable when a system lacks intuitive design, requiring users to first learn its operations, a potential limiting condition for system access in this context.

Representational Fidelity, described as "the extent to which a user is obtaining representations from the system that faithfully reflect the domain being represented" (Burton-Jones and Grange 2013, p. 642), can improve effectiveness by enhancing the user's understanding of the subject matter, subsequently diminishing ambiguity. When system representations are accurate, representational fidelity can amplify efficiency by reducing the time users spend cross-referencing information. This dimension also fosters situational awareness, thereby supporting decision-making affordances. In the current study, it impacts the affordance of daily data collection, as identified limitations in available information proved problematic for both data collection and analysis. Representational fidelity also has implications for the weekly data aggregation affordance, as aggregated data sets the basis for subsequent representations and analysis.

[13] The extended version from emergency management context which includes the environment (Bonaretti and Piccoli 2018)

Situational awareness is the foundation of informed action, enhancing effectiveness by deepening the understanding of a given situation, which in turn can minimize the time wasted on uninformed decisions. It is crucial for the actualization of affordances that entail decision-making—such as operationability, accountability, and contextuability at the project coordination level—as well as managing the ward or accessing patient data at the facility.

The conceptualization of the dimensions for effective use—as a hierarchical pathway leading to improved performance, as detailed in the theoretical model of effective use—resonates with the contextual examination of the H-HMIS and the distinct affordances identified. These affordances operate on varying steps of the ladder towards effective use. A noteworthy finding from the analysis is the emphasis on transparent interaction in a humanitarian context. This corresponds with humanitarian technology acceptance literature which suggests that barriers encountered at the access level might culminate in the abandonment or misuse of a digital system (Kabra and Anbanandam 2016). Users, stationed in remote and tumultuous environments, necessitate a degree of independence. Their roles demand agility and decisive problem-solving judgement.

Subsequently, I will delve into the user actions that serve as drivers for effective use.

Drivers for effective use (learning and adaption actions): The theoretical model for effective use puts forth two principal user actions to enhance effective use: adaptation and learning. Learning actions encompass endeavors to understand the system and decode its representations. Meanwhile, adaptation actions involve efforts to modify the system or its representations to better cater to user requirements. These actions collectively target all effective use dimensions, with a pronounced emphasis on enhancing transparent interaction—a pivotal first step in the dimension hierarchy (Burton-Jones and Grange 2013).

However, relying on user actions like training and adaptation appears misaligned with the humanitarian context. The divergence between the first guiding principle and the theory of effective use emerges when juxtaposing the role of learning and adaptations in the theory with the principles governing information systems in humanitarian settings. Specifically, the first principle, which touches upon training and adaptations notes: “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”. This underscores a significant potential limitation in the theory of effective use's relevance to humanitarian settings.

To summarize, the analysis of the theory of effective use within the context of humanitarian settings underscores two pivotal insights. Firstly, Transparent interaction stands as a critical dimension for effective use, playing a determinant role in system utilization and acceptance. Secondly, depending on user-driven actions, such as training and adaptation, to bolster effective use appears incongruous with the humanitarian context. These findings point to an impending query, setting the stage for the subsequent section: How might an organization enhance transparent interaction to minimize training dependence and avert major system adjustments?

Prior to probing this question, I'll encapsulate the conclusions drawn from this initial phase of analysis.

Addressing the research question

How can the theoretical model for effective use be made relevant for humanitarian settings and diverse context?
This analysis addresses the third research question. The previous analysis results in defining three principles for information systems in a humanitarian setting: 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 analysis of the adequacy of model of the theory of effective use in responding to these principles identifies *i)* transparent interaction as the key dimension for attaining effective use and *ii)* the drivers for effective use as the main limitation for the applicability of the theory of effective use in humanitarian settings. Effective use in humanitarian settings, requires not relying on users´ actions. In the search of effective use, humanitarian organizations should focus on maximizing the dimension of transparent interaction.

Transparent interaction in humanitarian settings

In the preceding section, I theorized that transparent interaction is paramount for effective use within humanitarian contexts, significantly influencing system utilization and adoption. Optimal user experience should be exceptionally intuitive, instilling a sense of usefulness. Moreover, to achieve a satisfactory level of transparent interaction, there's a pressing need to minimize the dependency on training and system adjustments. This heightened emphasis on transparent interaction prompted my intention to revisit and refine its definition to better reflect the nuances of humanitarian contexts. To this end, I delved into its etymological origins. Transparent[14] means “having the property of transmitting light, so as to render bodies lying beyond completely visible; that can be seen through; diaphanous”. Figuratively, “easily seen through, recognized, understood, or detected; manifest, evident, obvious, clear”.

[14] Oxford English Dictionary

When contextualized within the user-digital system interface, it can be inferred as the system's capability to let its utility (akin to light) permeate through the system structures, enabling users to effortlessly discern potential actions. It signifies that users, by merely observing the interface, would intuitively grasp that *i)* they can execute specific tasks, such as patient searches, without a preceding learning curve, and *ii)* such actions are of value, and any invested effort in performing them is justified by the ensuing benefits.

This interpretation resonates with Gibson's (1979) foundational definition of affordances: “the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill” (p. 127). In Gibson's conceptualization, there's no inherent cognitive load on the animal to realize an affordance; it's inherently perceptible. A parallel notion of user experience is described by Winograd and Flores (1986) in their exposition of 'readiness-to-hand', which was foundational to Burton-Jones & Grange's (2013) coining of the term 'transparent interaction'. Readiness-to-hand underscores the user's awareness of their end goal (for instance, driving a car) without being mired in the intricacies of the process (like the precise turn of a steering wheel) (Winograd and Flores 1986). This concept zooms in on the user's perception of potential actions.

In the theory of effective use, the term “Transparent Interaction” is described as “the extent to which a user is accessing the system's representations not impeded by its surface and physical structures” (Burton-Jones and Grange 2013, p. 642). However, considering the unique characteristics of humanitarian contexts, I propose augmentations in two facets of this definition. Firstly, the system structures that factor into transparent interaction deserve scrutiny. Secondly, there's a need to unpack and elaborate upon the concept of 'impeded system access'.

Regarding system structures, the definition of transparent interaction primarily alludes to accessing through surface and physical structures, omitting the deep structure. Yet, my analysis underscored that the deep structure can equally impact user experience. Identified barriers to use include inadequate or unsuitable information present in the system. This encompasses not just gaps arising from incomplete data collection but also the data units (fields) present or absent in data entry forms. Such aspects are anchored in the deep structure (database modeling) and can obstruct the envisioned transparent interaction. They can introduce constraints stemming from the intrinsic model that no user interface can overcome. In certain systems, like the one examined in this study, the deep structure is adaptable, and the system's ontology directly depends on it. This accentuates the role of the deep structure in laying the groundwork for a user-centric domain. Instances like data entry forms misaligned with user expectations or data models failing to generate the desired representation for data analysis reinforce this argument. Therefore, my initial recommendation advocates for a transparent interaction definition that embraces all three components of the information system structures.

Pertaining to system access, the existing definition touches upon "impeded access" but lacks clarity on what qualifies as impediment or the nature of unobstructed access. My

research deduced that affordances, which foster intuitive system interactions, are more predisposed to actualization compared to those demanding learning or effort. In this light, if we discern learning as an untenable conduit to effective use, then the learning curve itself emerges as a barrier to perceiving potential system utility for a set objective.

Delving deeper into system access and drawing from Winograd and perspective on transparent interaction, the essence of such not impeded perception largely emanates from establishing “the right coupling between the user and the action they want to perform in the relevant domain” The domain alluded to corresponds to the reality within which the user operates. The duo underscores the pivotal role of language in constructing that world. Hence, the quest for achieving transparent interaction largely pivots on the semantics and visuals employed to craft the domain, especially as users navigate those constructs. This becomes exceptionally salient for humanitarian interventions, which frequently employ a specialized lexicon rooted in operational terminology (e.g., “mission,” “project,” “service,” “explo,” “movement”) along with numerous acronyms (like “HoM” denoting “Head of Mission,” “MedCo” for “Medical Coordinator,” “PMR” representing “Project Medical Referent,” and “NaM” signifying “Nurse Activity Manager”).

Both Gibson's original definition of affordances and Winograd and Flores's interpretation of readiness-to-use converge on the same type of seamless experience delineated in this research's findings for actualizing affordances in humanitarian settings. Drawing a parallel to the etymological essence of transparency — where a transparent substance permits light to traverse it, enabling clear visibility of objects beyond — I propose that transparent interaction is realized when the system's structures facilitate an access level where users can intuitively "see through" these structures, thereby naturally discerning the system's potential applications.

Bearing these insights in mind, I offer the following refined definition for transparent interaction:

> *Transparent Interaction:* The extent to which a user accesses the system's representations in a way that *its potential use is perceived through its surface, physical, and deep structures*[15].

While the notions of learning as an impediment to use, and the domain's pivotal role in aligning the user with a specific action, aren't explicitly articulated in the definition, they are tacitly embedded. I perceive them as instruments to amplify the sense of usefulness and afford "transparency" upon the user. These concepts, nevertheless, chart a trajectory for evaluating and enhancing transparent interaction, emphasizing the minimization of training needs and the establishment of a streamlined and coherent ontology for the user interface.

Complementing prevailing strategies for measuring transparent interaction, this dimension could be scrutinized by the extent of training required for system operation

[15] Text in italics are the modified parts of the definition.

and the degree of alignment between the system's ontology and the domain in which the user is engaged. To exemplify this proposition, existing evaluation instruments could be strengthened by incorporating metrics aligned with the ensuing parameters:

- When using the system, I have difficulty to complete my task because I do not know how to do it without training.
- When using the system, I have difficulty to understand the prompts, menus, and labels because the vocabulary used is unfamiliar.

The definition stems from three qualitative field studies that examined the environment, identified the affordances, and delved into the process of affordance actualization within a humanitarian context. I hope that this work, along with the suggested definition, serves as a valuable tool for researchers and practitioners when evaluating their systems' level of transparent interaction, whether in the design phase, during active use, or in comparison with other systems.

Addressing the research question

How can the theoretical model for effective use be made relevant for humanitarian settings and diverse context?
Prior analyses underscored the challenge of maximizing transparent interaction. To further address the research question, this study refines the definition of transparent interaction by encompassing all system structures and characterizing impediments as a constrained perception of usefulness. Transparent interaction: The extent to which a user accesses the system's representations in a way that its potential use is perceived through its surface, physical, and deep structures. The analysis indicates that the foundational principles of this definition emphasize that transparent interaction can be enhanced and evaluated based on the amount of training necessary to operate the system and the alignment between the system's ontology and the domain in which the user functions.

5.2.6 Summary of findings

This section provides a concise response to the overall research question:

> *What constitutes effective use of a health information system in a humanitarian organization?*

Effective use of the H-HMIS centres on the effective actualization of contextualized affordances, which can potentially advance organizational objectives. The identified affordances include collecting data *daily, managing the ward, accessing patient information, aggregating data weekly, operationability, accountability and contextuability*. Their actualization hierarchically contributes to the organizational objectives: monitoring the quality of health services, reducing data management

workload, shortening reporting times for integrated analysis, and facilitating informed decision-making.

The information system functions within the context of clashing institutional logics: dynamicity versus stability, heterogeneity versus homogeneity, and independence versus dependence on a restrictive infrastructure. These contradictions impact the system's deep, surface, and physical structures. Effective use is influenced by these institutional logics, which shape the actualization of affordances through these institutional conditions: mature use of information, limited availability of information, characteristics of the humanitarian work environment, and technical features of the system.

In humanitarian contexts, the innate perception of technology use profoundly influences the actualization of technology affordances. This perception undergoes change only when the technology presents an immediate sense of usefulness by significantly cutting down data management time. The environmental conditions shaping the implementation and adoption of information systems in humanitarian settings characterize it as a critical case of information system implementations. This is defined by the following guiding principles:

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 analysis of the response of the theoretical model of effective use to these principles identifies:

(i) Primary constraints for effective use stem from relying on user actions and emphasizing learning or adaptation actions as its core drivers,

(ii) Transparent interaction stands out as the central dimension for effective use in humanitarian scenarios. Realized at the system access level, it underscores that instinctive use and perceived utility are vitally significant.

To wrap up the analysis, I present a definition of transparent interaction tailored to the unique characteristics of the institutional context and its implications on the digital initiative:

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

This definition suggests that enhancing transparent interaction hinges on two focal points: *i)* the training needed to navigate the system, and *ii)* aligning the system's ontology with the domain in which the user operates. Evaluations of transparent interaction should include these elements to optimize the system's transparent interaction.

This analysis has identified certain constraints when applying the theoretical model for effective use in humanitarian environments. Nevertheless, the theoretical model holds significant promise for applicability, offering potential improvements to the effective use of routine information systems within the examined context. This research's diverse phases have yielded both practical and theoretical insights, which will be elaborated upon in the subsequent chapter.

6 Research Contributions

This study contributes to the domain of implementation of humanitarian health IS; and more broadly to IS research. Specifically, it enhances our understanding of the theories of effective use and affordance, as applied to humanitarian IS. Empirically it contributes to strengthening the informational response in humanitarian settings. By positioning humanitarian information systems within the mainstream IS literature, it addresses Professor Geoff Walsham's query, "Is ICTs making the world a better place for us to live?" (Walsham 2012). This is especially pertinent given that humanitarian organizations are dedicated to saving lives and enhancing conditions for those in dire need.

The primary contribution of my research lies in adapting the theory of effective use to the context of humanitarian interventions. I analysed an H-HMIS project, conceived at the headquarters and globally implemented in the field, as well as a subsequent intervention aimed at enhancing system acceptance within its specific environment. The H-HMIS functions as an instrumental aid for managing health interventions in humanitarian contexts, serving as the foundation for data-driven decision-making and actions—a core application area for the theory of effective use.

In my research, I apply the theory of effective use to assess the robustness of the digital intervention related to the H-HMIS in a particular situated context. This context is unique because it involves both novel managerial and operational components in a dynamic environment that differs from a typical business organization. This unique context, characterized as a critical case (Firestone 1993; Flyvbjerg 2006) allowed me to refine and adapt the original theory of effective use for a humanitarian environment, which represents the central contribution of my thesis.

My research adopted a ground-up approach, contextualizing a general information systems theory through an inductive process (Burton-Jones and Volkoff 2017). It combines principles from both the theory of effective use and affordance actualization theory. My examination suggests an enhancement to this contextualization process by including elements of environmental analysis. The environment is woven in through institutional analysis, the third theoretical component of this study, shedding light on the antecedents of effective use shaped by the system's design and implementation context.

The analytical process, illustrated in the Figure 27, places the concept of effective use (Burton-Jones and Grange 2013) at its core and integrates the two additional theoretical facets:

- Institutional theory, which helps discern both drivers and stressors effective use from an environmental perspective, and
- Affordance actualization theory, which lends depth to our understanding of effective use and the tangible challenges users face with technology.

This study offers both practical and theoretical insights that can guide a deeper understanding of the objectives managers aspire to realize in these environments, and

how this can be approached conceptually towards a better understanding of information systems in organizations (Burton-Jones and Volkoff 2017). The contextualization of the theory of effective use to the humanitarian context is realized through three means:

- Introducing the environmental role through the perspective of institutional logics.
- Investigating the micro-level network of affordances and their actualization process.
- Re-examining the Transparent Interaction dimension and suggesting a method to measure effective use within its context.

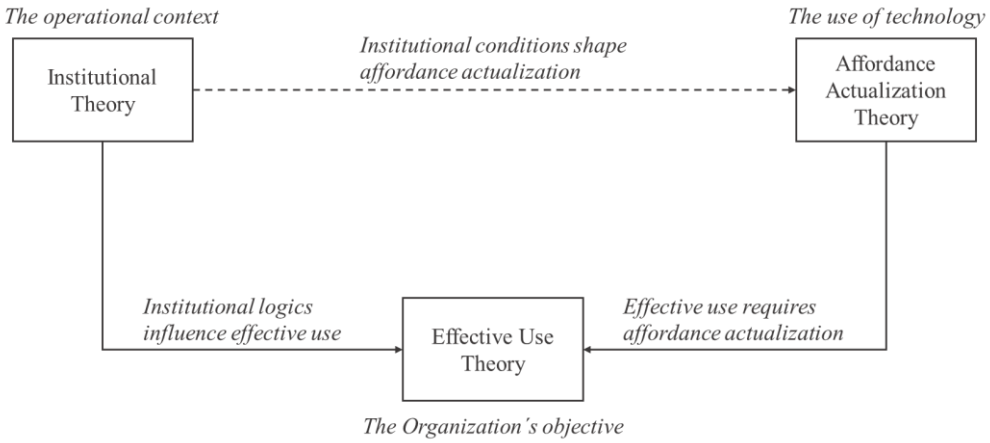

Figure 27 – Analytical process

This research primarily unfolds within the ontological realm, as the core objective revolves around examining the specific organization and its users. Its primary contribution is rooted at this level (Burton-Jones et al. 2017a). Nonetheless, there are insights that can broaden current perspectives in the epistemological domain, especially concerning the nexus between effective use and the suggested drivers to amplify its dimensions. This is particularly evident in the exploration of transparent interaction as a means of facilitating technology adoption.

Each of these contributions is now discussed.

6.1 Contextualization of the theory of effective use to a Humanitarian Context

This research positions the implementation of information systems in humanitarian settings as a critical case within the broader domain of information systems implementation. The definition of this critical case is shaped by three guiding principles:

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 contextualization of the theory of effective use takes these three principles into account, pinpointing potential boundary constraints of the theoretical framework. This analysis yielded two observations:

(i) Transparent interaction stands out as a pivotal dimension for attaining effective use within the complexities of humanitarian environments. Barriers in system access and low perceived usefulness could culminate in users abandoning the system or seeking alternative solutions. The ideal actualization of affordances emerges when users' experiences resonate with Gibson's (Volkoff and Strong 2013) original definition, which posits that there's no need for a distinct cognitive process to exploit the affordance. In this scenario, affordances are intuitively perceived.

(ii) The premise that training and adaption actions predominantly drive effective use arguably holds limited weight in humanitarian contexts. This challenges the full applicability of the theoretical model of effective use specific to such settings.

Collectively, these insights suggest that to facilitate effective system use in humanitarian contexts, organizations should concentrate on amplifying transparent interaction. The objective is to reach a level where users instinctively recognize the system's utility, thus minimizing the need for extensive training. This perspective complements existing literature where transparent interaction has been spotlighted as the most crucial aspect of effective use (Eden et al. 2019) notably during the system's initial adoption phase. During training, organizations should direct their efforts towards improving system interaction rather than emphasizing solely on data use and analysis. Further complicating this, humanitarian organizations face a continuous loss of capacity due to turnover, necessitating the provision of learning continuity through means other than training. As such, enhancing user interaction remains pivotal, even for systems that have been operational for an extended period.

This discussion underscores the challenge of enhancing transparent interaction within an organization. In addressing this, this research redefines the concept to integrate nuances specific to the humanitarian context. The refined definition posits two main elements: *i)* emphasizing the significance of all system structures (deep, surface, and physical) within the transparent interaction dimension, and *ii)* characterizing non impeded access as an interaction where the user perceives the usefulness of the system by interpreting its potential applications through these system structures. The revised definition of transparent interaction reads as follows:

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

This reframed definition accentuates that transparent interaction enables users to intuitively perceive the system's potential use. For instance, when users navigate a system, such as searching a patient in a healthcare information system, their ability to anticipate the completion of the task is facilitated by observing the system. This indicates available resources like power supply and internet connectivity or independent solutions (physical infrastructure). The search functionality employs recognizable fields tailored for healthcare professionals, incorporating domain-specific terms like patient name, date of birth, and medical record number (deep infrastructure). As a result, users can intuit or infer the process to locate a patient by scrutinizing menu options, interpreting labels and icons, and following calls to action like 'search' or 'submit' buttons (surface structure). Broadly, this user perception of usefulness is facilitated by two key aspects: *i)* the minimal training requisites for system operation and *ii)* the alignment between the system's ontology and the user's domain knowledge.

The updated definition of transparent interaction strengthens the theory of effective use by presenting a holistic view of the transparent interaction dimension, enveloping all three system structures. Additionally, it offers clarity by incorporating the notion of perceived usefulness as the means to guarantee not impeded access.

In response to the call by Burton-Jones and Grange (2013) for context-specific insights into the theory of effective use, researchers have attempted including finance (Haake et al. 2018), healthcare (Eden et al. 2019), emergency management (Bonaretti and Piccoli 2019), and business intelligence (Trieu et al. 2022). Burton-Jones and Grange (2013) proposed examining the theory's suitability in settings where data representation is not self-evident, and the reality is either ambiguous or susceptible to misrepresentation. The research in emergency management addresses such situations. Bonaretti and Piccoli (2018) explored the theory's relevance in chaotic environments and championed further exploration of Emergency Management Information Systems grounded in this theory. However, they also stressed the importance of empirical evaluations of its validity (Bonaretti and Piccoli 2019).

While Bonaretti and Piccoli's research aligns closely with my field of inquiry, their study predominantly delves into inter-agency coordination and information dissemination among entities active in emergency responses. Conversely, my research zeroes in on the internal processes inherent to a single humanitarian entity. Thus, my research builds upon their foundational work by undertaking empirical scrutiny within health humanitarian interventions, a distinctive environment, that stands “platform for the study of hard-to-get-at organizational phenomena” (Hällgren et al. 2018, p. 112).

I contend that the implementation and use of information systems within humanitarian contexts represent a critical case, being a "least likely” scenario

(Flyvbjerg 2006). This implies that introducing technology to users, who operate under the substantial environmental pressures and work conditions unique to humanitarian settings, creates a daunting backdrop wherein successful system implementation and user adoption—culminating in effective use—are challenging to achieve. Consequently, under the assumption of similar information requirements, a routine system that is successfully adopted in a humanitarian context would likely be successfully adopted in any resource-limited environment, and even more so in a conventional setting. This reasoning is rooted in the critical case logic of "If it is valid for this case, it is valid for all (or many) cases" (Flyvbjerg 2006, p. 230). A degree of transparent interaction that enables the user perception of usefulness and lessens the reliance on training, if deemed effective in humanitarian contexts, would be equally, if not more, effective in many other scenarios.

Specifically, my contextualization of the theory of effective use to humanitarian scenarios offers a substantive contribution by suggesting a redefined dimension of transparent interaction. This revised definition accentuates the importance of all three system structures within this dimension and distinguishes impeded access as users' diminished or absent perception of system usefulness. This refined definition holds the potential to underpin future research endeavours that focus on operationalizing the theory and strengthening systems through effective use. Both training initiatives and system ontology emerge as obstacles in recognizing the potential applications of a system, thereby acting as potential barriers for system access. Integrating these pivotal elements into evaluation tools could enhance researchers' capabilities to assess the transparent interaction dimension at its maximum levels, crafting systems adept for contexts that present extreme challenges to system use.

For the contextualization of effective use, three areas of extension are proposed and developed next which I will elaborate on subsequently.

6.2 Identifying Environmental Influences on Effective Use

Effective use refers to utilizing a system’s capabilities within a particular context to further the aspirations of an organization. The dynamics of this utilization are moulded by the environment wherein the system finds its application. Given the intertwined relationship between a system's goals and the organizational objectives, discerning the environmental challenges and their ramifications on the information system's conceptualization, design, implementation, deployment, and subsequent user adoption is paramount.

My underscores the instrumental role of institutional analysis in identifying the nature of environmental influences, both enabling and constraining. In this paradigm, the information system is conceptualized as an institutional entity possessing the capacity to guide the transformation of organized activities within its operational context (Avgerou 2002). This influence is shaped within an organizational field (Piotti et al. 2006), where different contexts of use, organizational levels, use cases, and user roles operate under “norms” introduced by the information system.

The research discerned specific institutional logics, such as dynamicity, restrictive and independent infrastructure, and heterogeneity, which stood in contrast to the logics inherent in routine information systems, typified by stability, dependency on infrastructure and heterogeneity. The foundational logics governing both the context and the system are in contradiction, forming a profound impact on the system and the ensuing user-technology interaction.

The juxtaposition of these logics bears significant implications for the structure of the information system. These implications extend beyond singular functionalities or aspects and encompass the holistic characteristics of the system, including its deep, surface, and physical structures. From design to deployment, these logics manifest their influence, shaping the trajectory toward achieving effective use. Chapter 5 delves into this analysis, featuring a diagram that elucidates the discordant institutional logics and their impact on system structures (Figure 23 - Conflicting logics and influence on system structures, pg. 76).

The institutional analysis has been instrumental in identifying the pivotal conditions crucial for understanding affordance actualization and the system's effective use. The Theory of Effective Use evolves from and expands upon the Representation Theory (Weber 1987), which predominantly concentrated on an internal view of the IS, detached from its social context and use. Nonetheless, Burton-Jones and Grange (2013) adapted the Representation Theory within the framework of effective use, thereby incorporating the reality of the system's deployment and use. This broader perspective is represented by the outer dashed box in Figure 28.

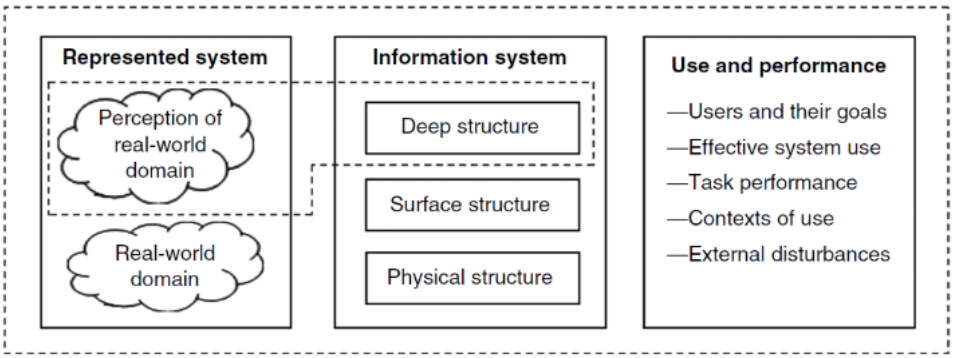

Figure 28 - Broadening the Scope of Representation Theory (Burton-Jones and Grange 2013)

In alignment with a broader understanding of the information system, the authors proposed the contextualization of the theory of effective use through the lens of affordance theory (Burton-Jones and Volkoff 2017). This was specifically tied to concepts surrounding the network of affordances and the intricacies of affordance actualization. The affordance actualization theory incorporates context (Strong et al. 2014), framing actualization as a confluence of three pivotal factors: context, user, and technology.

However, this contextualization rooted in affordance theory does not explicitly address the study of antecedents to effective use (Burton-Jones and Volkoff 2017). My research extends this perspective by introducing a supplementary phase that delves into the operational environment, leveraging insights from institutional theory. This contribution amplifies the study of the context's influence on the effective use of an information system—a facet initially not within the scope of the theory of effective use (Burton-Jones and Grange 2013).

The resulting extended process includes:

0. Understanding how the environment affects the organisation and system goals.
1. Understanding how a network of affordances supports the achievement of organisational goals.
2. Understanding how the affordances are actualised.
3. Using inductive theorizing to elaborate those principles in a given context.

The primary contribution lies in incorporating the institutional perspective to scrutinize the environment and its prevailing logics. This is relevant for scholars aspiring to contextualize the theory of effective use within a particular context, following the outlined process. The institutional analysis provides a framework to dissect environmental condition and comprehend their influence on user-technology interactions. This analysis contributes to the process of theorization, being particularly relevant on the step numbered 2. Such an institutional analysis of underlying logics can help better equip researchers to study processes of affordance actualization.

6.3 Developing Multi-level Conceptualization of Network of Affordances

Burton-Jones and Volkoff (2017) built their methodology upon two primary concepts rooted in the affordance actualization theory (Strong et al. 2014): the affordance network and affordance actualization. These foundational concepts elucidate the components of effective use within an information system's context. The affordance network defines the outcomes of effective use as a mesh of individual potential actions, termed affordances, and their respective outcomes. Individually, these affordances contribute to the overarching network, steering towards the fulfilment of organizational objectives.

Affordance actualization offers pivotal insights into the dynamic engagements users undergo when navigating the system to meet their specific goals. Pertinent to this research, the focus shifts to the tasks executed by health workers in the field, particularly as they interface with the H-HMIS. This is envisioned as a network of affordances, instrumental in deconstructing the overarching goals of the humanitarian organization. The network of affordances is moulded by users' perceptions of the H-HMIS technology within their professional setting. This exploration delves into the system's actual application in real-world scenarios and the interconnectedness and reliance of various tasks. The affordance network sheds light on the interplay between tasks, illustrating how impediments in one segment can compromise other areas. Such

insights are invaluable for humanitarian organizations, equipping them to better support their field personnel in optimizing the H-HMIS.

This work builds upon the approach of contextualizing effective use through a network of affordances (Burton-Jones and Volkoff 2017), which has previously been applied to community health systems (Burton-Jones and Volkoff 2017) and the introduction of wearable devices in senior population (Abouzahra and Ghasemaghaei 2021), and applies it to a novel context of humanitarian organizations. The contribution responds to the need to closely examine the micro-level processes through which humanitarian workers incorporate or abandon digital solutions when introduced in their daily work (Kabra and Anbanandam 2016), and the added value they see in developing their everyday work processes.

6.4 Developing a Competing Affordance Potency Framework

With the influx of new digital interventions, there arises the inherent challenge of coexistence with, or replacement of systems or manual operations deeply embedded in an organization's modus operandi. This investigation turned its lens on users juggling traditional paper-based methods alongside a new digital solution, through the prism of "competing affordances." The competing affordances framework allowed an examination of both the nature of affordances enabled by the different solutions and the situated potencies users simultaneously recognized.

The analytical journey unearthed these situated affordances by dissecting explicit technological features and adaptations formulated by users to cater to specific requisites. Subsequently, the potency of each affordance was assessed based on its manifestation through user capabilities, environmental factors, and inherent system attributes. Findings highlighted a preference among users for solutions that were perceived as useful and did not require explicit additional cognitive processes.

Aligned with the foundational concept of affordance in the domain of ecological psychology (Gibson 1979), the preferred solution invariably provides a user experience reminiscent of an animal's perception of an object based on its affordances. This insight underscores that digital solutions in humanitarian environments should prioritize ease-of-use and minimize friction, akin to effortlessly picking an apple from a tree. Such a system responds promptly to user needs. This knowledge holds profound implications for comprehending system access dynamics, especially since affordances that exhibited high potencies presented fewer barriers to usage, reflecting the dimension of transparent interaction.

This section outlines three seminal theoretical contributions. First, it extends the affordance potency framework (Anderson and Robey 2017) by examining its relevance to technology adoption in humanitarian scenarios and introduces the notion of competing affordance potencies. This approach underscores the importance of delivering an intuitive digital interaction. In these volatile environments, where both user profiles and operational scenarios continually shift and are often remotely situated, the seamless incorporation of technology becomes pivotal (Kabra et al. 2017). If technology doesn't weave seamlessly into daily routines, users might resort to

alternatives, which could entail different technologies or abandoning digital tools altogether (Kabra and Anbanandam 2016). Enhancing our understanding of high potency of affordances boosts the chances of users actively engaging with a system and leveraging its inherent affordances.

Second, this contribution delves into the concept of competing affordances, building upon prior studies that concentrated solely on individual digital solutions. Such an exploration is valuable as introducing new technologies invariably signals a shift from established systems to innovative ones, resulting in inevitable competing affordances. This scrutiny addresses the need to comprehend how users discern, amalgamate, and over time, refine their usage patterns (Burton-Jones and Grange 2013). Introducing a perspective that contemplates the competition or rivalry among affordances, and acknowledging the remains of legacy systems, offers valuable insights for IS research. Historically, inquiries predominantly focused on the new system's affordances in isolation, detached from pre-existing context.

The third academic contribution pivots on the integration of the affordance potency concept with the contextualization of effective use. The presented framework is a steppingstone towards the development of contextual theories of IS utilization. This endeavour pinpointed the potential actions the IT artifact offers its users, as well as its practical implications in distinct scenarios (Burton-Jones & Volkoff, 2017), as discerned through the lens of situated affordances (Anderson & Robey, 2017).

From a practical standpoint, this part of the study offers two distinct ways of improvement. Firstly, the situated affordance approach is relevant in uncovering unexpected system affordances, along with the associated potencies as discerned by users. Secondly, the framework provides a tool for analysing the utilization of technology when it competes with pre-established solutions.

This inquiry leans on the "competing affordances" paradigm to understand the interplay of competing legacy and modern systems and how these dynamics mould adoption decisions. Striking strong potencies poses a challenge for IS deployment and use. In this context, the legacy system was paper based. Subsequent studies can refine this methodology by juxtaposing multiple digital solutions cohabiting or being evaluated concurrently during processes of change. Applying this in arenas beyond healthcare or humanitarian contexts could provide added validity to the framework.

6.5 An Affordance-Based proposal for Assessing Effective Use in Context

This final contribution addresses the task of operationalizing "effective use" and equips practitioners with tools to evaluate the efficacy of their system utilization. While rooted in theory, this contribution carries significant promise for offering actionable insights for practical contributions, such as pinpointing areas suitable for refinement to strengthen effective use. It emerges from the need to furnish organizations with strategies to enhance their H-HMIS deployment in the field.

Burton-Jones and Grange (2013, p. 653) asserted that “researchers need instruments to test the relationships in the theory of effective use model, and practitioners need

instruments to assess how effectively systems are being used." Drawing from the understanding and insights from this study, this section aspires to provide humanitarian organizations with pragmatic directives on assessing the effectiveness of their informational systems.

Some researchers have operationalized the theory of effective use by hypothesizing the relationships between its dimensions (Haake et al. 2018; Trieu 2013). Others have delved into the nexus between performance and each individual dimension (Campbell and Roberts 2019), or assessed the overarching construct of effective use Eden et al. (2020) endeavoured to operationalize the theory of effective use, proposing a survey tool for its assessment. They built upon metrics suggested by Burton-Jones and Grange (2013) proposing an assessment tool that integrates the system within the measurement items.

The process proposed is a mixed-methods survey, which enhances the extant measurement tool (Eden et al. 2020) by intertwining it with the "network of affordances" concept (Burton-Jones and Volkoff 2017). This approach is anchored in the refined notion of transparent interaction, underscoring the pivotal role of transparency as the system's ability to make its usefulness apparent, letting users "see through" the system's structure and the potential tasks at their disposal. Thus, the methodology strives to blend tasks, as identified by users for their importance or utility, within the dimensions of effective use. The methodology is spread over four stages, resulting in a measurement instrument that incorporates specific tasks within the measurement items. A detailed breakdown of these stages is described next.

The initial step in this process entails the identification of relevant tasks by formulating a network of affordances. Ideally, this network should stem from a qualitative analytical process where affordances are discerned based on users' perceptions and applications in situated contexts. This accentuates tasks that users deem valuable in their routine activities.

The subsequent step involves categorizing the discerned affordances in terms of granularity using the Nested Affordance Process (NAP) model (Valbø 2022). This model segments affordances into three distinct layers:

- Low-level affordances, which imply direct use of technology.
- Mid-level affordances (Valbø and Sanner 2022), emerge from actualising low-level affordances, are closely related to technology use, but do not require it;
- Higher-level affordances, emerge from actualizing mid-level affordances but operate at higher levels and are not explicitly related with use of technology.

The third step pivots on pinpointing the low-level affordances. In instances where mid or higher-level affordances are recognized, it is necessary to delve deeper and identify the associated low-level affordances, which correlate with direct technology-use. Not all It's noteworthy that not every low and mid-level affordance will ascend to a high-level one, yet every high-level affordance should be traceable to its low-level counterpart.

The second and third steps zero in on discerning the granularity levels of the affordances. This differentiation is required because the dimensions for effective use vary based on the levels of affordance. For instance, the dimension of transparent interaction pertains to system access, encompassing the direct engagement with technology. Such direct interaction invariably occurs in low-level affordances and occasionally in mid-level ones. Conversely, the dimension of situational awareness doesn't inherently entail the direct use of technology. Instead, it emphasizes the user's cognitive process in deciphering information gleaned from system representations. An affordance that does not imply direct technology interaction is deemed a high-level affordance. Consequently, discerning the level of each affordance is paramount to appropriately align them with the pertinent dimensions. Figure visually represents the interrelation between dimensions of effective use and levels of affordance.

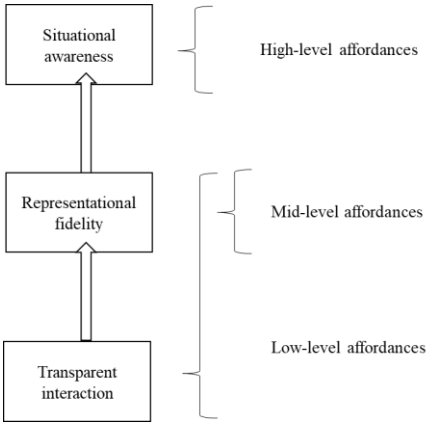

Figure 29 - Dimensions of effective use and affordances levels

After categorizing the affordances, the fourth step involves generating a questionnaire by integrating the measurement items of each dimension (detailed in Appendix 1) with the identified affordances at their pertinent levels. Every measurement item within a given dimension should be assessed concerning its corresponding affordances. By the end of this procedure, researchers will possess an all-encompassing measurement instrument that incorporates tasks into measurement items for each appropriate dimension. Conversely, it will weave dimensional measurement items into the user-defined tasks. To provide clarity, an example of this process applied in the humanitarian setting developed using the findings from this research is included in Appendix 2. The resulting exemplifying measurement tool is included in Appendix 3.

This work aims to contribute to the operationalization of effective use within a humanitarian context, offering a method for its measurement. Building on the foundational work by Eden (2020), this study introduces the concept of integrating contextualized tasks into an established survey instrument designed to measure effective use. The outcome is a mixed-methods approach to assessing effective use contextually. This approach merges: *i)* insights from a qualitative process of contextualization (constructing the affordance network), and *ii)* a quantitative measurement tool that results in a contextualised measurement instrument.

The aim of this contribution is to enrich the evaluation of the theory of effective use's applicability (Burton-Jones and Grange 2013) by suggesting an assessment method tailored for an H-HMIS. From what I understand, current survey metrics for effective use do not specifically cater to the nuances of the humanitarian environment. Theoretically, the application and validation of this method could enhance the evaluation techniques for effective use within specific contexts. Practically, this methodology has the potential to be used in subsequent initiatives to assess the effective use of systems by humanitarian professionals and other varied scenarios. By weaving specific tasks into the evaluation tool, there's the opportunity to yield insights that not only assess effective use in relation to its dimensions, but also pinpoint areas where the system's efficacy is hindered, whether due to task-related challenges, dimensions, or a combination of both.

I will now describe the practical contributions that this work produced for the organization.

6.6 Practical Contributions

6.6.1 Building a foundation of knowledge for strengthening H-HMIS in the field

My research furnished MSF-Spain with a deeper understanding of their operational environment and the potential friction points that influence the implementation and use of their H-HMIS system. As the study advanced, a series of reports emerged, detailing the research's practical consequences, and offering insights and recommendations.

An institutional analysis facilitated a more nuanced grasp of the operational environment pivotal for successful technological deployments. Given their familiarity with complex, resource-limited settings, the intricacies of their environment were often overlooked. Examining the distinct operational paradigms in their fieldwork versus the prerequisites of standard information systems proved invaluable. This made explicit the obstacles they encountered in tech endeavours. Such insights not only resonate with the on-ground challenges users experience but also have implications for system design, configuration, and by extension, project management. This knowledge can guide MSF-Spain in forthcoming launches of other IT systems, informing decisions related to infrastructure, rollout strategies, testing protocols, and other pivotal project considerations.

Scrutinizing the affordances and how they're actualized spotlighted the challenges their field users encountered, identifying the data collection process as a major impediment to system acceptance on-site. This prompted an on-ground intervention to transition to digital data collection and aggregation methods. Consequently, the organization now has a detailed map of the affordances related to their H-HMIS in the field projects and the consequent affordance network that steers effective system use. The affordance perspective, potency framework, and guidance for facilitating transparent interaction can profoundly shape the design of existing and future data

collection systems. Additionally, these insights can inform tailored training materials to address system use essential aspects.

6.6.2 Digitalizing field data collection in regular interventions

The main problem with data management was the data collection process. To address this, we started using mobile technology in medical wards to make data collection digital. This new method aimed to automatically aggregate weekly data into the routine reporting system, H-HMIS. This change had big benefits. Users spent less time collecting data, which let them focus more on patient care and managing the wards. The quality of the data also showed improvements, especially in the main areas linked to running the medical wards. The main changes were collecting data using mobile devices and having the data aggregated automatically.

Since starting, the initiative has experienced a successful evolution. At the time of writing this (August 2023), the updated version has been used for two years and three months. This version added features based on the first round of research, like more details about patients and an easier way for users to search for and filter patient information. The organization is now preparing the scalation for using this solution in other interventions.

Overall, this work has helped the organization build a foundation of deep knowledge of their H-HMIS from an IS/organizational perspective. In doing so, it has facilitated the generation of valuable guidance and recommendations for IS professionals and strategic decision makers. Achieving the equilibrium between introducing novel systems and having the organizational capacity to integrate them is of utmost importance. This study demonstrates how introducing innovative technology can effectively overcome the challenges posed. Throughout the research project, the organization has received practical recommendations for strengthening their H-HMIS in the field during all iterations. All field visits of this research project contributed to strengthening the information system adoption.

The next chapter will close this thesis with the concluding remarks of this work, highlighting the potential for generalization, as well as the main limitations of this research project and possibilities for future work.

7 Concluding Remarks

This chapter concludes my thesis by summarizing some of the key learnings arising from my analysis and their potential for generalization and extension, some key limitations and potential for future work.

My study aimed to understand what it takes to use health information systems effectively in a humanitarian setting. What are the challenges that the environment poses into the deployment and use of technology, and how can organizations strengthen their information systems to provide better acceptance in the field. I approached this challenge by contextualizing the theory of effective use in the humanitarian context.

The contextualization of effective use was informed by an analysis developed at two levels. The macro-level analysis of institutional logics identified a context driven by the logics of dynamicity, heterogeneity, and independence, in contrast to an information system that relies on logics of stability, homogeneity, and dependency on infrastructure. These conflicting logics challenge the information system and need to be taken into account from the early design phases of the project. They affect the deep, surface, and physical structures of the information system, inevitably influencing its effective use.

The micro-level analysis of how institutional logics shape the use of the system in the field is done with an affordance lens. Building the affordance network helped understand the different affordances operating in the field project and trace their contribution to organizational goals. The study of the actualization of the individual affordances highlighted the key role of providing friction-free access to the system, where the perception of usefulness compensates the effort required to introduce the technical artifacts in daily work. Aiming for a natural interaction between the user and the digital technology helps compensate for the lack of time for training activities, which is even more relevant due to the high turnover rates of field workers.

These findings define a context in which attaining effective use is of utmost importance, and the theory has high potential to help humanitarian practitioners and researchers strengthen information systems. However, there are inherent challenges that need to be overcome. The drivers for effective use based on learning and adaptation actions are arguably minimally applicable in humanitarian settings and providing a maximal transparent interaction must be the core strategy for information systems projects. In response, this thesis proposes an extended definition of the dimension and highlights two key aspects of the information system for its assessment: the need for training required and the alignment with the user domain of work. The thesis concludes by proposing an affordance-based method for building measurement tools to assess effective use. The process brings the desired outcomes of the users (as tasks) into the measurement items and has potential for both measuring the effective use of the information system and helping organizations identify where the actualization of their network of affordances is experiencing challenges.

At a practical level, this thesis studied novel approaches for strengthening health information systems within organizations. The need to guarantee efficiency and efficacy in humanitarian interventions is imperative. However, it is still difficult to track due to a lack of data that is either unavailable or not measured at all (ALNAP 2022). Some organizations have made conscious efforts, but it is still challenging to draw firm conclusions about the effectiveness of interventions (ALNAP 2022). The deployment of information systems that are effectively used and contribute to improving the performance of organizations by providing relevant information remains a challenge in the humanitarian domain.

Access to field settings is sensitive and highly restrictive, and any specific purpose of field visits must be justified with a clear and practical contribution to the project. Hence, conducting IS research is a novel activity for the organization, where institutionalized operational research typically falls under medical science. For MSF Spain, engaging in research in this field has been a brave and determined decision. It proves the gradual increase in acknowledging the central role of health information systems in facilitating operational action and accountability.

Emerging technology holds many potential benefits for humanitarian action, yet it also introduces challenges. It is crucial to strike a balance between introducing these novel systems that can enhance quality and streamline accountability, and the organizations readiness to assimilate them and strengthen their existing processes. Learning from users' experiences in the most remote and challenging settings is key to finding this balance and creating strong use cases for different user groups. I believe this study contributes to the challenges faced by IS professionals concerned with the research and practice of humanitarian organizations.

7.1 Potential for Generalization

My work connects the field of information systems with a global humanitarian organization. This empirical approach is novel and has reciprocal benefits. The field of information systems can benefit and learn from being applied in such environments, and it opens a new research line within the organization to strengthen their information systems through the application of general IS knowledge, which could inspire others.

This project positions the humanitarian setting as a critical case for the implementation and adoption of information systems. From this viewpoint, organizations and researchers engaged in similar challenging settings or normally less demanding environments, could derive meaningful insights from these findings and recommendations in their empirical IS related projects. I believe that the theoretical frameworks presented here could help further empirical research disentangle the role and challenges of information systems implementation and strengthen our understandings of effective use. The lens of institutional shaping of affordances can help identify contextual challenges faced by digital technologies and disentangle their potential for change. The framework of “competing affordance potency” can potentially be applied to studies of IS implementation, where new technologies work in parallel

with previous or competing solutions. Its application can inform IS practitioners to ensure a smooth process of replacement or identify areas for improvement by learning from working solutions. The contextualization of effective use and the identification of its potential boundary conditions when applied to resource-constrained settings, could also be relevant in contexts other than humanitarian settings that undergo similar or less challenging scenarios.

Particularly for the organization under study, the knowledge gained, and solutions developed can be and are being taken to other projects and missions and spread throughout the global organization to improve upon the effectiveness of their digitalization interventions.

7.2 Limitations and Future Research

There are two main limitations to this research at the micro-level. First, the advantages and challenges identified were discerned within the particular environment of healthcare services at a moderate-capacity facility. In addition, the data collection processes, even if based in paper, were functioning prior to the implementation. As a result, the recommendations presented in this study cannot be directly generalized to other types of projects where there are other kinds of digital or manual systems. To strengthen the suitability of the frameworks used, further studies could explore their effectiveness in high-volume patient services or projects in acute emergency mode where the immediate need to deliver medical attention contends with other tasks related to data management processes. Similarly, the framework's applicability could be explored in projects beyond health facility premises, like community outreach, where data collection processes may be less mature. Secondly, certain advantages identified, such as the time saved in the data collection process, posed challenges for objective quantification. This was attributed to the intensive and critical work in the medical ward, where users were constantly interrupted by managerial or medical duties.

At the macro-level, the operationalization of the new definition of transparent interaction and the proposed method for assessing effective use in context is in the initial developmental phase, and further research is required to test and validate them. The affordance-based process proposed for measuring effective use has potential for helping organisations to evaluate the impact of their information systems in supporting their specific organisational objectives. Applying the method for testing and validation can be part of future research.

At a practical level, the organization could benefit from mapping the network of affordances leading to effective use of the complete data flow. Such an exercise would extend the network of affordances of their H-HMIS system to incorporate the higher levels involving country coordination and headquarters users. This would increase the relevance of the intervention and research for headquarters and increase the knowledge and potential studies of effective use within the organization. Overall, this could support strengthening the use of data for informing various humanitarian interventions.

Appendix 1

Construct	Item
Transparent Interaction	TI1: When using [System], I have seamless access to the content that I need to complete [System]. TI2: When using [System], I have difficulty obtaining the content I need to complete my job task because of [System]'s interface. TI3: When using [System], I have difficulty obtaining the content I need to complete my job task because of the physical characteristics of the device I use to access [System].
Representational Fidelity	RF1: When completing my job task using [System], the information provided is complete. RF2: When completing my job task using [System], the information provided is clear. RF3: When completing my job task using [System], the information provided is correct. RF4: When completing my job task using [System], the information provided is meaningful.
Informed Action	IA1: When I obtain information from [System], I look for the relevant aspects that I can act upon to improve my task performance. IA2: When I obtain information from [System], I seek ways to leverage good pieces of information for my job. IA3: When I obtain information from [System], I avoid acting on information that I think is suspect.6

Table 12 - Measurement Tool (Eden et al. 2020)

Appendix 2

Step 1. Identify the affordances leading to effective use.

The network of affordances was developed as part of the research project and analysis. The process is documented in the Research Analysis and Findings chapter. The resulting affordances are listed below:

- Collecting data daily
- Managing Inpatient ward
- Accessing patient data
- Aggregating data weekly
- Operationability
- Accountability
- Contextuability

Step 2. Classify the identified affordances per level of affordance (Valbo,2022)

The affordances identified operate at different levels.

Affordance	Lower-level	Mid-level	Higher-level
Collecting data daily	x		
Managing Inpatient ward		x	
Accessing patient data		x	
Aggregating data weekly	x		
Operationability			x
Accountability			x
Contextuability			x

Table 13 - Example: classification of affordances in granularity levels

Step 3. If affordances in mid or higher-level are identified, drill down to find the related lower-level technology-use affordances

By analysing the affordances to find their lower-level affordances, we observe that different lower-level affordances can contribute to the emergence of one mid-level affordance, and one lower-level affordance can contribute to many mid-level affordances. Ans the same occurs between mid and higher levels. We also observe that all affordances contribute to the higher-level ones. The relationship of affordances between levels is n:n.

Identified Affordance	Lower-level	Mid-level	Higher-level
Collecting data daily	Collecting data daily	(6) Generate reporting data	(12) (13) (14)
Managing Inpatient ward	List admitted patients	(7) Managing Inpatient ward	(12) (13) (14)
Accessing patient data	Search for patient	(8) Accessing patient data	(12) (14)
Aggregating data weekly	Aggregating data weekly	(6)	(12) (13) (14)
Operationability	Generate chart/table	(9) Open a new health service	(12) Operationability
Accountability	(5)	(10) Justify need of new service	(13) Accountability
Contextuability	(5)	(11) Analyse seasonal malaria	(14) Contextuability

Table 14 - Example: Identification of affordances at lower levels

This analysis has been made for demonstration purposes and, for example, the mid-level affordances for operationability, accountability and contextuability have been extracted from the data in the interviews to provide meaningful examples. A deeper analysis will reveal more mid-level affordances contributing to the three high-level affordances identified.

Step 4. Generate the survey

Generate the measurement items by combining the original items with the affordances according to the following reference the table.

	Transparent Interaction	Representational Fidelity	Situational awareness
Low-level	x	x	
Mid-level		x	
High-level			x

Table 15 - Dimensions of effective use and affordances levels

Appendix 3

Construct	Item + Affordance
Transparent Interaction	**Lower-level affordances**
	TI1.1: When using the H-HMIS, I have seamless access to the content that I need to *collect data daily*. TI1.2: When using H-HMIS, I have difficulty obtaining the content I need to *collect data daily* because of H-HMIS's interface. TI1.3: When using H-HMIS, I have difficulty obtaining the content I need to *collect data daily* because of the physical characteristics of the device I use to access H-HMIS.
	TI2.1: When using the H-HMIS, I have seamless access to the content that I need to *list all admitted patients*. TI2.2: When using H-HMIS, I have difficulty obtaining the content I need to *list all admitted patients* because of H-HMIS's interface. TI2.3: When using H-HMIS, I have difficulty obtaining the content I need to *list all admitted patients* because of the physical characteristics of the device I use to access H-HMIS.
	TI3.2: When using H-HMIS, I have difficulty obtaining the content I need to *search for a patient* because of H-HMIS's interface. TI3.3: When using H-HMIS, I have difficulty obtaining the content I need to *search for a patient* because of the physical characteristics of the device I use to access H-HMIS.
	TI4.1: When using the H-HMIS, I have seamless access to the content that I need to *aggregate weekly data*. TI4.2: When using H-HMIS, I have difficulty obtaining the content I need to *aggregate weekly data* because of H-HMIS's interface. TI4.3: When using H-HMIS, I have difficulty obtaining the content I need to *aggregate weekly data* because of the physical characteristics of the device I use to access H-HMIS.
	TI5.1: When using the H-HMIS, I have seamless access to the content that I need to *generate an analytical object*. TI5.2: When using H-HMIS, I have difficulty obtaining the content I need to *generate an analytical object* because of H-HMIS's interface. TI5.3: When using H-HMIS, I have difficulty obtaining the content I need to *generate an analytical object* because of the physical characteristics of the device I use to access H-HMIS.

Representational Fidelity	RF1.1: When completing my job task using H-HMIS, the information provided to *collect data daily* is complete. RF1.2: When completing my job task using H-HMIS, the information provided to *collect data daily* is clear. RF1.3: When completing my job task using H-HMIS, the information provided to *collect data daily* is correct. RF1.4: When completing my job task using H-HMIS, the information provided to *collect data daily* is meaningful.
	RF2.1: When completing my job task using H-HMIS, the information provided to *list all admitted patients* is complete. RF2.2: When completing my job task using H-HMIS, the information provided to *list all admitted patients* is clear. RF2.3: When completing my job task using H-HMIS, the information provided to *list all admitted patients* is correct. RF2.4: When completing my job task using H-HMIS, the information provided to *list all admitted patients* is meaningful.
	RF3.1: When completing my job task using H-HMIS, the information provided to *search for a patient* is complete. RF3.2: When completing my job task using H-HMIS, the information provided to *search for a patient* is clear. RF3.3: When completing my job task using H-HMIS, the information provided to *search for a patient* is correct. RF3.4: When completing my job task using H-HMIS, the information provided to *search for a patient* is meaningful.
	RF4.1: When completing my job task using H-HMIS, the information provided to *aggregate weekly data* is complete. RF4.2: When completing my job task using H-HMIS, the information provided to *aggregate weekly data* is clear. RF4.3: When completing my job task using H-HMIS, the information provided to *aggregate weekly data* is correct. RF4.4: When completing my job task using H-HMIS, the information provided to *aggregate weekly data* is meaningful.

	RF5.1: When completing my job task using H-HMIS, the information provided to *generate an analytical object* is complete. RF5.2: When completing my job task using H-HMIS, the information provided to *generate an analytical object* is clear. RF5.3: When completing my job task using H-HMIS, the information provided to *generate an analytical object* is correct. RF5.4: When completing my job task using H-HMIS, the information provided to *generate an analytical object* is meaningful.
	Mid-level affordances
	RF6.1: When completing my job task using H-HMIS, the information provided to *generate reporting data* is complete. RF6.2: When completing my job task using H-HMIS, the information provided to *generate reporting data* is clear. RF6.3: When completing my job task using H-HMIS, the information provided to *generate reporting data* is correct. RF6.4: When completing my job task using H-HMIS, the information provided to *generate reporting data* is meaningful.
	RF7.1: When completing my job task using H-HMIS, the information provided to *manage the inpatient ward* is complete. RF7.2: When completing my job task using H-HMIS, the information provided to *manage the inpatient ward* is clear. RF7.3: When completing my job task using H-HMIS, the information provided to *manage the inpatient ward* is correct. RF7.4: When completing my job task using H-HMIS, the information provided to *manage the inpatient ward* is meaningful.
	RF8.1: When completing my job task using H-HMIS, the information provided to *access patient data* is complete. RF8.2: When completing my job task using H-HMIS, the information provided to *access patient data* is clear. RF8.3: When completing my job task using H-HMIS, the information provided to *access patient data* is correct. RF8.4: When completing my job task using H-HMIS, the information provided to *access patient data* is meaningful.

	RF8.1: When completing my job task using H-HMIS, the information provided to *make operational decisions* is complete. RF8.2: When completing my job task using H-HMIS, the information provided to *make operational decisions* is clear. RF8.3: When completing my job task using H-HMIS, the information provided to *make operational decisions* is correct. RF8.4: When completing my job task using H-HMIS, the information provided to *make operational decisions* is meaningful.
	RF9.1: When completing my job task using H-HMIS, the information provided to *open a new health service* is complete. RF9.2: When completing my job task using H-HMIS, the information provided to *open a new health service* is clear. RF9.3: When completing my job task using H-HMIS, the information provided to *open a new health service* is correct. RF9.4: When completing my job task using H-HMIS, the information provided to *open a new health service* is meaningful.
	RF10.1: When completing my job task using H-HMIS, the information provided to *justify the need of new service* is complete. RF10.2: When completing my job task using H-HMIS, the information provided to *justify the need of new service* is clear. RF10.3: When completing my job task using H-HMIS, the information provided to *justify the need of new service* is correct. RF10.4: When completing my job task using H-HMIS, the information provided to *justify the need of new service* is meaningful.
	RF11.1: When completing my job task using H-HMIS, the information provided to *analyse seasonal malaria* is complete. RF11.2: When completing my job task using H-HMIS, the information provided to *analyse seasonal malaria* is clear. RF11.3: When completing my job task using H-HMIS, the information provided to *analyse seasonal malaria* is correct. RF11.4: When completing my job task using H-HMIS, the information provided to *analyse seasonal malaria* is meaningful.

Informed Action	**Higher-level affordances**
	IA12.1: When I obtain information from H-HMIS, I look for the relevant aspects that I can act upon to improve *my operational decisions*. IA12.2: When I obtain information from H-HMIS, I seek ways to leverage good pieces of information for *my operational decisions*. IA12.3: When I obtain information from H-HMIS, I avoid acting on information that I think is suspect for *my operational decisions*.
	IA13.1: When I obtain information from H-HMIS, I look for the relevant aspects that I can act upon to improve my *accountability*. IA13.2: When I obtain information from H-HMIS, I seek ways to leverage good pieces of information for my *accountability*. IA13.3: When I obtain information from H-HMIS, I avoid acting on information that I think is suspect for my *accountability*.
	IA14.1: When I obtain information from H-HMIS, I look for the relevant aspects that I can act upon to improve my *knowledge of the context*. IA14.2: When I obtain information from H-HMIS, I seek ways to leverage good pieces of information for my *knowledge of the context*. IA14.3: When I obtain information from H-HMIS, I avoid acting on information that I think is suspect for my *knowledge of the context*.

Table 16 - Example: measurement items for assessing effective-use in context

References

AbouZahr, C., and Boerma, T. 2005. "Health Information Systems: The Foundations of Public Health," *Bulletin of the World Health Organization* (83), pp. 578-583.

Abouzahra, M., and Ghasemaghaei, M. 2021. "Effective Use of Information Technologies by Seniors: The Case of Wearable Device Use," *European Journal of Information Systems* (31), pp. 1-15.

Adu-Gyamfi, E., Nielsen, P., and Sæbø, J. 2019. "The Dynamics of a Global Health Information Systems Research and Implementation Project," *Scandinavian Conference on Health Informatics*, pp. 73-79.

Alford, R., and Friedland, R. 1985. *Powers of Theory: Capitalism, the State and Democracy*. Cambridge: Cambridge University Press.

Ali, M., and Bailur, S. 2007. "The Challenge of "Sustainability" in Ict4d—Is Bricolage the Answer," *International Conference on Social Implications of Computers in Developing Countries (IFIP WG 9.4)*, Sao Paulo, Brazil: Citeseer, pp. 54-60.

ALNAP. 2015. "The State of the Humanitarian System," ALNAP/ODI, London.

ALNAP. 2018. "The State of the Humanitarian System," ALNAP/ODI, London.

ALNAP. 2022. "The State of the Humanitarian System," ALNAP/ODI, London.

Altay, N., and Labonte, M. 2014. "Challenges in Humanitarian Information Management and Exchange: Evidence from Haiti," *Disasters* (38 Suppl 1), pp. S50-72.

Alwan, A., Ali, M., Aly, E., Badr, A., Doctor, H., Mandil, A., Rashidian, A., and Shideed, O. 2016. "Strengthening National Health Information Systems: Challenges and Response," *Eastern Mediterranean Health Journal* (22), pp. 840-850.

Anderson, C., Kaul, M., and Edberg, D. 2019. "Increasing Affordance Potency through Process Improvement: Case Study of a Healthcare System," *Journal of Information Technology Case and Application Research* (21(1)), pp. 1-16.

Anderson, C., and Robey, D. 2017. "Affordance Potency: Explaining the Actualization of Technology Affordances," *Information and Organization* (27:2), pp. 100-115.

Angell, I. O., and Smithson, S. 1991. *Information Systems Management: Opportunities and Risks*. Springer.

Avgerou, C. 2002. *Information Systems and Global Diversity*. Oxford: Oxford University Press.

Avgerou, C. 2019. "Contextual Explanation: Alternative Approaches and Persistent Challenges," *MIS Quarterly* (43:3), pp. 977-1006.

Baxter, P., and Jack, S. 2008. "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers," *The Qualitative Report* (13:4).

Bonaretti, D., and Fischer-Preßler, D. 2021. "Timeliness, Trustworthiness, and Situational Awareness: Three Design Goals for Warning with Emergency Apps," *International Conference on Information Systems (ICIS 2021)*, Austin, Texas, USA, pp. 1-17.

Bonaretti, D., and 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, pp. 1-17.

Bonaretti, D., and Piccoli, G. 2019. "Unifying the Emergency Management Research Program in Is: A Representation Theory Perspective for Effective Use in Chaotic Environments," *European Conference on Information Systems (ECIS 2019)*, Stockholm, Sweden, pp. 1-10.

Brophy-Williams, S., Hardman, J., Leaning, J., Meier, P., Olafsson, G., Pham, P. N., Quintanilla, J., Sandvik, K. B., and Segaren, N. 2013. "World Disasters Report - Focus on Technology and the Future of Humanitarian Action," International Federation of Red Cross and Red Crescent Societies, IFRC.

Braa, J., and Hedberg, C. 2002. "The Struggle for District-Based Health Information Systems in South Africa," *The information society* (18:2), pp. 113-127.

Braa, J., Monteiro, E., and Sahay, S. 2004. "Networks of Action: Sustainable Health Information Systems across Developing Countries," *MIS quarterly* (28:3), pp. 337-362.

Braa, J., and Sahay, S. 2017. "The Dhis2 Open Source Software Platform: Evolution over Time and Space," *LF Celi, Global Health Informatics* (451).

Burton-Jones, A., Bremhorst, M., Liu, F., and Trieu, V.-H. 2017a. "It Use: Notes from a Journey from Use to Effective Use," in *The Routledge Companion to Management Information Systems,* R. Galliers and M.-K. Stein (eds.). Abingdon, Oxon: Routledge, pp. 152-165.

Burton-Jones, A., and Grange, C. 2013. "From Use to Effective Use: A Representation Theory Perspective," *Information Systems Research* (24:3), pp. 632-658.

Burton-Jones, A., Recker, J., Indulska, M., Green, P., and Weber, R. 2017b. "Assessing Representation Theory with a Framework for Pursuing Success and Failure," *MIS Quarterly* (41:4), pp. 1307-1334.

Burton-Jones, A., and 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), pp. 468-489.

Bødker, S., Ehn, P., Knudsen, J., Kyng, M., and Madsen, K. 1988. "Computer Support for Cooperative Design," *Proceedings of the 1988 ACM conference on Computer-supported cooperative work*, pp. 377-394.

Campbell, D., and Roberts, N. 2019. "Effective Use of Analytic Dss and Job Performance: Looking Beyond Technology Acceptance," *Journal of Organizational Computing and Electronic Commerce* (29:2), pp. 125-138.

Chan, J. N., Gabriel, Marshall, A. G., and Purohit, H. 2019. "Trends in Humanitarian Health Information During 2010 Haiti Earthquake: Motivation for Curating Domain Knowledge Base," *ISCRAM*, Valencia, Spain.

Chatterjee, S., Moody, G., Lowry, P. B., Chakraborty, S., and Hardin, A. 2015. "Strategic Relevance of Organizational Virtues Enabled by Information Technology in Organizational Innovation," *Journal of Management Information Systems* (32:3), pp. 158-196.

Checchi, F., Warsame, A., Treacy-Wong, V., Polonsky, J., Ommeren, M., and 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), pp. 2297-2313.

Chemero, A. 2003. "An Outline of a Theory of Affordances," *Ecological Psychology* (15:2), pp. 181-195.

Chemero, A., and Turvey, M. T. 2007. "Complexity, Hypersets, and the Ecological Approach to Perception-Action," *Biological Theory* (2:1), pp. 23-36.

Comes, T., and Walle, B. 2016. "Information Systems for Humanitarian Logistics," in *Supply Chain Management for Humanitarians: Tools for Practice*. London: Kogan Page, pp. 257-284.

Comes, T., Walle, B., Laguna Salvadó, L., and Lauras, M. 2015. "Understanding the Health Disaster: Research Design for the Response to the 2014 West African Ebola Outbreak," *Procedia Engineering* (107), pp. 81-89.

Davidson, R. M., Martinsons, M. G., and Kock, N. 2014. "Principles of Canonical Action Research," *Information Systems Journal* (14:1), pp. 65-86.

Day, J., Junglas, I., and Silva, L. 2009. "Information Flow Impediments in Disaster Relief Supply Chains," *Journal of the Association for Information Systems* (10:1), pp. 637-660.

Diggle, E., Welsch, W., Alkema, G., Warsame, A., Wafai, M., Jasem, M., Ekzayez, A., Cummings, R., and Patel, P. 2017. "The Role of Public Health Information in Assistance to Populations Living in Opposition and Contested Areas of Syria, 2012–2014," *Conflict and Health* (11), pp. 1-12.

DiMaggio, P. J. 1986. "Structural Analysis of Organizational Fields: A Blockmodel Approach," *Research in Organizational Behavior* (8), pp. 335-370.

DiMaggio, P. J. P., Walter W. 1983. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields," *American Sociological Review* (48:2), pp. 147-160.

Eden, R., Akhlaghpour, S., Staib, A., and 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., and 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., and 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), pp. 32-64.

Fast, L., and Waugaman, A. 2016a. "Fighting Ebola with Information: Learning from Data and Information Flows in the West Africa Ebola Response," USAID, Washington, DC.

Fast, L., and Waugaman, A. 2016b. ". Fighting Ebola with Information: Learning from Data and

Information Flows in the West Africa Ebola Response," USAID, Washington, DC.

Firestone, W. A. 1993. "Alternative Arguments for Generalizing from Data as Applied to Qualitative Research," *Educational researcher* (22:4), pp. 16-23.

Flyvbjerg, B. 2006. "Five Misunderstandings About Case-Study Research," *Qualitative inquiry* (12:2), pp. 219-245.

Friedland, R., and Alford, R. R. 1991. "Bringing Society Back In: Symbols, Practices, and Institutional Contradictions," in *The New Institutionalism in Organizational Analysis,* W.W.D. Powell, Paul J. (ed.). pp. 232-263.

Gavidia, J. 2017. "A Model for Enterprise Resource Planning in Emergency Humanitarian Logistics," *Journal of Humanitarian Logistics and Supply Chain Management* (7:3), pp. 246-265.

Gibson, J. J. 1979. *The Ecological Approach to Visual Perception*. Boston, USA: Houghton Mifflin.

Glaser, B. G., Strauss, A. L., and Strutzel, E. 1968. "The Discovery of Grounded Theory; Strategies for Qualitative Research," *Nursing Research* (17:4), p. 364.

Goyet, C. d. V., Sarmiento, J. P., and Grünewald, F. 2011. "Health Response to the Earthquake in Haiti - January 2010," Pan American Health Organization/WHO.

Harvard-Humanitarian-Initiative. 2011. "Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Emergencies," Harvard Humanitarian Initiative, UN Foundation, OCHA, Vodafone Foundation Technology Partnership, Washington, D.C. and Berkshire, UK.

Hausvik, G., and Thapa, D. 2016. "“What You See Is Not What You Get” - Challenges in Actualization of Ehr Affordances," *International Conference on Information Systems*, Seoul.

Hayes, N., and Rajão, R. 2011. "Competing Institutional Logics and Sustainable Development: The Case of Geographic Information Systems in Brazil's Amazon Region," *Information Technology for Development* (17:1), pp. 4-23.

Heeks, R. 2006. "Health Information Systems: Failure, Success and Improvisation," *International journal of medical informatics* (75:2), pp. 125-137.

HISP-Centre. 2022. "Hisp Centre Annual Report 2022," HISP Centre.

Hällgren, M., Rouleau, L., and De Rond, M. 2018. "A Matter of Life or Death: How Extreme Context Research Matters for Management and Organization Studies," *Academy of Management Annals* (12:1), pp. 111-153.

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

IOM. 2021. "Malakal Poc Report," International Organization for Migration (IOM)

ISO, I. O. f. S. 2007. "Software Engineering — Software Product Quality Requirements and Evaluation (Square) — Data Quality Model."

Jobanputra, K., Greig, J., Shankar, G., Perakslis, E., Kremer, R., Achar, J., and Gayton, I. 2016. "Electronic Medical Records in Humanitarian Emergencies–the Development of an Ebola Clinical Information and Patient Management System," *F1000Research* (5).

Jones, M. 2018. "What We Talk About When We Talk About (Big) Data," *The Journal of Strategic Information Systems* (28:1), pp. 3-16.

Kabra, G., and Anbanandam, R. 2016. "Exploring the Challenges in Implementation of Information Technology in Humanitarian Relief Organisations in India: A Qualitative Study," in *Managing Humanitarian Logistics*. New Delhi: Springer, pp. 105-113.

Kabra, G., Ramesh, A., Akhtar, P., and Dash, M. K. 2017. "Understanding Behavioural Intention to Use Information Technology: Insights from Humanitarian Practitioners," *Telematics and Informatics* (34:7), pp. 1250-1261.

Kimaro, H. C., and Nhampossa, J. L. 2005. "Analyzing the Problem of Unsustainable Health Information Systems in Less-Developed Economies: Case Studies from Tanzania and Mozambique," *Information Technology for Development* (11:3), pp. 273-298.

Klein, H. K., and Myers, M. D. 1999. "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *MIS Quarterly* (23:1), pp. 67-93.

Korzybski, A. 1931. *A Non-Aristotelian System and Its Necessity for Rigour in Mathematics and Physics*.

Kotlarsky, J., Scarbrough, H., and Oshri, I. 2014. "Coordinating Expertise across Knowledge Boundaries in Offshore-Outsourcing Projects: The Role of Codification," *MIS Quarterly* (38:2), pp. 607-628.

Kuehne, A., and Roberts, L. F. 2021. "Learning from Health Information Challenges in the Central African Republic: Where Documenting Health and Humanitarian Needs Requires Fresh Approaches," *Conflict and Health* (15:1).

Lewis, D., and Madon, S. 2004. "Information Systems and Nongovernmental Development Organizations: Advocacy, Organizational Learning, and Accountability," *The Information Society* (20:2), pp. 117-126.

Li, M., and Nielsen, P. 2019. "Making Usable Generic Software. A Matter of Global or Local Design?," in: *Scandinavian Conference on Information Systems*.

Lippeveld, T., Sauerborn, R., and Bodart, C. 2000. *Design and Implementation of Health Information Systems*. World Health Organization.

Madon, S., and Schoemaker, E. 2021. "Digital Identity as a Platform for Improving Refugee Management," *Information Systems Journal* (31:6), pp. 929-953.

Magnuson, J. A., and Dixon, B. 2020. *Public Health Informatics and Information Systems*. Spinger Nature.

Maiers, C., Reynolds, M., and Haselkorn, M. 2005. "Challenges to Effective Information and Communication Systems in Humanitarian Relief Organizations," *IEEE International Professional Communication Conference*, Limerick, Ireland.

Markus, M. L. 1997. "The Qualitative Difference in Information Systems Research and Practice," *International Conference on Information Systems and Qualitative Research (IFIP 8.2)*, Philadelphia, Pennsylvania, USA: Springer, pp. 11-27.

Mcguire, M. 2021. "Data and Technology in Humanitarian Organizations: Patient Data Protection and Privacy in the Digital Era." University of North Carolina at Chapel Hill

Meier, P. 2011. "New Information Technologies and Their Impact on the Humanitarian Sector," *International Review of the Red Cross* (93), pp. 1239-1263.

Meier, P. 2015. *Digital Humanitarians: How Big Data Is Changing the Face of Humanitarian Response*. Crc Press.

Mesmar, S., Talhouk, R., Akik, C., Olivier, P., Elhajj, I. H., Elbassuoni, S., Armoush, S., Kalot, J., Balaam, M., Germani, A., and 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), pp. 167-200.

Miles, M. B., Huberman, A. M., and Saldana, J. 2013. *Qualitative Data Analysis, 3rd Ed.* SAGE.

Molina-de la Fuente, I., Benito, M. J. S., Flevaud, L., Ousley, J., Pasquale, H. A., Julla, A., Abdi, A. M., Chol, B. T., Abubakr, B., Benito, A., Casademont, C., Nanclares, C., and Berzosa, P. 2023. "Plasmodium Falciparum Pfhrp2 and Pfhrp3 Gene Deletions in Malaria-Hyperendemic Region, South Sudan," *Emerging Infectious Diseases* (29:1), pp. 154-159.

Monteiro, E., Constantinides, P., Scott, S., Shaikh, M., and Burton-Jones, A. 2022. "Qualitative Research Methods in Information Systems: A Call for Phenomenon-Focused Problematization," *MIS Quarterly: Management Information Systems* (46:4).

MSF, E. R. B. 2020. "Msf Research Ethics Framework," MSF.

MSF International. 2022. "Activity Report," MSF International.

MSF Spain. 2021. "Informe De Operaciones," MSF Spain.

MSF Spain. 2022. "Annual Report," MSF Spain.

Maanen, J., Sorensen, J., and Mitchell, T. 2007. "The Interplay between Theory and Method," *Academy of Management Review* (32), pp. 1145-1154.

Nair, S., Attal-Juncqua, A., Reddy, A., Sorrell, E., and Standley, C. 2022. "Assessing Barriers, Opportunities and Future Directions in Health Information Sharing in Humanitarian Contexts: A Mixed-Method Study," *BMJ open* (12:4).

Nicholson, B., Nielsen, P., Saebo, J., and Sahay, S. 2019. "Exploring Tensions of Global Public Good Platforms for Development: The Case of Dhis2," *International Conference on Social Implications of Computers in Developing Countries (IFIP 9.4)*, Dar es Salaam, Tanzania: Springer International Publishing, pp. 207-217.

Niyonzima, F., Kamosi, H., Soro, J., Ntihabose, O., Hehadji, D., and Briskin, E. 2023. "Facteurs Associés À Une Issue Défavorable Chez Les Brûlés Hospitalisés," *Public Health Action* (13:2), pp. 25-29.

North, D. C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

O'Mathuna, D. P. 2015. "Research Ethics in the Context of Humanitarian Emergencies," *Journal of Evidence-Based Medicine* (8:1), pp. 31-35.

Orlikowski, W., and Baroudi, J. 1991. "Studying Information Technology in Organizations: Research Approaches and Assumptions," *Information Systems Research* (2:1), pp. 1-28.

Orlikowski, W. J., and Barley, S. R. 2001. "Technology and Institutions: What Can Research on Information Technology and Research on Organizations Learn from Each Other?," *MIS Quarterly* (25:2), pp. 145-165.

Orlikowski, W. J., and Iacono, C. S. 2001. "Research Commentary: Desperately Seeking the "It" in It Research - a Call to Theorizing the It Artifact," *Information Systems Research* (12:2), pp. 121 - 134.

Orton, M., Agarwal, S., Muhoza, P., Vasudevan, L., and Vu, A. 2018. "Strengthening Delivery of Health Services Using Digital Devices," *Global Health: Science and Practice* (6), pp. S61-S71.

Patton, M. Q. 1990. *Qualitative Evaluation and Research Methods, 2nd Ed*. Thousand Oaks, CA, US: Sage Publications, Inc.

Piotti, B., Chilundo, B., and Sahay, S. 2006. "An Institutional Perspective on Health Sector Reforms and the Process of Reframing Health Information Systems: Case Study from Mozambique," *The Journal of Applied Behavioral Science* (42:1), pp. 91-109.

Read, R., Taithe, B., and Mac Ginty, R. 2016. "Data Hubris? Humanitarian Information Systems and the Mirage of Technology," *Third world quarterly* (37:8), pp. 1314-1331.

Robinson, E., Crispino, V., Ouabo, A., Soung Iballa, F., Kremer, R., Serbassi, M., Lenthe, M., and Carrion Martin, A. 2019. "Mortality and Health Survey, Walikale, Democratic Republic of the Congo, 2017: An Example of the Use of Survey Data for Humanitarian Program Planning," *Conflict and Health* (13:1).

Sahay, S., Mekonnen, S. M., Gizaw, A. A., and Sæbø, J. I. 2010. "Interplay of Institutional Logics and Implications for Deinstitutionalization: Case Study of Hmis Implementation in Tajikistan," *Information Technologies and International Development* (6:3), pp. 19-32.

Sahay, S., and Walsham, G. 2006. "Scaling of Health Information Systems in India: Challenges and Approaches," *Information Technology for Development* (12:3), pp. 185-200.

Sanner, T. A., Roland, L. K., and Braa, K. 2012. "From Pilot to Scale: Towards an Mhealth Typology for Low-Resource Contexts," *Health Policy and Technology* (1:3), pp. 155-164.

Sheather, J., Jobanputra, K., Schopper, D., Pringle, D., Venis, S., Wong, S., and Vincent-Smith, R. 2016. "A Mèdecins Sans Frontières Ethics Framework for Humanitarian Innovation," *PLoS Medicine* (13:9).

Sigala, I., Kettinger, W., and Wakolbinger, T. 2020. "Digitizing the Field: Designing Erp Systems for Triple-a Humanitarian Supply Chains," *Journal of Humanitarian Logistics and Supply Chain Management* (10:2), pp. 231-260.

Silva, L., and Hirshheim, R. 2007. "Fighting against Windmills: Strategic Information Systems and Organizational Deep Structures," *MIS Quarterly* (31:2), pp. 327-354.

Sood, S. P., Nwabueze, S. N., Mbarika, V. W., Prakash, N., Chatterjee, S., Ray, P., and Mishra, S. 2008. "Electronic Medical Records: A Review Comparing the Challenges in Developed and Developing Countries," *Hawaii International Conference on System Sciences (HICSS 2008)*: IEEE, pp. 248-248.

Stansfield, S., Orobaton, N., Lubinski, D., Uggowitzer, S., and Mwanyika, H. 2008. "The Case for a National Health Information System Architecture; a Missing Link to Guiding National Development and Implementation," *Making the eHealth Connection*.

Stoffregen, T. 2003. "Affordances as Properties of the Animal-Environment System," in *How Shall Affordances Be Refined?* Routledge, pp. 115-134.

Stratton, C., Sholler, D., Bailey, D., Leonardi, P., and Rodriguez-Lluesma, C. 2016. "Competing Institutional Logics in Ict4d Education Projects: A South American Study," *International Conference on Information and Communication Technologies and Development*.

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

Suchman, L. A. 2002. "Practice-Based Design of Information Systems: Notes from the Hyperdeveloped World," *The Information Society* (18:2), pp. 139-144.

Sæbø, J. I., Kossi, E. K., Titlestad, O. H., Tohouri, R. R., and Braa, J. 2011. "Comparing Strategies to Integrate Health Information Systems Following a Data Warehouse Approach in Four Countries," *Information Technology for Development* (17:1), pp. 42-60.

Tafere, M. 2014. "Knowledge Management in the Humanitarian Sector: Challenges in Improving Decision-Making," in: *Professionals in Humanitarian Assistance and Protection*.

Thieren, M. 2005. "Health Information Systems in Humanitarian Emergencies," *Bulletin of the World Health Organization* (83:8), pp. 584-589.

Thornton, P. H., and Ocasio, W. 2008. "Institutional Logics," in *The Sage Handbook of Organizational Institutionalism*. Los Angeles: Sage Publications, pp. 99-129.

Trieu, V.-H. 2013. "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, pp. 1649-1659.

Trieu, V.-H., Burton-Jones, A., Green, P., and Cockcroft, S. 2022. "Applying and Extending the Theory of Effective Use in a Business Intelligence Context," *MIS Quarterly* (46:1), pp. 645-678.

Turvey, M. T. 1992. "Affordances and Prospective Control: An Outline of the Ontology," *Ecological Psychology* (4:3), pp. 173-187.

Tusiime, E., and Byrne, E. M.-T. 2011. "Information Systems Innovation in the Humanitarian Sector," *Information Technologies and International Development* (7:4), pp. 35-52.

Valbø, B. 2022. "The Nested Affordance Process Model: Bridging Technology Use and Societal-Level Impact," *Annual Workshop of the AIS Special Interest Group for ICT in Global Development*, Copenhagen, Denmark.

Valbø, B., and Sanner, T. 2022. "Investigating Mid-Level It Affordances as Drivers for Societal Change: Addressing the Education Data Challenge in the Gambia," *International Conference on Social Implications of Computers in Developing Countries (IFIP 9.4)*, Online Conference, pp. 471-489.

Van Velthoven, M., Cordon, C., and Challagalla, G. 2019. "Digitization of Healthcare Organizations: The Digital Health Landscape and Information Theory," *International Journal of Medical Informatics* (124).

Vila-Pozo, M. M., Martinez, R., and 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., and 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: Springer, pp. 496-507.

Volkoff, O., and Strong, D. 2013. "Critical Realism and Affordances: Theorizing It-Associated Organizational Change Processes," *MIS Quarterly* (37:3), pp. 819-834.

Walliman, N. 2011. *Your Research Project: Designing and Planning Your Work*. SAGE.

Walsham, G. 1993. *Interpreting Information Systems in Organizations*. New York: John Wiley & Sons, Inc.

Walsham, G. 1995. "Interpretive Case Studies in Is Research: Nature and Method," *European Journal of Information Systems* (4:2), pp. 74-81.

Walsham, G. 2012. "Are We Making a Better World with Icts? Reflections on a Future Agenda for the Is Field," *Journal of Information Technology* (27:2), pp. 87–93.

Walsham, G. 2020. "Health Information Systems in Developing Countries: Some Reflections on Information for Action," *Information technology for Development* (26:1), pp. 194-200.

Wand, Y., and Weber, R. 1995. "On the Deep Structure of Information Systems," *Information Systems Journal* (5:3), pp. 203-223.

Weber, R. 1987. "Toward a Theory of Artifacts: A Paradigmatic Base for Information Systems Research," *Journal of Information Systems* (1:2).

Wikfeldt, E. 2016. "Generalising from Case Studies," in: *School of Business, Engineering and Science*. Halmstad University.

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

Yin, R. 2013. "Validity and Generalization in Future Case Study Evaluations," *Evaluation* (19), pp. 321-332.

Yin, R. K. 2009. *Case Study Research: Design and Methods*, (4th ed.). Sage Publications, Inc.

Zheng, Y. 2015. "Ict4d, Overview of Theories In," in *The International Encyclopedia of Digital Communication and Society*. John Wiley & Sons, Inc.

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Humanitarian Health Information Systems: Different Challenges and Responses.

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HUMANITARIAN HEALTH INFORMATION SYSTEMS: DIFFERENT CHALLENGES AND RESPONSES

Research paper

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Abstract

The role of humanitarian organizations is becoming increasingly vital in a world characterized by conflicts, natural and man made disasters, and disease epidemics. For these organizations to become more effective, they need robust supporting information systems. These systems are complex to design and use for two reasons. One, the context is unstable, unpredictable and extremely dynamic. Two, the methods for design of these systems typically follow structured methods assuming routine information systems. There is thus a mismatch resulting in emerging contradictions, which in the short-run have adverse consequences, but in the longer run provide the potential for positive change. Theoretically, we draw upon some concepts from institutional theory, such as institutions, logics and contradictions to understand what are the emerging contradictions, why do they occur, and what can we do about them. Empirically, we study a large humanitarian organization (MSF), and analyze some of their processes around the design and development of their "humanitarian health management information system." We identify contradictions arising from various technical, institutional and contextual conditions, and analyze how the potential for change carried in them can be positively leveraged upon.

Keywords: humanitarian organizations, HIS, institutional logics, contradictions, change

1 Introduction

The importance of reliable information in humanitarian interventions is heightened as the number of people affected by humanitarian crises has almost doubled over the past decade and is expected to keep rising (MSF Spain, 2014). Reliable information, that which is complete, timely, and without errors, tends to be at a premium given the context of uncertainty coupled with the need for swift reporting and response. This heightens the need for effective access to reliable information to address challenges arising through the unstable and changing environment of humanitarian interventions, which requires rapid decision-making and response. The absence of this could potentially result in wrong decisions, slow reactions that could adversely impact upon the well-being and lives of people. A recent study of the humanitarian system´s performance published by the Active Learning Network for Accountability and Performance in Humanitarian Action (ALNAP) pictures a humanitarian system that has expanded its operational modalities, but not its operational capacity, including its information systems (ALNAP, 2015). Despite increased investments in technologies, commensurate improvements are not reflected in results, especially related to coverage and capacity of the supporting information system (MSF Spain, 2016).

Humanitarian organizations operate in both short and long-term interventions. Short term or "emergency interventions" typically require a response in less than 72 hours to natural disasters, man-made emergencies such as armed conflicts, industrial accidents, or disease outbreaks. There are also protracted social conflicts (Azar, Jureidini, & McLaurin, 1978) involving complex contexts contributed to by a

combination of natural and man-made elements and different causes of vulnerability emerging not from one unexpected isolated event. Such long-term activities evolve into "regular interventions". Response to emergencies inevitably involves the coordination of multiple actors requiring effective interagency information management (Altay, 2014). In the quest for inter-agency coordination, the need for examining the effectiveness of an agency's internal information system tends to be marginalized (Miskovich (2013). Strengthening this focus is a primary aim of this paper.

Challenges to information management in humanitarian organizations come from the unpredictability of needs, multiplicity of interests, unique structure of the organizations, inadequate funding, limited technological infrastructure, and organizational secrecy and exclusivity requirements (Tafere, 2014). While activities of a global humanitarian organization in a country are defined by particular needs in the field, interventions need to be approved and followed up by the headquarters level of that organization. This raises the need for the Health Management Information System (which we refer to as HHMIS – humanitarian health management information system) to adhere to needs for a certain degree of integration and standardization, to ensure completeness and quality in data collection and use. Therefore, this HMIS needs to have a structural stability and routine processes of what data to collect, when and by whom. However, this need contradicts with the reality of the humanitarian setting where the context is uncertain and by definition cannot be well structured, and at best is semi-structured, and very often unstructured. This mismatch creases technical and institutional contradictions, which is currently under-researched in terms of both the challenges they raise and the potential opportunities they provide to strengthen the HHMIS. This paper thus explores the following research question:

> *What are the inherent contradictions between routine HHMIS and the information needs of a humanitarian organization, and what challenges and opportunities come with them?*

Empirically, we address this question in the context of Doctors Without Borders / Médecins sans Frontières (MSF), a global humanitarian organization which have been engaged in strengthening their supporting HHMIS, with a view to improve support for the effectiveness of their interventions. We adopt an institutional theory perspective to understand the nature of the contradictions and what we can do with them. This paper makes important contributions to theory and practice. Firstly, it seeks to bring to the forefront the problem of information systems in humanitarian organizations, which has to date been largely ignored in IS research. By helping to strengthen the HHMIS through a theoretically informed approach, we expect to contribute to improving the efficacy humanitarian interventions and potentially improve the lives of affected people. This helps to engage with Walsham's (2012) question of "Are ICTs making the world a better place for us to live?"

The rest of the paper is organized as follows. In the next section, we discuss our institutional theory informed analytical framework. Sections 3 and 4 describe research methods and the case study respectively. In section 5, we present our case analysis and discussions, followed by a brief concluding section.

2 Institutional Theory as a Theoretical framework

North (1990) describes **institutions** as "the rules of the game" (North, 1990) and organizations as the players. An **organizational field comprises** those organizations that, in the aggregate, constitute a recognized area of institutional life (DiMaggio, 1983). Such a conceptualization entails organizational and societal levels in the study of social and community change (DiMaggio, 1986). **Organizations** are not passive entities controlled by the environment but are active players capable of responding to environmental pressure (Orlikowski & Barley, 2001) emerging from the organizational field.

Avgerou (2002) argues that technology, on its own, can be considered an institution that can influence adequately the process of transformation of organised activities in society. Piotti et al (2006) extend the idea of the organizational field also to include the role of ICT and the formal and informal practices that surround their use in organizations. We understand the IS as the institution, and its users as independent actors, shaping organizational behaviour, emphasizing the role of human agency to influence the

institution. Drawing from the concept of organizational field as an interactive network, we introduce **institutional logics** as the organizing principles that supply guidelines to actors, guiding both, the means and ends of individual behaviour (Friedland & Alford, 1991). Institutional logics are not necessarily homogeneous; they are multiple, and could be simultaneously in play and not in synch, often contributing to **institutional contradictions** (Friedland & Alford, 1991).

Our case study is of the deployment of a HHMIS in a medical humanitarian organization, where in **the field**, operations are managed at two levels, the projects, where the intervention takes place physically, and the coordination office, usually at the capital of the country, where the intervention is managed. From **headquarters,** field interventions are followed up and supported, drawing upon varying levels of real-time access to information. While the operations department works more transversally to support every intervention as a whole, the medical department, with specialised health professionals, focusses to guarantee standards and quality of medical activities. We position the HHMIS as the institution, representing a common working tool that all actors use for performing their activities, while being engaged with the different influences from the organizational field. The HHMIS imposes on and is also influenced by different institutional logics, which sometimes is in synch and at other times creates contradictions. We outline the concepts used in our theoretical framework in Figure 1.

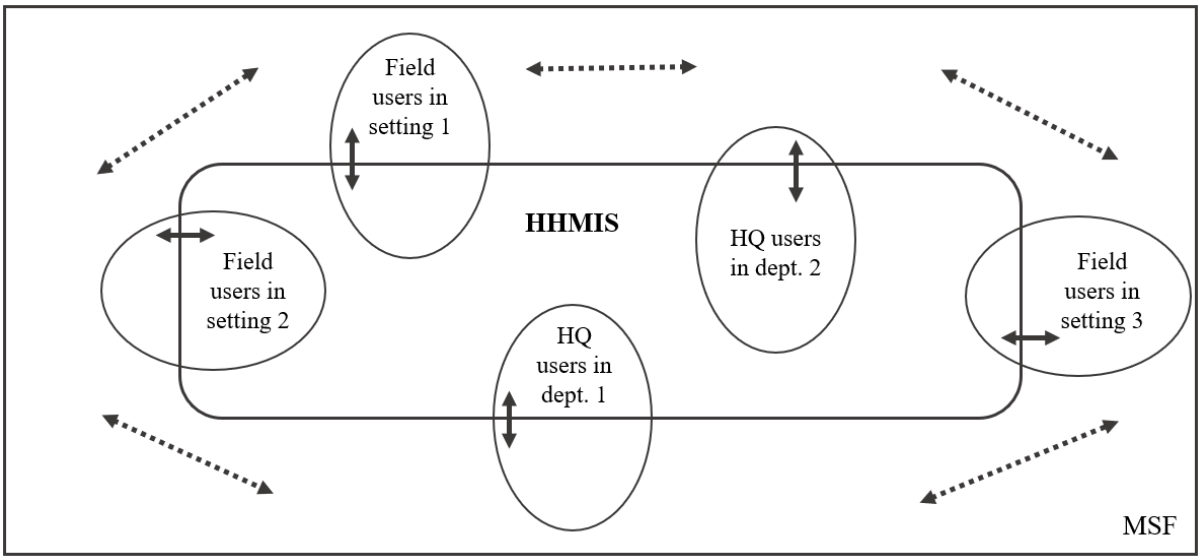

Figure 1 – The Organizational Field

The main rectangle encompassing all elements represents the organizational field. In our case study, it represents MSF performing humanitarian interventions globally. The ellipses represent different groups of users from the field settings and headquarters. Health data needs act as independent agents with capacity to individually respond to and influence the institution. The HHMIS, the institution, is represented by the rounded rectangle in the middle, touching the whole organization, with various overlapping influences. Different grades of overlap represent the level of response of the functionalities of the HHMIS to each particular use-case. Where the system and particular information needs collide represent the competing logics and the institutional contradictions (depicted by the homogeneous short arrows). When contradictions occur, users try to adapt the system to their needs and as independent agents, influence the evolution of the system, and through this interfere with other user logics (represented with the discontinuous arrows). The organizational field provides the space where the interplay of competing logics evolves to the benefit or detriment for the other actors.

We propose this framework of concepts as a foundation for understanding the underlying nature and reasons for emerging contradictions. As stated by Stratton et al. (2016) contradictions can result in processes of change. This assumption guides us to empirically identify examples of competing logics, the contradictions they create, and how this influences the resulting evolution, reflecting change or stability.

3 Research Setting and Methods

3.1 Researcher positioning and research setting

The research setting encompasses the project of design and implementation of a HHMIS in MSF, an international medical humanitarian organisation that delivers emergency aid to people affected by armed conflict, epidemics, and natural disasters. It offers assistance to people based on need, irrespective of race, religion, gender or political affiliation (MSF Association, 1995). MSF supports field operations worldwide across the five continents and has been active for more than 40 years. MSF operates interventions in many different countries. Every country has a coordination office, usually based in the capital, from where a number of projects (2 to 5 approximately) are coordinated. Projects have their own sub-coordination offices. At the moment of writing this paper, MSF is operating 26 long-term interventions in addition to three short-term emergency projects.

The first author was part of MSF headquarters from August 2013 to February 2017, during which she worked as an information systems specialist working on tasks of requirements gathering, design and deployment of the global HHMIS. In this role, she was visiting field sites, designing and building systems, and supporting their global rollout. This work was not initially part of a research project but has with time now become part of her PhD work, which she formally started in August 2017. MSF has provided support and access to the first author to conduct the research, positioning her as an "insider" researcher (Walsham, 1995). This paper is based on reflections from that exploratory period at MSF. The other author is the research supervisor of the first author. Over the last year, she left her formal role at MSF and enrolled as a PhD researcher allowing her to research activities she was previously engaged with, from the "outside". The second author has supported processes of reflection and theorization of concepts and linking them with the empirical experiences. Being on the "outside", he has helped provide a degree of "objectivity" and "neutrality" to the interpretive process. Developing this paper is our first combined attempt to link theory, experience and practice.

Research design: The study is interpretive in that the focus is to understand the limitations in the adoption of a health information system in an organization from the perspective of the subjective interpretations of users, based on a retrospective case study. Case study is appropriate since the problem under investigation is practice-based, where the experiences of the actors within situated contexts are important. The case study strategy helps observe the adoption of the system in different settings (countries) and allows to compare and contrast the challenges shaped by the context in shaping the implementation of the information system. The cases involve varying contexts in terms of volume of intervention, local context, individual capacities, and technological settings. The study is multilevel in that action happened at all levels of the organization ranging from the headquarters to project setting, during the period 2013 – 2016.

3.2 Data Collection and analysis

Data collection was not formal, but an engagement of the first author with everyday work, while actively participating in the project at multiple levels. System design happened during the early phases of the project, during which semi-structured interviews were conducted, and observation notes made of activities. Additionally, while studying the headquarters practices, participant observation in meetings of the Medical and Operations department was also conducted. This included coordination meetings, system design workshops, internal project team meetings, and capacity building activities. In addition to the work in the headquarters, during the deployment phase the researcher performed field visits to four countries with twelve projects, actively participating in organizing and performing all deployment related activities.

Field and headquarters users in humanitarian organizations are difficult to access, due to limited resources and existing ones being overworked. Day to day work is dynamic and unpredictable, characterized by multiple travels and high turnover. The spirit of collecting feedback whenever possible was very

strong and was collected at different phases of the project. This feedback helped provide different perspectives of the users to different issues, allowing comparison across people and use cases.

Secondary data analysis was based on study of documents from different sources, including project reports. The researcher created a process documentation of projects which described on-going project challenges and potential risks. This has been very useful to reconstruct the processes and methodologies followed in the project. Field visit reports, used to collect relevant information in each country during the roll out, were also a rich source of information for identifying the particularities and challenges of each setting. Meeting notes were used to support the chronological reconstruction of events.

Data analysis followed an interpretive process in which we tried to holistically make overall sense of the empirical experiences, including the challenges experienced during design, configuration and deployment of the HHMIS, and relating them to theoretical concepts. Gradually, by moving iteratively from discussions to documentation and theory, concepts evolved giving more coherence and naturally grouping into themes which represented the main challenges faced in the project. Interesting events were discussed and developed by the authors to identify examples that clearly illustrate the themes. These examples were developed as vignettes to illustrate key practices or events relevant to the analysis (Kotlarsky, Scarbrough, & Oshri, 2014). A vignette "has a narrative, story-like structure that preserves chronological flow and that is normally limited to a brief time span, to one or a few key actors, to a bounded space, or to all three" (Miles, Huberman, & Saldana, 2013).

Having an insider and an outsider researcher doing a retrospective study resulted in many conversations between the authors, including story-telling where the "inner" researcher had to reflect on her thoughts and develop rich examples to underpin her statements. The representation of the conflicting logics through encapsulated vivid examples evolved naturally into vignettes, which became the primary vehicle for the analysis, highlighting challenges faced in the design and adoption of the HHIS in the organization. The next section on case findings is presented through the vehicle of vignettes.

4 Case findings

To strengthen follow up of its medical interventions in the field, MSF initiated a project to change its information system from a set of Excel spreadsheets to a centralized web-based health information system, based on the District Health Information System platform (DHIS2). DHIS2 is an open source software platform for reporting, analysis and dissemination of data for health programs. It is developed and maintained by the Health Information Systems Programme (HISP) in the University of Oslo (UiO), supporting its use in more than 70 countries and more than 60 international organizations like MSF.

DHIS2 has been configured and adapted by MSF in terms of content, functionality and technical architecture for being the HHMIS used at the headquarters and field level. The system collects and reports aggregated data from most of their medical activities and is accessed by all projects and coordination offices in the field and medical and operations department at headquarters. All users have access to the same generic configuration and specific modules available depending on the services provided at the facilities and the types of users. At the project level, data is collected in health facilities, then aggregated and introduced into the system. This happens in an offline instance that guarantees access to data independent from the availability of Internet connection. From there, data is periodically sent up to the coordination office where it is validated and imported in an online server. Coordination offices and HQ have access to that central server through the Internet.

The design, implementation and deployment of the described system encountered several challenges, which we illustrate through 3 vignettes. Through these, we describe the contradictions between the intrinsic characteristics of the HHMIS and the particular requirements of information (referred to as use cases), and how those contradictions led to change or carried the potential for change.

4.1 Vignette 1: complex design methodology in a "hectic" and dynamic setting

The process of data modelling and design process was led by two health data technicians and one epidemiologist, and included the following aspects: i) data flows from collection to integration and analysis (*organizational aspects*); ii) standardization of nomenclature of data being collected across existing legacy systems (consisting of 21 Excel files) currently in use in the field (*data source aspects*); and, iii) the rationalization of information to be collected to support decision making (*information needs*). The intention was to reconcile the three inter-related aspects of the HHMIS in order to more completely satisfy the information needs, while minimizing data collection workload at field project levels.

The process of gathering information requirements involved active participation from users from the field and the headquarters. In the first step, users were asked to go through all the indicators present in the legacy system and provide information about which managerial decisions they made on their daily activities based on the information provided. The second step consisted of designing an abstract model of information requirements by adapting the i* modelling language suitable for early phase of system modelling. The methodology was applied because one member of the team had positive experience in using this technique, which however in hindsight was seen to be ill-suited to the context of MSF.

Using this methodology, one model was generated to represent every health service such as external consultations, hospitalization ward, emergency room or operating theatre. Each model was a graphical representation of the relations of their internal processes, goals and information required to measure the achievement of the goals (information needs). To help illustrate the idea, the legend used for the models can be seen in Figure 2. The last step was to share the models with all users to comment on its suitability.

To obtain feedback, in addition to the medical managers in headquarters, a group of nine medical staff from the field with experience in coordinating interventions were selected to participate. The first step planned was to conduct a two-day workshop with them to share the models and have an open discussion in person; however, it was not possible due to their lack of availability to travel to headquarters. It was then decided to share the models and encourage the discussion online, with users given a period of 1 month to share their feedback. During that period, the team at headquarters in charge of the design was available for support through email or Skype (or in person for those in the headquarters).

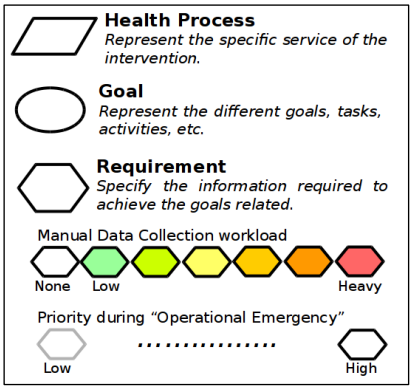

Figure 2 - Legend for the i models*

The overall participation of users in the process was below the minimum required to make informed design decisions. The medical referents in headquarters adopted successfully the upper three levels of the representation (health process, goal, requirement), but were unable to use the two layers in the lower level (data collection workload and priority in emergency), crucial for designing a dynamic and flexible system. Secondly, after the model was distributed to the participants from the operations department (field and headquarters), feedback was very weak in terms of the number of responses and the comprehensiveness of their inputs. After the model was distributed to the participants from the operations

department (field and headquarters), feedback was very weak in terms of the number of responses and the comprehensiveness of their inputs. Despite several communications to encourage participation, limited response was received, and so was the requests for online support. A field medical coordinator commented that every time she decided to work in this task, when she understood what had to be done, she did not have time to do it anymore.

In retrospect, the methodology selected was inadequate, as it required the ability of users to think of information conceptualized in modular representations. In addition, this type of activity cannot be done in a fragmented manner, requiring quality time and specific dedication. The users did not have the expertise of using modelling languages or the time required to engage resulting in inadequate feedback. Consequently, the resulting system design could not meet the goal of minimising data collection to only those indicators that supported decision making. The resulting system was designed by keeping almost the same amount of existing information, resulting in limited change.

The methodology and approach followed by the design team contradicted with the institutionalized routines of the users and their skill sets, and set the basis for further challenges. A positive outcome of this process was the building of realization of the HHMIS team on the need to find adaptive mechanisms to engage with the users.

4.2 Vignette 2: Real-time information in offline settings

Timely consolidated analysis of health data from the field by headquarters demands close to real time access to information. At the project level, where data is generated, it is rare to find reliable internet connections with sufficient bandwidth, eliminating options to use a web-based system which can facilitate real time access. To overcome this limitation, the architecture proposed was to have a local server in every field project, and at the end of the reporting period (day, week, month); each project will send their data to the coordination level, in charge of validating it and uploading it to the central server, where it can be accessed by headquarters.

The intervention we refer to in this vignette is of a country that has suffered prolonged armed conflict, making it difficult for expatriate teams to operate. The project office was then placed in the nearest border of a neighbouring country to coordinate required medical activities which were implemented in-country by a local team. This led to having two teams and two project offices.

The original architecture designed included one offline server at the project level which could not respond well to this situation, as two servers were required, one each in the field project offices. This added one more manual step of exporting/importing data across the servers, which could not be automated due to internet constraints. The external team considered this would introduce a risk of having data going directly from the internal team to coordination without passing through them and decided that the offline server will only be installed at their office outside the border.

After the system was running for some months, staff in the coordination office were collecting data twice, first in the in-country office in Excel files, and then from there to the new HHMIS in the office outside. This introduced delays and an extra data collection step, which was opposite of the intended purpose. This situation made the medical coordinator of this country to say that entering data in the offline server was like having data in a heavy suitcase that she had to haul with me her in case of evacuation. She couldn't imagine herself in an evacuation saying, "don't forget the HHMIS!"

This example reflects the contradiction between headquarters needs, field technical limitations and software architecture. In-country coordination office and headquarters required close to real time data, but there was no internet access at the project level, where data was generated. The resulting complex technical architecture was not agile for the field staff, and inadequate in performance. It was difficult to invest in improving the offline capabilities of the system before demonstrating that it was functional for the organization. Even not being perfect, the architecture described was deployed and is working since August 2015.

When a second partner section of MSF selected the same software for their operations, having an example of a working system, helped justify further investment in improving offline functionalities of the DHIS2 software. They decided to invest in developing a synchronization module for DHIS2 in collaboration with the University of Oslo, which later evolved into a generic functionality of DHIS2. Having automatic synchronization between offline and online servers, reduced the manual steps and the system became more agile with data being automatically sent whenever internet connection was available. This maximized availability of "as real time data as possible.".

4.3 Vignette 3: Stable population figures for displaced populations

The population targeted in humanitarian interventions fluctuates due to unstable contexts and forced displacement of people. The MSF HHMIS, initially, was collecting population figures on a yearly basis at project level on the assumption of a stable population which was reflected in the software configuration.

In a project in Sudan, the use of population data on annual basis was completely unmanageable. This project offered health services to three Internal Displaced Population (IDP) camps. In June 2016, the population of two camps had been relatively stable for some years, which however was not the case for the third one. Its name, "New Arrivals" indicated this sudden establishment. At the moment of deploying the system, population had arrived three months before, fleeing from rebels' attacks in their region of origin. Displaced population kept on increasing gradually, and the project was reporting their indicators based on population data updated every two months out of manual headcounts in the refugee camps

The workaround to have population-based indicators was to generate tables in the new HHMIS with the volume of the activities (i.e. number of consultations, doses of antigens, disease cases) and then export those values into an Excel file to keep track of the fluctuating population figures and calculate indicators on coverage of activities, or the incidence of diseases. Nowadays, "New Arrivals" in IDP camp has been assigned a different and permanent name, with the intention of using "New Arrivals" to refer to sudden displacements of population. This situation of unstable population is not universal, and in many project sites, project population figures are stable and can be collected annually.

In this case, the contradiction resulted in the use of third party custom-made tools in the project, while abandoning the use of a standard tool. Due to the risk of failure in adopting the new system, it was configured to collect population figures every six months in all settings, as it was not possible to have different reporting periods for different settings in the software, and 6 months was considered a middle point between the one-year stable numbers and the two-month dynamic ones. Practically, this meant that every project had to collect their population figures twice every year which actually, was an extra step for those with stable populations and a halfway solution for the ones working with IDP's.

This example reflects contradictions at two levels. One, between the built-in functionalities of DHIS2 which was not built to handle multiple periodicities, and also cater to the need for both dynamic and stable figures in varying settings. The second version with a new configuration offered a slightly better solution for some projects and worsened the functionality for others, reflecting a contradiction from the user perspective where improvement for one contributed to a negative effect on the other. MSF still has to invest in a better solution for all projects to resolve this contradiction and also avoid third party competing tools being established instead of their HHMIS.

In the next section, we further discuss the role of these contradictions in shaping the HHMIS use.

5 Analysis and Discussion

In this section, we draw upon our institutional perspective to analyse the nature of the contradictions and how potentially these can become agents of change. First, we identify the different institutional logics in play, and how they create contradictions. We next discuss how these contradictions may carry the potential for change.

5.1 Identifying institutional logics

The logic of routine health management information systems (HMIS)

A HMIS is typically a routine system responsible for the periodic collection and reporting of predefined data primarily upwards for monitoring and evaluations purposes. Since its inception, the MSF system was envisioned as an HMIS, which largely assumes stable and homogeneous settings and systematic actions. These principles were inscribed in the software design and shaped the institutional logics around the system.

In the first vignette, we exemplify the institutional logic of **stability** in location and day-to-day practices of MSF staff, and their expertise to work with formal software design methodologies that had prior application in non-humanitarian organizations. Using this methodology required skills in interpreting abstract representations of information and based on-site workshops that was physically not possible. Existing work routines were deeply institutionalized, and space and time for the introduction of new routines and was not possible at the higher levels. Operational level efforts to gain feedback or have meetings failed in this absence.

The second vignette exemplifies contradictions between the required need for real time information, assuming stability of location and **dependencies** on Internet connection which was at odds with the existing reality. While DHIS2 provided functionalities for unstable and weak connections, it did not support completely offline work. This set up required manual actions for synchronizing data, resulting in rigid processes that did not respond well to different project configurations. There was thus this on-going contradiction between the assumption of a generic setting and internet supply which largely did not exist.

The third example assumes stable and homogenous populations targeted in the interventions. The software was not designed for collecting population figures with different periodicities and varying levels of stability. It could handle shorter or longer periods but assumed **homogeneity** amongst all settings, which encouraged a design of a homogeneous configuration of periodicity for collecting population, but doing data collection twice a year, significantly increasing workload.

In summary, this discussion highlights how design inscriptions in the software give rise to certain institutional logics, which then have to conform the logics inscribed in everyday work routines, realities of the empirical settings, and the changing nature of the context, like migratory populations. These engagements of the software with different realities becomes a source for the creation of contradictions. Humanitarian organizations like MSF are characterized by hectic day-to-day work, scarce human resources who are also overworked with high turnover rates, making it difficult for them to work with new and demanding institutions like which HHMIS entail. The HHMIS, like many modern-day software applications also assume stable and reliable internet, and its lack contributes to another source of contradictions. There exist also some inherent limits in technical design, such as the ability to deal with multiple periods and population types, further creating contradictions with the reality.

5.2 The nature of contradictions and their inherent potential for change

Summarizing from the above discussion, the HHMIS is designed under assumptions of ***stability*** (of context), ability to work ***independent*** of the internet environment, and the existence of ***homogeneous*** environments. The reality does not fit these assumptions, with the environment being extremely ***dynamic and heterogeneous,*** internet environment being ***restrictive***, and in some cases ***independent*** of the core functionalities available in modern software platforms like DHIS2. Figure 3 helps to understand the nature of the ensuing contradictions.

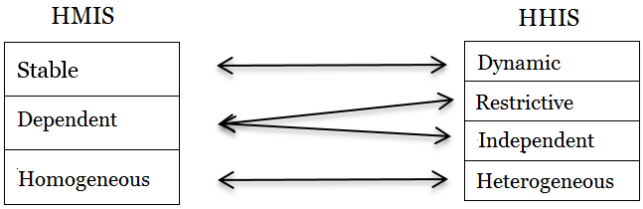

Figure 3 – Institutional Contradictions

Introducing technical and work routines inscribed in the software, necessarily require the creation of new institutions, and supporting logics. These are not easily forthcoming, given the existing challenges of the humanitarian context and their everyday work routines. Competing logics naturally get created. Drawing from the organizational field concept, the use cases presented through the vignettes coexist as independent organizations in a common field, and without coherent linkages with what exist become a source for discord.

An effective system requires both stability and to some extent flexibility to exist in different situations. Understanding the nature of these contradictions, technical and institutional, provide the potential to design possible solutions.

The three vignettes illustrate competing logics that create contradictions which can be both an enabler and barrier for change. Contradictions can block short-term initiatives of change if not adequately identified and considered from the early phases of a project. In our example, we observed how an initiative that had the main goal of reducing data collection at field level failed in its purpose of building a minimal data model due to an inappropriate choice of a design methodology. Understanding of this failure led the team to redesign feedback mechanisms, which although was still not optimal, was better than the original plan of co-located workshops. Most importantly, there was learning on how to approach this complex problem, which could not be just dismissed as "users are not interested in change".

Contradictions can introduce changes by adapting a competing logic in favour or the detriment of its opposite, and also reaches a broader scope than originally intended. In our example in the second vignette, having a setting of technical deficiencies, helped firstly in expanding the functionalities (for enabling offline use), and benefiting also the larger DHIS2 community. However, this also created the need for new routines of synchronizing servers, requiring new supporting institutions. Further technical and institutional work would then be required to deal with these consequences. There are thus dialectical influences at play between the multiplicity of institutional logics within the organizational field. Changes in reducing contradictions in one sphere can sharpen them in others. There is a need for a balanced response, examining the different trade-offs involved. in response to the change. The lens of institutional logics, their interplay, the ensuing contradictions and actions to try and unravel them provide arguably a sensitive lens to approach this complex problem.

6 Conclusions and future work

This paper has tried to identify the underlying multiplicity of institutional logics in an organizational field conceptualized in the context of a humanitarian organization. Contradictions arise through the interplay of the logics in play and often result in contradictions in domains of technology, everyday work, and the context of the intervention. While in the short-run, the challenges may seem difficult to surmount, however, through sensitive understanding of the nature of these contradictions, the potential for change can be positively leveraged. In future work, the plan is to apply this theoretical framework in other settings of humanitarian interventions, and examine how their potential may be effectively materialized.

7 References

Alford, R., & R, F. (1995). *Powers of Theory: Capitalism, the State and Democracy.* Cambridge: Cambridge University Press.

ALNAP. (2015). *The State Of The Humanitarian System.* London: ALNAP.

Altay, N. a. (2014). Challenges in humanitarian information management and exchange: evidence from Haiti. *Disasters, 38*, S50--S72.

Avgerou, C. (2002). *Information Systems and Global Diversity.* Oxford: Oxford University Press.

Azar, E. E., Jureidini, P., & McLaurin, R. (1978). Protracted Social Conflict; Theory and Practice in the Middle East. *Journal of Palestine Studies, 8*, 41-60.

Cristal Miskovich, B. A. (2013). Evaluating the Relationship between Knowledge Management Usage and the. *IEEE workshop proceedings.*

DHIS2. (n.d.). (Health Information Systems Programme (HISP) - University of Oslo) Retrieved from https://www.dhis2.org/

DiMaggio, P. (1986). Structural analysis of organizational fields: A blockmodel approach. *Research in Organizational Behavior, 8*, 335-370.

DiMaggio, P. a. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review, 48*, 147-160.

DiMaggio, P. J. (1991). Bringing society back in: Symbols, practices, and institutional contradictions. In R. &. Friedland, *The new institutionalism in organization analysis* (pp. 232-266). Chicago: University of Chicago Press.

Dorasamy, M., Raman, M., & Kaliannan, M. (2013). Knowledge management systems in support of disasters management: A two decade review. *Technological Forecasting & Social Change*, 1834–1853.

Friedland, R., & Alford, R. R. (1991). Bringing Society Back In: Symbols, Practices, and Institutional Contradictions. In W. a. Powell, *The New Institutionalism in Organizational Analysis* (pp. 232-263).

Hayes, N., & Rajão, R. (2011). Competing Institutional logics and sustainable development: the case of geographic information systems in Brazil's Amazon region. *Information Technology for Development, 17:1*, 4-23.

Kotlarsky, J., Scarbrough, H., & and Oshri, I. (2014). Coordinating Expertise Across Knowledge Boundaries in Offshore-Outsourcing Projects: The Role of Codification. *MIS Quarterly, 38*(2), 607-627.

Miles, M. B., Huberman, A. M., & Saldana, J. (2013). *Qualitative Data Analysis, 3rd Ed.* SAGE.

MSF Association, M. S. (1995). *Chantilly Principles.* Retrieved from Médecins Sans Frontières Association: http://association.msf.org/sites/default/files/documents/Principles%20Chantilly%20EN.pdf

MSF Spain. (2014). *OCBA Strategic Plan 2014-2017.* Barcelona: MSF Spain.

MSF Spain. (2016). *Emergency gap: Humanitarian action critically wounded.* Barcelona: MSF OCBA. Retrieved from https://arhp.msf.es/emergency-gap-papers-aid-environment/emergency-gap-humanitarian-action-critically-wounded

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance.* Cambridge: Cambridge University Press.

Orlikowski, W. J., & Barley, S. R. (2001). Technology and Institutions: What Can Research on Information Technology and Research on Organizations Learn from Each Other? *MIS Quarterly, 25*(2), 145-165.

Piotti, B., Chilundo, B., & Sahay, S. (2006). An Institutional Perspective on Health Sector Reforms and the Process of Reframing Health Information Systems: Case Study From Mozambique. *THE JOURNAL OF APPLIED BEHAVIORAL SCIENCE, 42*(1), 91-109.

Sahay, S., Mekonnen, S. M., Gizaw, A. A., & Sæbø, J. I. (2010). Interplay of Institutional Logics and Implications for Deinstitutionalization: Case Study of HMIS Implementation in Tajikistan. *Information Technologies and International Development*.

Silva, L., & Hirshheim, R. (2007). Fighting Against Windmills: Strategic Information Systems and Organizational Deep Structures. *MIS Quarterly, 31*(2), 327-354.

Stratton, C., Sholler, D., Bailey, D., Leonardi, P., & Rodriguez-Lluesma, C. (2016). Competing institutional logics in ICT4D education projects: A South American study. *Eighth International Conference on Information and Communication Technologies and Development.*

Tafere, M. (2014). Knowledge management in the humanitarian sector: Challenges in improving decision-making.

Thieren, M. (2005, September). Health information systems in humanitarian emergencies. *Bulletin of the World Health Organization, 83*(8), 584-9.

Thornton, P. H., & Ocasio, W. (2008). Institutional logics. In R. Greenwood, C. Oliver, R. Suddaby, & K. S.-A. Sahlin-Andersson, *The SAGE Handbook of Organizational Institutionalism* (pp. 99-129). Los Angeles: Sage Publications.

Walsham, G. (1993). *Interpreting Information Systems in Organizations.* New York: John Wiley & Sons, Inc.

Walsham, G. (1995). Interpretive case studies in IS research: nature and method. *European Journal of Information Systems, 4*(2), 74-81.

Walsham, G. (2012). Are we making a better world with ICTs? Reflections on a future agenda for the IS field. *Journal of Information Technology, 27*, 87–93.

Yusof, M. (2009). HOT-fit evaluation framework: Validation using case studies and qualitative systematic review in health information systems evaluation adoption. *4th International Conference on Information Warfare and Security, ICIW 2009* (pp. 359--365). Curran Associates Inc.

Zheng, Y. (2015). ICT4D, Overview of Theories in. In *The International Encyclopedia of Digital Communication and Society.* John Wiley & Sons, Inc.

Institutional Shaping of Affordances: Implications on Information Use in Global Humanitarian Organizations

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Abstract. To support global humanitarian organizations in carrying out interventions in project sites, information is needed that is situationally relevant and timely, while also being relevant to the HQs. The macro-level formal institutional conditions of the HQ and informal constraints at the project sites shape the design and content of Humanitarian Health Management Information Systems (HHMIS), and we focus in the paper on the aspect of information use. We use an ensemble view of the HHMIS, comprising of paper, the computerized system based on DHIS2, and other tools like Excel, to understand how these different components have varying affordances and are influenced differently by the formal and informal institutional conditions. Our theoretical perspective is thus shaped by the notion of "institutional affordances" which we draw upon to understand the affordance actualization of the HHMIS. We identify through our empirical analysis based on a project site in South Sudan, three key affordances relevant to the use of data – operationability, accountability and contextuability. Our analysis makes two key contributions: One, the different affordances of the components in the ensemble have interaction effects, sometimes positively influencing actualization and at other times is limiting. Two, we identify 4 sets of institutional (both formal and informal) influences on actualization coming from availability of information, existing maturity in the use of information, unique features of the humanitarian setting and technical features. We believe this paper makes an overall contribution in helping to situate the informational challenges faced by humanitarian organizations more firmly in the ICT4D agenda.

Keywords: Institutional logics · Affordances · Health management information system · Humanitarian organizations

1 Introduction

In humanitarian interventions, information is needed that is situationally relevant, timely, and at a level of detail to understand the current health status of the people affected, their locations, associated risks and resource needs [1].

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While humanitarian organizations are making systematic efforts to strengthen their supporting health management information systems, these benefits have not materialized in practice [2]. To understand why is the case and what can be done about it, this paper addresses the following specific research question: *How do constraining and enabling institutional influences shape the actualization of HMIS affordances within the context of global medical humanitarian organization?*

Our empirical site is the Doctors Without Borders Spain/Médecins sans Frontières Spain (MSF-E). We adopt an "institutionalized affordance" approach to analyse how and why are Humanitarian HMIS (HHMIS) contributing to strengthening MSF's interventions in South Sudan.

In the next section, we discuss our theoretical framework drawing from institutional and affordance theories and develop a synthesized analytical framework. Section 3 describes research methods and Sects. 4 and 5, we present our case analysis and discussions respectively, followed by a brief future work plan in Sect. 6.

2 Relevant Literature

This section includes 4 sub-sections. The first describes our conceptualization of the HHIMS. In the second, we discuss affordance, and conceptualize HHIMS from this perspective. In the third, we discuss the influence of institutional conditions on affordances. Finally, we present our analytical framework.

2.1 Conceptualizing HHIMS: An Ensemble Perspective

Orlikowski and Iacono [3] describe an ensemble view of the IT artefact to include the "ensemble of equipment, techniques, applications, and people that define a social context, including the history of commitments in making up that ensemble, the infrastructure that supports its development and use, and the social relations and processes that make up the terrain in which people use it (p. 122)". The HHMIS under study similarly represents an ensemble including multiple inter-connected components of both paper and a recently introduced technology platform, and the work practices around both of them. An ensemble view helps to capture the different techno-social aspects associated with the overall system and their inter-linkages.

2.2 An Affordance Perspective Around an Ensemble View of Technology

Drawing from ecological psychology, Gibson [4] describes affordance as how a goal-directed actor perceives an object in terms of how it can be used without a cognitive analysis. Affordances reflect a relational property emerging from the animal-environment system [5] with a key focus on the relationships [6] between the users and the technology [7].

Affordance Actualization (AA) theory [8] describes affordance as "the potential for behaviours associated with achieving an immediate concrete outcome and arising from the relation between an artefact and a goal-oriented actor (p. 69)". AA theory is relevant to our analysis of how the HHMIS strengthens or not the use of information

[9]. From an ensemble view, emphasizes how different components of the HHMIS responds to specific needs of users in varying ways, representing a multiplicity of affordances. Actualization of affordances in shaped by various conversion factors [10], such as personal, social and environmental. We conceptualize these as institutional conditions. We adopt an expanded form of AA by emphasizing a multiplicity of interacting affordances which are shaped by different institutional conditions. Understanding the institutional-affordance linkages is the focus of our analysis.

2.3 An Institutionalized Perspective on Affordances

Institutional theory is relevant to understand the implementation dynamics of health information systems in developing countries [11] by understanding the nature of institutions and their influences [12]. Concepts of the organizational field [13, 14] and institutional logics [15] inscribe the organizing principles that guide individual behaviour [16]. Institutional logics are multiple and could be simultaneously in play and not in synch, often contributing to institutional contradictions [16]. Piotti et al. [17] also include the role of ICT and formal rules and informal practices surrounding their use.

The ensemble perspective allows to discern the formal and informal practices surrounding the sub-components of the system, and their enabling and constraining conditions. The organizational field perspective helps to understand the different influences and how they interact and sometimes create contradictions.

2.4 Proposed Analytical Framework

We conceptualize the HHMIS as an institutionally ensembled system comprised of ICTs, paper, associated protocols in use, infrastructural limitations and existing work practices of users. The affordance perspective helps to analyse the relationships between different components of the system for interaction effects with users, to understand to what extent they are able to make expected use of it - to actualize the affordances. This framework helps us to analyse the relation between institutional conditions, affordances, and their actualization and trajectory.

3 Research Methods

3.1 Case Context

Médecins Sans Frontières (MSF) is an international, non-profit, self-governed, member-based organisation that delivers emergency aid to people affected by armed conflict, health epidemics and natural disasters [18]. Our research focuses on the operational directorate of MSF Spain, who during 2017 worked in 25 countries, with 43% of emergency interventions and 57% long-term missions [19]. Specifically, we analysed MSF's HHMIS implementation in their South Sudan Mission (SSM), including coordination office in Juba, two projects in the Greater Upper Nile Region, north of the country. The first project runs 2 hospitals, 4 mobile clinics and community

health promotion activities. The second project runs 1 hospital, 2 mobile clinics and community health promotion activities. The HHMIS project was launched in MSF headquarters in 2013 and was deployed in South Sudan in 2015.

3.2 Data Collection

Our research covered two sets of data collection methods: one, at MSF Spain HQ where the HHIMS was first designed. This helped to understand the HQ's institutional influences on projects. The second concerns the field site in SSM to understand how micro-level dynamics around affordances are shaped and actualized.

Headquarters
This research builds upon 4 years exploratory period (2013–2017) in which the first author was leader of the MSF Spain HHMIS team. She later left MSF to start a PhD programme in 2017 under a formal research agreement between MSF and the University of Oslo. For this reason, she is positioned as an "insider" researcher [20] and the second author an "outsider", collaborating on analysis, interpretations and theory development. Moving from insider to researcher helped in developing sharper insights of the HHMIS phenomenon [21]. Between July 2017 and February 2018, she made 3 visits to the HQ for data collection, in addition to regular emails and skype calls.

Field Engagement
Field engagement included a visit to the South Sudan Mission in February 2018. In MSF interventions, each country has a mission, with an office which coordinates the different projects in the country (usually 2–5). Projects have sub-offices which manage health facilities.

Data was collected primarily through interviews, observant participation, and informal conversations with staff. Some interviews were conducted in Spanish and others in English. As the first author is a native Spanish speaker, she experienced no problems in switching between these two languages. A semi-structured protocol guided the 22 interviews conducted, including of field staff (21) and medical profiles (20). Interviews ranged from 15 min to an hour, and they were recorded after obtaining explicit consent from the respondents.

Participant observation was ongoing and integrated with project activities like coordination and weekly medical meetings. Visits were made to 3 hospitals and 2 facilities to observe the data collection flow and have informal discussions with staff about their experiences. Notes were made of each interaction. All the recordings and notes were subsequently transcribed, and the raw data was ordered and made ready for analysis.

3.3 Data Analysis

Data analysis involved both qualitative and quantitative methods. Qualitative analysis involved a process of iterative coding, while quantitative analysis included aggregating the frequency of codes and ranking them to interpret their salience. The most salient codes were then interpretively analysed to understand their underlying meanings.

Interviews were transcribed by the first author, and then shared with the second author. Both then independently read the transcripts and developed first level codes to help answer the research questions. Following this, both had face to face discussions to discuss the respective codes and resolve disagreements, which were limited. A total of 408 raw codes were identified, such as difficulty to find information, lack of time, data used for accountability, data quality problems and the predominant use of paper. For example, quotes leading to the code "Data is highly valued" were: *"data is important because we care about results", "Having access to HHMIS makes us autonomous", "use of HHMIS should be available for all staff"*. After this followed a second-round of higher-level analysis in which codes were combined and grouped in more generic themes, such as different use of data, perceptions of data, challenges in work practices, challenges in the use of the system. Example in the development of a theme: **Theme:** Mature use of information and good perception of data. **Codes:** Data highly valued, Use of heuristics, Collaborative analytical process.

The developed themes provided the analysis basis for a third level of analysis, were they were linked to predefined theoretical concepts of affordances and institutions. 75 of the 408 codes were classified as affordances (18.5%), 162 as institutional conditions (39.7%), 162 as resulting influences (39.7%). Remaining 9 codes were not matched.

4 Case Study and Analysis

We present an analysis of affordances, followed by a description of relevant institutional conditions. Next, we present our analysis of the impact of institutional conditions on affordances actualization.

4.1 Affordances and Their Actualization

Affordances refers 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 information. Within an ensemble perspective, we focused on both the paper and computer-based components of the HHIMS, their interactions and implications on actualization. The 3 most important affordances identified were: operationability (62.7% salience), accountability (12%) and contextuability (8%). These contributed to 82% of overall salience.

Operationability
Drawing from MSF's use of the term operational as related to the field intervention, we describe operationability as "*the possibility to use data to follow up trends and identify alerts for constant response and adaptation of activities*".

Respondents, both the medical and management staff, saw this affordance as significant given that they were operating in a dynamic environment requiring constant follow up of day-to-day project management and organizing of health service delivery at the facilities, including decisions related to logistics, budget, capacity building and human resources.

Predominantly, staff saw paper-based data to be more operationally useful than computers, and they reverted to the paper clinical files to routinely provide patient care. To analyse trends and incidence of diseases, most doctors would directly use data from the paper forms or their own personal note books and diaries. They saw HHIMS data as not always available or sufficient: "*I don't have the information in HHMIS to follow up the community health workers, I have made my own records*". Another doctor said: *"I do check my data, but I do it at data entry for current data. I do not build charts or follow trends (…) paper is always there"*. The higher-level follow-up from the mission coordination office was based on HHMIS data and through email communication. Access to the paper records was not possible there, and so its use was not an option.

Accountability

We describe accountability as "*the possibility of data to be accountable for day to day activities and operational decisions*". This was especially relevant for mid-range coordination positions, and for reporting and justifying operational decisions cross different levels by both medical and management staff. At the health facility, the laboratory technician and the medical officers were aware of the importance of having their work reflected in numerical values, for example: "*you need your data to prove your work to others*", "*if I have empty records, means that that day I have not worked*."

The clinical officers at the facility always interacted with paper, which was their primary source for accountability, as they did not have access to the system. For expatriates and higher-level positions, the HHMIS was used when information was available to generate their reports. When unavailable, they used parallel tools (like Excel) that allowed for sharing reports to higher levels as a temporary solution. However, they were conscious of the importance of having data in the "official" channel. We saw a nurse to be collecting data on the number of deliveries in paper. She had asked for a maternity service in he system, which was not offered at that moment in the facility. She realized only when data on deliveries went through the HHMIS would her request for a maternity service be heard by the higher ups.

Contextuability

We describe contextuability as "*the possibility to know and analyse context when you are new to the situation*". This was relevant when users needed access to medical data from the previous periods when they were new in a project or mission. When new staff arrived to the project, they requested access to HHMIS to follow up data on daily basis: "*when I just came to the project, data was my daily bread"*. This prior data helped them understand the context and how to readjust their interpretation of data. A very descriptive example of this was: *"Now when I arrive to DRC, with the same population, the number of malaria cases is 200 per week, and for me that was a normal situation… and the Medical Coordinator was surprised of why was I not raising an alarm… because was increasing… 200, 250, 300… but for me was normal… I was actually focussing on Cholera, because in my country (Niger) one case of cholera is an outbreak and we had 10 cases, and no one was talking about it… so I was like… what happens here?"*.

4.2 Institutional Conditions and Their Influences

We identified 4 institutional conditions reflecting pre-existing aspects which influence the interaction of the users with the HHIMS: (i) mature use of information and positive perception of data (29.6% salience); (ii) limitations of information available (24.7%); (iii) humanitarian setting characteristics (20.4%); and, (iv) technical features (16.7%). Together, they comprised more than 90% of the total salience. These are now discussed.

Mature Use of Information and Positive Perception of Data
Most users perceived the important role of data in shaping their everyday work and the overall effectiveness of the project and of the HQ. Despite the limitations of existing data and systems, the value of data was universally recognized. Some illustrative quote: *"data is important because we care about results", "Having access to HMIS makes us autonomous" "use of HMIS should be available for all staff".*

The medical teams had weekly meetings where they discussed service by service important events of the week, and the underlying reasons. There was a generalized use of heuristics and experience-based knowledge to analyse data and follow up on particular diagnosis. A doctor said: *"Numbers tell me the workload of staff and the treatments that I could need based on diagnosis. If there have been many diarrhoeas, I know I will need ORS (…) I also see if treatment consumption matches diagnosis."*

The mature use of information and positive perception towards data was an enabling condition for affordances actualization and promoted the use of the paper and parallel tools to predominate over the use of the new technical solution. For example, to enable operationability, in weekly meeting all doctors had the numbers that they wanted to share in their notebooks, copied from the manual system. For accountability, they used the parallel excel files to show their numbers. For contextuability, they complemented the computer system data with a printed version of the past reports. Overall, we see a positive affordance actualization of the ensemble system.

Limitations of Unavailable Information
The institutional condition of unavailable information is related to the technological component of the HHMIS, specifically its configuration in terms of content, metadata and logic. The system is configured to collect certain data points from each health service and calculate a set of indicators. This configuration is standard for all interventions, across settings, and often is inadequate to cater to local specificities.

The available data was described by the user as, paradoxically, extensive and limited at the same time: "*there is a huge amount of data collected in HHMIS that is not used*", "*too much data, but yet important data not collected*". While users recognise the value of using standard systems, they also see their limitations "*using standard systems is needed but it will not work for those in the extremes*".

Having limited information available affected negatively the actualization of all three affordances. In the case of operationability and accountability users had to find alternative ways to collect and manage their data, such as through paper or parallel tools. For contextuability, the lack of information limited actualization of the affordance and users tried to find alternative sources of information, but since data is studied retrospectively, it did not result in the creation of parallel channels.

Paper and parallel tools are components of the ensemble system, and it is planned for the technical component to gradually replace them. Paper is inherently limiting to the quality of data as it leads to data loss and impedes the creation of historical trends. Use of parallel tools also creates multiple flows and potential duplications. In the long run, the use of paper and parallel tools negatively impacts user's motivation for data tasks: "*time dedicated to data collection does not compensate if you don't use data".*

Humanitarian Setting Characteristics

The atmosphere in the project office is of intense activity. The working day is long and there is no clear distinction between work and personal spaces as also the project office and residences are co-located. In addition, medical staff are on call at night and on weekends. In the interview records, there was always a lot of background noise, with sounds of radios and walkie-talkies, and many interviews were frequently interrupted. All users talked about the lack of time: "*I don't have time to sit and look at data*".

There is also a high staff turnover, the average time an expatriate medical staff in one field location was 2 to 12 months. Since field staff are working with sustained high intensity, they find difficult to be responsible for teaching newcomers. One field staff said: "*high intensity makes you rely on the ones who know instead of teaching the newcomers*". Users do not find the time to train themselves: "*Paper is always there, and you don't need to learn".* And the same is the case with Excel files.

The institutional conditions of the humanitarian setting tend to be restrictive to the actualization of all affordances as users are unable to dedicate quality time for learning, and their transitory mindset makes them rely on shortcuts and local improvisations.

Technical Features

Institutional conditions inscribed in technology were both enabling and constraining. While the technical system is centralized and web-based on the District Health Information System platform [22], the architecture includes offline servers which store all collected data from each project and synchronize with the central instance when internet is available. Having data integrated from the field, directly into one centralised system contributes to the actualization of operationability and accountability, specially at coordination level, where data is available almost in real time. It also improves data quality in contrast with other means of data collection.

The centralized offline-online architecture enables data to be entered and modified only from the field project, which was not the case before. This improves data ownership by field users, which will have a positive influence in the long term. On the other hand, offline deployment limits content updates to once a year, contributing to a perceived rigidity and complexity which constrains the actualization of operationability at the project level and limits availability of data.

Regarding the user experience, all users without exception were able to enter data, but only a few could use the analytic tools for generating charts or tables, generally the ones in management positions. It was common practice to extract data from the HHMIS as a simple table, and then create more elaborate tables or charts in Excel, because "*I already know it*". The complex user interface of DHIS2 prompted users to use Excel.

4.3 Summarizing Analysis

The paper sought to answer the answer the research question: *How do constraining and enabling institutional influences shape the actualization of HMIS affordances within the context of a global medical humanitarian organization?*

Firstly, we have identified through our empirical analysis three key affordances relevant to the use of data – operationability, accountability and contextuability. Operationality refers to the ability to work with data in routine use, accountability concerns the ability to show the value of a user's work to the higher levels, and contextuability reflects the ability to get historical data to guide current use of data in an unknown environment. All these affordances are particularly relevant to a humanitarian setting given the high importance of data, the challenge of people in the field in isolated settings to make their work visible to the coordination levels, and the dynamic nature of the humanitarian setting where is challenging to access historical data.

Secondly, while we find the actualization of affordances to be shaped to different degrees by the features of the paper and the computer-based system, our ensemble view also helps to understand how these individual affordances interact with each other. For example, with respect to operationability, paper allows the affordance of quick local availability of data found in local diaries of the staff, which enables the use of data combined with experiential knowledge of the staff. With respect to the same operationability, the HHMIS designed with an integrated database helps build perceptions of sounder data quality, which encourages data use. These individual affordances have interaction efforts. In some cases, the easy access to paper-based data discourages users from using the computer-based system, in other cases the paper printouts are used in conjunction with the computer reports of aggregate data.

Thirdly, we have identified four key institutional influences on the actualization of affordances towards data use. These are an existing maturity in the use of information, limited availability of information, the unique features of the humanitarian setting, and the technical features. While some of these conditions, such as technical features of the system can be seen as formal institutions defined by the HQ for the project level, others such as the hectic nature of the humanitarian setting resulting in high staff turnover can be seen as informal institutional constraints. These formal and informal institutions are not isolated, they influence each other enabling and constraining the actualization of affordances. For example, the centrally defined technical architecture is enabling as it is seen as heightening accountability. The same architecture, for operationability, is seen to be rigid and difficult to change which then encourages the use of paper to fill the gaps. A summary of the impact of institutional influences in the actualization of affordances can be found in the table below (Table 1).

Table 1. Institutional influences in affordances actualization

Operationability	Accountability	Contextuability
Information limitations		
Constraining: increases use of paper and parallel tools	Constraining: increases use parallel tools	Constraining: limits retrospective analysis
Mature use of data		
Enabling: origin, fuel of all affordances. Results in the use of paper or parallel tools which makes benefits of new system explicit		Enabling: origin, fuel of all affordances
Humanitarian setting		
Constraining: impacts the actualization of all affordances as results in the combination of a continuous loss of capacities with lack of time for training		
Technical features		
Enabling: increases data quality, enables for integrated analysis, enhances ownership of data, and gives almost real time access to information Constraining: rigid data model, complex analytic tools		Enabling: increases data quality, enables for integrated and retrospective analysis Constraining: complex analytic tools

5 Discussion

Humanitarian organization settings by principle are complex because of them having to intervene in dynamic and unstable situations, where project locations are in environments which are remote, politically charged and having sub-optimal infrastructure. For these very reasons, they need robust information support to guide their interventions, especially related to using information for local action. This as our case study has described is a non-trivial challenge.

We have examined these challenges from the lens of "institutional affordances." Our point of departure and contribution is primarily twofold. One, we have conceptualized the artefact from an "ensemble" view to highlight the artefact is not one monolithic entity but comprised of different components, in our case including the technology, the paper-based records, parallel tools like Excel, and the idiosyncrasy of the humanitarian environment. These components have varying affordances, they are differently influenced by the institutional conditions and have interaction effects – enabling or constraining, which shape the overall actualization of the affordances. Two, we have examined the institutional influences on affordance actualization both with respect to the formal rules of the game (such as the HQ defined technical configuration and metadata) and informal constraints (such as the work practices or the hectic and unstable environment of a humanitarian setting). These influences are also enabling in some cases and constraining in others.

Arguably, our paper makes some notable contributions to the important and emerging field of humanitarian assistance, and the role which ICTs can play in this domain. Till date, the study of humanitarian systems has received scant attention in IS

research. And as Walsham [23] has argued, this represents an important domain for ICT4D research and strengthens our quest to make a better world with ICTs.

6 Conclusion and Future Work

What we have presented in this paper is part of a larger and ongoing work at MSF Spain, where the commitment is to make a real difference in data use for project settings through the use of ICTs. In future, we seek to explore the potential of using mobile devices to bring the technology closer to the user to improve data collection processes. We will be guided by our understanding of institutional affordances to examine how data can be got "closer" to end users, and by supporting local action taking will enhance affordance actualization. The mobile technology will be introduced and analysed as a component of the ensemble system, including the evolution of the trajectory of affordances over time.

The paper contributes to the conference theme by examining how the current north-south (HQ-mission) networks are problematic. The institutional affordance lens helps to understand these challenges and identify approaches to address them. These solutions can subsequently be taken to other projects and missions, and effectively implemented to south-south driven collaborations.

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References

1. Thieren, M.: Health information systems in humanitarian emergencies. Bull. World Health Organ. **83**(8), 584–589 (2005)
2. ALNAP: The State of the Humanitarian System. ALNAP, London (2015)
3. Orlikowski, W.J., Iacono, C.S.: Research commentary: desperately seeking the "IT" in IT research - a call to theorizing the IT artifact. Inf. Syst. Res. **12**(2), 121–134 (2001)
4. Gibson, J.J.: The Ecological Approach to Visual Perception. Houghton Mifflin, Boston (1979)
5. Stoffregen, T.: Affordances as properties of the animal-environment system. Ecol. Psychol. **15**(2), 115–134 (2003)
6. Chemero, A.: An outline of a theory of affordances. Ecol. Psychol. **15**(2), 181–195 (2003)
7. Chemero, A., Turvey, M.: Complexity, hypersets, and the ecological approach to perception-action. Biol. Theory **2**, 1–14 (2007)
8. Strong, D.M., et al.: A theory of organization-EHR affordance actualization. J. Assoc. Inf. Syst. **15**(2), 56–85 (2014)
9. Lanamäki, A., Thapa, D., Stendal, K.: When is an affordance? Outlining four stances. In: Introna, L., Kavanagh, D., Kelly, S., Orlikowski, W., Scott, S. (eds.) IS&O 2016. IFIPAICT, vol. 489, pp. 125–139. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-49733-4_8

10. Hausvik, G., Thapa, D.: What you see is not what you get" - challenges in actualization of EHR affordances. In: International Conference on Information Systems Proceedings, Seoul (2016)
11. Sahay, S., Mekonnen, S.M., Gizaw, A.A., Sæbø, J.I.: Interplay of institutional logics and implications for deinstitutionalization. Inf. Technol. Int. Dev. **6**, 1–19 (2010)
12. North, D.C.: Institutions, Institutional Change and Economic Performance. Cambridge University Press, Cambridge (1990)
13. Powell, W.W., DiMaggio, P.: The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. Am. Sociol. Rev. **48**, 147–160 (1983)
14. Orlikowski, W.J., Barley, S.R.: Technology and institutions: what can research on information technology and research on organizations learn from each other? MIS Q. **25** (2), 145–165 (2001)
15. Alford, R.R., Friedland, R.: Powers of Theory: Capitalism, the State and Democracy. Cambridge University Press, Cambridge (1995)
16. Alford, R.R., Friedland, R.: Bringing society back in: symbols, practices, and institutional contradictions. In: The New Institutionalism in Organizational Analysis, pp. 232–263 (1991)
17. Piotti, B., Chilundo, B., Sahay, S.: An institutional perspective on health sector reforms and the process of reframing health information systems. J. Appl. Behav. Sci. **42**(1), 91–109 (2006)
18. MSF Web site: About us. https://www.msf.org. Accessed 17 Oct 2018
19. MSF-Spain: MSF Spain Annual Report 2017. MSF Spain, Barcelona (2018)
20. Walsham, G.: Interpretive case studies in IS research: nature and method. Eur. J. Inf. Syst. Proc. **4**(2), 74–81 (1995)
21. Vila-Pozo, M.M, Sahay, S.: Humanitarian health information systems: different challenges and responses. In: European Conference on Information Systems Proceedings (2018)
22. DHIS2: Health Information Systems Programme (HISP) - University of Oslo. https://www.dhis2.org/. Accessed 17 Oct 2018
23. Walsham, G.: Are we making a better world with ICTs? Reflections on a future agenda for the IS field. J. Inf. Technol. **27**, 87–93 (2012)

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Competing Affordance Potencies Shaping Data Collection: Case of Humanitarian Organizations

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Abstract

Individual adoption of technology in humanitarian settings is linked with expectancies of performance and effort, and users tend to easily default to "whatever works". A deeper understanding of the process of field users' adoption of a new technology is of utmost importance for humanitarian organizations. We used Affordance Potency framework for comparing competing affordances of a mobile based solution with existing paper-based processes, against 4 identified affordances. The mobile solution was deployed in seven inpatient wards of two humanitarian field hospitals during a period of four months. This analysis demonstrated how technology features are as important as it is to be flexible to respond to contextualised work practices. The affordance potency lens helped understand how competing systems can shape the data collection process. A key contribution of this study is the use of affordances from a "competing" lens perspective within the unique context of a humanitarian organization.

Keywords: affordances, affordance potency, health information system, humanitarian organizations, mobile data collection

Introduction

Humanitarian interventions are rapid and uncertain. In response to a sudden need, international organizations deploy multiple response mechanisms where specialised human resources, logistics, and information comes together to act in remote and usually unknown settings under emergency conditions. Whether caused by manmade or natural disasters, humanitarian crises generate immense acute and long-term health impacts on hundreds of millions of people, who have restricted access to the basic health care services. For humanitarian organisations, having access to data on the health status and needs of the population is at the basis of decision-making and a central component of humanitarian response.

In global responses to big humanitarian crises, the capacity to collect and share information across organizations is of vital importance, as demonstrated during the 2010 Haiti crisis response, where SMS and social media were used for sharing information in ´real-time´. The high degree of information fragmentation in the Haiti response highlighted the importance of the inter-agency coordination (Altay and Labonte 2014; Chan et al. 2019). Maxwell and Watkins (2003) analysed the interdependent components of a humanitarian information system by studying long-term emergency cases in the Horn of Africa,

identifying the cost of vital gaps in baseline information in the Ethiopia food security crisis (1998-2000), the program management in the Kenyan rainy seasons crisis (1999-2022), and the early warning system crisis to support the Burundi political violence (1996-2001).

The need of information for coordinating emergency response is crucial, but this is dependent on the intra-organizational capacity of actors to generate data from its internal systems and processes. The primary focus of this research is on information systems (IS) in intra-organizational settings of humanitarian entities which remains a neglected area in IS research, and reflects unique characteristics as contrast with inter-organizational IS. These include: i) extreme reliance on paper-based data tools partially caused by the speed and changing dynamics of daily work; ii) uneven and low IT literacy levels and high staff turnover, raising the need for constant retraining, which is hard to come by; and, iii) limited digital infrastructure and prior experience with digital systems.

In such unique conditions, digital interventions may be seen as a burden rather than a boon, as the field teams need to constantly juggle resources and time with providing urgently required medical care. As a result, many modern digital solutions are rejected in favour of low-tech solutions, or even no tech solutions (Harvard Humanitarian 2011). This raises the need to pay close attention to micro-level processes of how users accept or reject new digital solutions, and what value they are seen to add or not to their everyday work processes in a humanitarian setting. As this field of research is relatively nascent (Kabra et al. 2017), there is a lack of systematic evidence of such implementation dynamics, which motivates us to analyse the routine Health Management Information Systems (HMIS) and learn from daily practices of data collection in the context of digital mediation inside one humanitarian organisation.

The research setting for this study is a field mission of Médecins sans Frontières Spain (MSF Spain), organisation delivering emergency aid to people affected by armed conflict, epidemics, natural disasters, and exclusion from healthcare. In 2014, MSF Spain developed their HMIS with the aim of enhancing the use of information to support operations throughout the organization. A significant amount of effort for data collection is invested in gathering and compiling data to enter in the HMIS, which is used for project management. There is a widely held perception, however, that the collection and analysis of data diverts resources away from more crucial operations of providing care services.

To ease the burden of data management, digitization of these processes is often presented as a possible solution, without taking resources away from care provision. Our project was carried out in an MSF mission ongoing in South Sudan, which provides medical services to an internally displaced population camp. Taking advantage of the introduction of a new mobile-based data collection system in the field hospital, we studied the day-to-day work processes of humanitarian workers and their interactions with both -old and new- data collection systems and related work processes.

By contrasting the perception of users to both paper and digital-based artefacts, this research aims at building understanding of the respective micro-level processes shaping the use of digital systems by humanitarian health staff, the competition which emerges across these two systems, and how the use of technology is shaped by the particular characteristics of the humanitarian setting. We adopt a theoretical perspective based on the Affordance Actualization Theory (AAT) (Strong et al. 2014) and Affordance Potency (Anderson and Robey 2017).

Affordances, which concern "the potential for behaviours… arising from the relation between an artefact and a goal-oriented actor" (Strong et al. 2014, p. 69), allows for a better understanding of the relationship between the technical and the social. AAT focuses on understanding how users can better actualize the affordance potential and make expected use of the technology. Drawing on AAT, we use the concept of affordance potency (Anderson and Robey 2017), defined as the strength of such relationship, as a framework for comparing how users perceive the competing paper and digital systems, and how this shapes their acceptance (or not) of the digital.

Our paper contributes by empirically building the concept of "competing affordances" which is relevant to understanding how the new digital interventions compete with the capabilities of existing systems, paper or otherwise. We conceptualize the system components, related practices and processes using an "ensemble" perspective (Orlikowski and Iacono 2001) to understand their implications on system use. This leads to the following research question:

How do competing affordances of paper and digital technologies shape practices of data collection in humanitarian settings?

To answer our question, we first identified the situated affordances (Anderson and Robey, 2017) by analysing the work of the health staff focussing on how systems are used, without limiting understanding only to the features of the system but to the actual information practices. The potency of the resulting affordances is then analysed from a "competing affordance" framework including the three factors influencing the actualization: user abilities, technical features, and context (Strong et al. 2014).

This research is an action case project (Vidgen and Braa 1997) which took place between September 2019 to March 2020 covering the deployment and assessment of the digital solution, with a total of 9 weeks in the field site over 2 separate trips. Data collection methods were carried out during both phases and included a mix of participant observation, focus group discussion, in-depth interviews, and studying the data from the HMIS system. Data analysis consisted of a thematic content analysis of the interviews transcriptions and research notes complemented with a quantitative data analysis of the HMIS.

Next, we first discuss literature relevant to our case and analysis, followed by a description of the research site and data collection and analysis methods. Following this, we present the analysis and findings, subsequently discussed to frame our contribution, followed by conclusions.

Literature Review

This section is divided into three sub-sections. We first position our work within the research field of humanitarian IS use and adoption. We then present key concepts of AAT and affordance potency, which provide the core for our analysis. Finally, we present the overall analytical framework that guides this research.

Humanitarian Health Information Systems

The importance of reliable information is heightened as the number of people affected by humanitarian crises has almost doubled over the past decade and is expected to keep raising (MSF 2014). Health management information systems play a crucial role in responding to emerging informational needs and strengthening systems of accountability in decision-making (Lewis and Madon 2004). Non-governmental organizations (NGOs) are increasingly using their routine data systems for their decision making (Braa and Sahay 2017), but their potential value has remained largely underutilized.

Three pillars are relevant for humanitarian organizations to monitor the progress and results of their health interventions: Surveillance, to track changes in disease incidence and mortality over time to guide disease control practices; monitoring, to check the progress of the interventions and; evaluation, to assess completed programs or phases and their impacts in reducing disease incidence and mortality (MEASURE-Evaluation 2020). Information for these three pillars is mainly obtained from i) routine health information systems (called HMIS), which facilitate ongoing facility and community level collection of health information and regular reporting throughout the organization; ii) health facility surveys, to examine whether or not patients are receiving the service they need, assess quality, infrastructure, supplies and human resources to provide adequate services and; iii) household surveys, usually covering multiple health interventions, whether age or disease-specific, or helping to populate demographics estimates (Sawadogo-Lewis et al. 2021). This study focuses on the routine HMIS, which provides the foundation for managing short and long term humanitarian interventions (Mesmar et al. 2016).

The nature and context of humanitarian business are different from other more structured and routine market-driven contexts (Tusiime and Byrne 2011). Humanitarian organizations face the unpredictability of situations, reduced human resources capacity, and general uncertainty about what happens next (Tafere 2014). Deploying new information systems becomes particularly challenging because of this and other contextual particularities related to limited existing experiences with digital systems, weak digital infrastructure, and extreme manpower turnover (Mesmar et al. 2016). These translate into challenges that generally go beyond technology and stem from organizational issues, culture, and environment (Maiers et al. 2005).

The highly decentralised model of humanitarian interventions also influences the processes of individual adoption of technology, which is often not linked with personal motivations or trust in the system, but rather to the performance and effort expectancies of individuals (Kabra et al. 2017). Users need to perceive that the selected solutions will easily add value to their hectic day-to-day activity and not merely add work, otherwise, they will default to "whatever works", which includes the rejection of the digital. In a field hospital, for example, users need to find a fine balance between information system needs –such as data collection or routine reporting, while engaging with their activities of providing medical care and managing the hospital wards. Finding the right balance is a non-trivial challenge, as the workers typically come from a health care background, IT competencies are limited and there is a rapid turnover of staff raising the need for continuous (re)training (Tafere 2014). Often field users might end up working according to their wishes, by choosing a separate software, or not using a software at all (Kabra and Anbanandam 2016).

Aspects like user involvement, human-computer interaction, and data workflows, haven't generally received much attention in this domain (Kumar et al. 2018). Deeper understanding of the processes that lead users to adopt or not a new solution is of utmost importance, particularly in the humanitarian field as technology penetration is relatively at a nascent stage (Kabra et al. 2017). Research focus must shift from evaluation of effects to study of processes around user adoption of technology (Tusiime and Byrne 2011), seeking to build context-specific theories (Burton-Jones and Volkoff 2017). Drawing upon learnings from IS research for such theoretical development, is crucial in this effort. This will contribute both to the domain of humanitarian health IS, and mainstream IS research which is increasingly focusing on digital interventions in humanitarian settings.

Affordance Actualization Theory and Affordance Potency

James J. Gibson (1979) articulated the concept of affordance in the domain of ecological psychology, to study the perception of animals of their surroundings. In its original definition, affordance is what is offered, provided, or furnished to someone or something by an object. It expresses that goal-directed actors perceive an object in terms of how it can be used, and not as a set of characteristics independent from them. Affordances are perceived directly, not requiring a cognitive analysis of the features or characteristics of the object, emphasizing the relational and emergent characteristics of the systems (Chemero and Turvey 2007).

This perspective was taken to the technology domain, emphasising the relationship between the users and the technology and not only of the technology itself and extended to the information systems research (Stoffregen 2003). Strong et al.(2014) developed a mid-range theory – AAT – to help study the process that makes the user actualize the potential of the affordance understood as "the potential for behaviours associated with achieving an immediate concrete outcome and arising from the relation between an artefact and a goal-oriented actor" (Strong et al. 2014, p. 69). Affordance is seen as a potential that can be actualized, actualization comprises "the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organization goals" (Strong et al. 2014, p. 70).

This has raised the challenge for information systems researchers to understand the conditions that influence the actualization of affordances in situated contexts (Chaterjee et al. 2020; Hausvik and Thapa 2016). At an individual level, AAT defines three factors: i) users' abilities, ii) the features of the technology, and iii) the work environment (Strong et al. 2014). These factors that lead individuals to actualize affordances contextualised in our work are:

i) **System Features**: Humanitarian information systems demand support for intuitiveness since high turnover causes a constant loss of organizational knowledge and there always exists competition of learning with the conduct of everyday urgent work. Support for the application of intuition becomes crucial in such a setting.

ii) **User´s abilities:** Data and digital literacy levels often vary, due to different prior exposure to technology which varies with the age or background of the health worker. Staff without the necessary competencies tend to consider the collection and reporting of data as an administrative function that competes with the provision of medical care.

iii) **Context:** In the physical context, some hospitals might have a proper desk and space for data collection, while others may not. Human resources (time and capacity) are frequently inadequate, contributing to a limited organizational data culture, which emphasizes care work over data related-work. The work atmosphere is intense and rapid, with health workers being often interrupted by different activities which need immediate attention, compromising time spent on data-related activities.

The model of affordance potency extends the idea of affordance actualization to understanding "the strength of the relationship between abilities of the individual and the features of the system at the time of actualization" (Anderson and Robey 2017, p. 103). Focusing on *the time of actualization* brings in the concept of situated affordances, which might or not correspond to the planned or designed uses of technology (Anderson and Robey 2017). Such a focus is of key importance in humanitarian settings where users are remote, making the provision of technical support challenging. The situated affordances empirical approach puts the users and their practices at the centre of the analysis situated in their everyday work context. These information practices provide the unit of analysis of the study.

The concept of the potency of situated affordances is relevant to study humanitarian technology adoption, as it provides a toolkit to i) position technology use in context and ii) assess the actual usability when combining the user, the solution, and the environment.

Proposed Analytical Framework

In humanitarian settings, everything starts on paper, which does not disappear even when mobile technology is deployed. We thus adopt an ensemble perspective comprising the "ensemble of equipment, techniques, applications, and people that define a social context, including (…) the social relations and processes that make up the terrain in which people use it (Orlikowski and Iacono 2001, p. 122)". This perspective helps study the multiple interconnected components of both paper and the newly introduced technology platform, the work practices around both, and how users interact with them within a situated context.

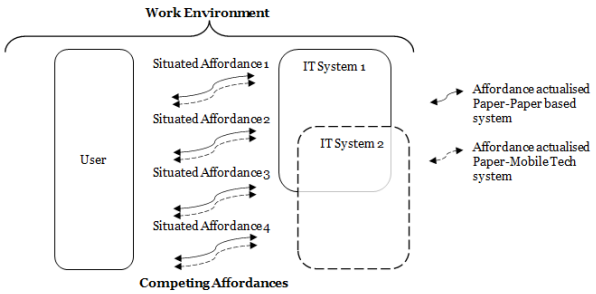

Figure 1 - Diagram for Competing Situated Affordances

We work with the hypothesis that a strong potency is more likely to be actualized, as humanitarian users will adopt the path of least resistance. This implies for mobile technology to be preferred by users, it needs to have equal or more potency over its paper competitor. Observing both systems in conjunction allows us to study and analyse the "competing affordances" responding to the same goal-oriented action. To do so, we aim at understanding the perception of the users when they compare their experiences. The analytical framework is presented in Figure 1 above.

Research Methods

This research project is one of action case (Vidgen and Braa 1997) aimed at learning from the deployment of a mobile-based application for data management processes. Action case represents an IS research framework for planning, controlling, and evaluating projects with high contextual immersion and situated research questions. Such a framework is particularly adequate for research in humanitarian settings that combines intervention and interpretation. Action case builds upon the assumption that organizations might limit what research can or cannot do, while at the same time benefitting from the potential to initiate change

from the research activity. This approach balances the contextual challenges of a full-scale research project by proposing a smaller scale intervention with deep contextual understanding, and the ability to learn from this smaller intervention when thinking about scale.

We find in recent literature small scale interventions with a deep contextual understanding using action case methodology such as a digital intervention for enhanced emotion analytics on user-generated content and behaviour in a large global automotive manufacturer (Sykora et al. 2022). Also, the development of multi-stakeholder partnerships to maximize the potential of collaboration for the refugee response. This intervention looked at a stakeholder partnership established to provide energy and host communities in refugee camps in northern Ethiopia (Moreno-Serna et al. 2021).

Our theoretical approach aligns with interventions where IS theories frameworks are used to study the changes that technical interventions can generate in an organisation, like the study of the implementation of a security awareness programme (Tsohou et al. 2013); to make deep theoretical analysis of the process of technology use (Hausvik and Thapa 2016), and technology implementation (Sigala et al. 2020); or to study the impact of a new technology on the decision-making processes of the organisation (Tona et al. 2016).

The study involved two main phases of deployment and assessment which took place between September 2019 to March 2020, with a total of 9 weeks in the field site over 2 separate trips.

Research Site and technical intervention

MSF is an international, independent, medical humanitarian organization delivering emergency aid to people affected by armed conflict, epidemics, natural disasters, and exclusion from healthcare. Our research was carried out under the operational directorate of MSF Spain, focused on providing care to victims of emergencies and operating in more than 30 countries in 2022. MSF uses the District Health Information System 2 (DHIS2) as their HMIS. DHIS2 is an open-source web-based health management information system developed and maintained by the University of Oslo (UiO), used extensively around the world by ministries of health, NGO´s and international agencies. In MSF, the role of the HMIS is to collect data routinely from the projects to facilitate access to information for the coordination teams at different levels, from the field project to headquarters in Europe, and support the design and monitoring of their interventions.

The South Sudan country mission was selected as the main setting of this overall research project by the organization's medical department in collaboration with the first author. Selection criteria included context stability, type and number of projects and health facilities, the services provided and their volume of activity, and the status of the HMIS in the mission. HMIS has been operational in the South Sudan mission since 2015 and is used for data management in its current projects. This research focused on one of the field projects which provides medical services to an internally displaced population (IDP) camp established due to violent clashes back in 2015 and is situated in the second biggest town in the country before the conflict started in 2013. Today, nearly 16,000 people live in the town, and around 32,000 IDPs live in the nearby Protection of Civilians site (PoC). The project manages the Town Hospital and the PoC Hospital and is guarded by forces from the United Nations mission in the country. Both hospitals were included in the pilot.

The deployment of the new mobile data collection system was conducted from October 2019 to January 2020 in seven inpatient services from the two hospitals, including Adults, Paediatrics, Inpatient Nutrition and Neonatology wards in PoC Hospital; and Paediatrics, Inpatient Nutrition and Neonatology wards in the Town Hospital.

The existing data collection system in the hospitals comprised of the following steps: i) admission of patients to the ward, when their details are added to the register book and the patient file is completed; ii) weekly aggregation (usually on Monday mornings for previous weeks) from the register book into tally sheets, where patient data is tallied by age and sex, diagnosis, type of exit, cause of death and diagnostic tests performed. The nurse supervisor is responsible for this process with support from the data collector when available; iii) validation of data compiled by the nurse activity manager or the project medical referent, and at the end of the aggregation day the tally sheets are taken to the project base office to be introduced into the computerized HMIS system.

The proposed solution for a new mobile tablet was designed as the above process was perceived by the staff as being repetitive, time-consuming, and prone to human error. The solution consisted of introducing the DHIS2 Android app for data collection and adding a custom solution to automatically integrate the aggregated data into the HMIS system. This solution did not replace the first manual step involving the register book, which is extremely local and difficult to standardize, and was planned to be covered later. The expected outcomes of the intervention were: i) replacing weekly manual calculations with an automated aggregation process, and ii) replacing manual data entry with an automatic sync process to send the aggregated data into the HMIS.

Role of researchers

The first author is a Ph.D. student and former member of MSF Spain, who was part of the team working on the design and global deployment of their routine HMIS. The second author is currently an active member of MSF Spain and plays the role of eHealth Epidemiology Advisor. The third author supervises the studies of the first author, contributes to the analysis and theoretical development, and oversees the Research Agreement between MSF Spain and the University of Oslo. The first and second authors were responsible for the technical intervention and field data collection.

Data collection

Data collection was structured in two phases covering deployment and assessment of the digital solution. The deployment consisted of a one-month field visit (September 2019) where the first and second authors conducted two weeks of preliminary work before the deployment started. Key activities included technical deployment and in-service hands-on training for the users; project launch and two weeks of on-site follow-up. After the visit, the project was monitored and supported remotely over four months while users were working with the system (September 2019 to January 2020). Additionally, during this time, both authors participated in online meetings with the medical and project staff and followed up the practices around data collection, validation, and transmission in both the hospitals and the project base office. For the assessment phase, the first author visited the project in March 2020 and conducted an analysis of data quality in terms of completeness and accuracy, to understand to what extent did the intervention meet its expected aims of improving data quality.

The users involved in the study in both phases were the HMIS users in the project taking part in any steps of the data collection process, its aggregation, and subsequent entry into the system. Data collection methods were carried out during both deployment and assessment phases and included a mix of (a) participant observation; (b) focus group discussion; (c) in-depth interviews; and (d) data quality analysis of HMIS data. The data collection methods and participants involved are presented in Table 1.

Phase	Data Collection	Participants Involved
Deployment	Participant observation	All Medical staff
Deployment	Focus Group Discussion	Project Medical Referent (1), Nurse Activity Manager (2), Pharmacist (1), Medical Doctor (2), Nurse Supervisor (2), Data encoder (1), Laboratory responsible (1)
Deployment	Interviews	Nurse Activity Manager (2), Nurse Supervisor (2)
Assessment	Interviews	Project Medical Referent (1), Medical Doctor (1), Nurse Activity Manager (1), Nurse Supervisor (3)
Assessment	Data Quality Analysis	*No external participants involved*

Table 1 - Data Collection sources

A pre-deployment **focus group discussion** was carried out to validate the findings from the previous visit and identify new challenges as well as understand the suitability of the solution from a comparative perspective based on the experience and interpretations of the users involved. With a duration of one hour, one facilitator and one note-taker participated in the focus group discussion. The session was audio-recorded with the permission of the participants. The data collection team held a debriefing meeting after

the session to immediately document their observations and make note of the key points raised by the participants.

Semi-structured interviews were carried out with all field-level users involved to explore in more depth the experience and perception when interacting with both the existing and new system. The interviews were recorded with the permission of the participants. The average duration is 28'57" with a minimum duration of 19'56" and a maximum of 41'36". Interviews were made in English except for one which was in Spanish. Audio recordings were transcribed and translated to English when needed, as is the common language of the three authors involved. **Participant observation** of the users' daily activities in their different hospitalization wards was carried out throughout the two visits. Also study of the artefacts in use, books, forms, and registers. Participant observation notes were taken by both authors in written and/or recorded format. A total of nine single-spaced pages of notes were compiled and complemented with five recordings.

Data Analysis

Data analysis took place in an interpretive mode of user perceptions around how the digital intervention had changed work practices and user perception around the data collection process. We tried to holistically make sense of the data collected combined with the empirical experiences and observations of the challenges experienced during the preparation, deployment, and assessment of the project. Our main analysis and findings are based on the interpretive process. The quantitative data quality analysis helped contrast findings as compared to user perceptions.

The onsite presence of two of the researchers during the deployment of the pilot solution resulted in many conversations between them, referring to respective notes, all of which deepened the understanding of the phenomenon under study. The third author enriched the structured analysis and discussions with an outsider view, linking the empirical understanding of the phenomenon with theoretical concepts around affordances.

A thematic content analysis (Miles and Huberman 1994) of the interviews transcriptions was used to identify emergent themes from the interviews and focus group discussion. Each author analysed the complete data set independently in two rounds. Results were shared among authors and combined with the notes from the day-to-day observations. The first round focused on the identification of our key themes for analysis, and the work practices. As our understanding developed, we grouped technology use with practices related to the paper-based data collection system. The uses of the system grew and took shape into the concept of situated affordances, which broadened the scope to more informal practices. The most salient work practices were identified through discussions between the authors. The second data analysis round aimed to relate those themes to our theoretical concepts around affordances. Identified practices were grouped as affordances and guided by the proposed potency framework, we analysed the response of both the new and old systems. This involved moving iteratively from data to theory and discussions to interpret the user's perception of the data collection processes from which the potency of each of the affordances was inferred.

An example to illustrate this process of analysis is the practices around the management of the ward. In the interviews, users were asked to describe the uses they made of the paper register. In the first round of analysis, we individually started observing that many of the responses described actions not related to the health conditions of patients in the ward (outcome of patients, causes of death, salient diagnosis). They referred to actions linked with the logistics of the ward. Some of those activities were: the counts of patients to plan for meals for the coming day, new admissions to keep track of bed nets distribution, or estimate the usage of clean bedsheets. Those activities were not considered by the data collection system and did not match any features of the system, neither the old nor the new one. They were however identified systematically by the authors and were grouped as daily logistics practices. In the second round, this theme was analysed and conceptualised as the affordance of *Managing ward logistics*.

Finally, the four resulting affordances were analysed individually and assessed comparatively for each system using the Affordance Potency framework. Affordance Potency was defined by the perception of the users about system features and the user abilities. An affordance with **strong potency** was that in which system features were seen by users as being adequate for the context, produced expected outcomes, and users felt comfortable in using the technology without functional barriers. Affordances had **weak potency**

when the system features were seen as a barrier and users did not have either the adequate conditions or capabilities to use the technology as expected.

The following table summarises the process for reaching conclusions about strong and weak potencies. Overall Potency of each affordance was decided as the result of combining the three factors in play.

Affordance Potency	Strong	Weak
System Features	System features produce expected outcome.	System features do not respond to users expected outcome.
User Abilities	Users feel comfortable using the technology with their skills and knowledge.	Users do not have the required skills to perform the desired actions.
Context	Work environment facilitates the interaction user-technology.	Work environment does not provide adequate conditions for user-technology interaction.

Table 2 - Framework guiding Potency Analysis

Data quality analysis was based on the assessment of two dimensions: Completeness, understood as the extent to which all expected and required data (records, attributes) are present or not missing, respectively (ISO 2008); and accuracy, the degree of agreement between data and real-life phenomenon under study (ISO 2008). For this purpose, two sources of data were contrasted: i) the actual data from the HMIS collected on paper during the four months before the deployment and data collected with the tablets during the four months of the project, and ii) a retrospective data entry of the same 8 months that was done manually using the same book source used by the health workers in their daily operations. In summary:

- HMIS Data: The comparison of completeness of data indicators for a period of 4 months before and 4 months after the deployment. This process allowed us to compare manual calculations and data entry with automatic aggregation and synchronization.
- Baseline Data: Data entered in HMIS before and during the deployment (8 months) was compared with a baseline retrospective data entry (8 months) manually collected by the first author. This data would serve as a reference for the accuracy of the project data before and after the intervention.

The indicators used to analyse completeness were those who could identify gaps on the records: Number of Patients discharged without diagnosis, Number of deaths without cause of death, Number of deaths without time of death from admission recorded, Number of admissions without birth weight recorded (for Neonatology ward and Nutrition program only). Those used for accuracy where related to volume of activity in the ward: Number of admissions, Number of exits, Bed Occupancy Rate and Average length of stay.

Case Findings, and Analysis

This section describes the analysis and findings structured around four identified affordances. The analysis is presented in two steps: i) the work practices and the perceptions of users on the comparison of the working of both systems; and ii) analysis of both systems based on the potency framework. The four identified affordances are: i) collecting patient data daily, ii) aggregating data weekly, iii) managing ward logistics, and iv) accessing patient historical data.

Collecting patient data daily

This process starts with the patient file as the source of information, where each patient is registered in the registry book during admission and patient details are updated and completed at discharge. These two steps happen in the ward, where the medical doctors complete the patient file and the nurse supervisors and medical officers complete the registry book on numerous occasions during the day, intertwined with the medical and operational activities. Users saw the purpose of the registry book to simplify the posterior weekly aggregation process in an easy-to-read format. *"Counting all the figures reported from the patient clinical file did not seem a feasible option since it had a lot of information and was not well structured. Objectively the registry book is to, at the end of the week, come out with the epidemiological week data collection"*. (Nurse activity manager)

When users were asked to **compare the paper and the tablet**, they all preferred entering data only in the tablet, which they found very intuitive, fast, and easy, while improving data quality. *"I've been observing national staff using it and I don't think they have any difficulty… maybe… they take a bit of time, but I think is a matter of practice, I think is ok, even for national staff…".* (Nurse activity manager)

They also referred to the data being more complete on the tablet, which required less information, prompted you to enter the right information through dropdowns, and highlighted forgotten fields. *"Sometimes we don't complete the book, because not everything is required".* (Nurse supervisor)

Interestingly, none of the fields were mandatory in the tablet, despite user perceptions of it being so. During design, we had explicitly decided not to make fields mandatory, as being too restrictive could become a barrier for data entry. We just trained them to complete the form which had some prompts and validations and could perfectly be closed while having empty fields. The quantitative analysis, however, revealed an improvement on the completeness of records. The sense of required completion seemed to be caused by the fact that information was already digitalized, but nothing on the technology was forcing them to do it.

Concerns about access to data on the tablet were common. National staff did not want to extend the mobile data collection to other health staff in the ward, like nurses or clinical officers, as they were worried about changes or deletions in the data or wrong data entry due to a lack of attention. During the deployment of the tablets, they requested us to put a password on the tablets to restrict access arguing that they wanted to protect the data from use by other health staff. What made this interesting is that all users have access to edit and modify the records in the book, it is true that is difficult to lose data from the book –unless you physically lose the book or tear off one page- but errors in data entry can equally happen. Again, it seemed like the digital component made users more protective of the information. Some other users, however, expressed more trust in the permanency of data once entered the tablet, since the book was exposed to physical incidents. *"In the book we can lose the information, but on the tablet, we will always have it. The book can be torn, water can be spilled".* (Nurse supervisor). In practice, it was easier to lose data on the tablet than in the book because it could be deleted or modified.

Some users preferred the flexibility of the book because they could write more locally required information using the margins or registering, for instance, two diagnoses instead of one. The HMIS collected only one main diagnosis per patient, but sometimes it was useful to look at the book and have more clinical details. During deployment, users considered it impossible to completely replace the book with the tablets but were more positive about the possibility post-deployment. After working with the tablet for four months, the use of the book was seen as redundant and therefore replaceable: *"…with the data from the tablet and the data of the patient file we can still work 100% without having the register, I don't need to have the register".* (Nurse supervisor)

However, replacing the book implied involving more people in data collection to cover for night shifts and weekends. The book was operated by nurse supervisors, nurses, and clinical officers, while the tablet was operated only by the nurse supervisors and the data collectors, who did not work on night shifts. There was reluctance to extend tablet access to all staff because of their perceived lack of IT literacy which would adversely affect data quality.

The potency framework analysis for collecting patient data daily

Both systems operated in the same **context,** where data entry, either in the book or on the tablet, would happen in the ward, during working hours, and in parallel with the regular medical activity.

The **system features** of the tablet were very well accepted, and users preferred that to paper for data collection. Users had no difficulties in using the mobile device and registering a digital form, with an instinctive willingness to complete all the fields – thus enhancing data completeness. The main concerns were related to the possibility to lose data because it was deleted or corrupted, while the book seemed more robust and under local control. On the other hand, some users found the book more susceptible to damage, such as rain and physical loss. Users liked the flexibility of collecting more data in the paper book, even if was not later used for weekly reporting. Most users were positive about the idea of replacing the book with the digital but raised the need for more training. When asked about replacing the book with the tablet, they were all in favour, but if supplemented with more IT training.

The **user abilities** required to operate the tablet were more demanding than the paper but were not perceived as being unrealistic or too high. In principle, all the medical staff knew how to read and write in

the book, but the familiarity with technology was diverse as some found manipulating a mobile device very challenging and requiring training.

Aggregating data weekly

Every week, the books are taken to the nurse's office, in the hospital, for the manual aggregation process. Usually, on Monday morning, the nurse supervisors, with help from the data collector when available, count all the patients of the prior week to calculate the necessary numbers required for posting to the weekly aggregated reporting form. At the end of the day, once the paper form is completed, it is taken to the project office, where the data collector or nurse activity manager enters the data into the HMIS for its validation and consolidation to the central database.

The reporting day was very hectic for the nurse supervisors because they needed to take stock of the past week while continuing their everyday tasks in the wards. While taking stock, they may identify discrepancies in the numbers, which they need to diagnose and correct. In many cases, making this rectification is problematic as the original source of information is no longer easily accessible because the patient has been discharged. The manual aggregation process took about 4 hours, during which the wards also needed to be operational, while the nurses would constantly be interrupted by different requests and work. In busy weeks, this process could be delayed by three or four days, which in a weekly reporting system, was significant.

When asked about **comparing the book with the tablet** for the weekly aggregation process, there was a strong consensus that the tablet helped them to save time. It was highly appreciated not having to review the data from all the previous week on Monday mornings. *"I prefer the tablet because is easy, you enter the patient, the discharge, everything, then you don't have to do the tally sheet again".* (Nurse supervisor)

The positive impact of the tablet on the data quality was highlighted because data was entered during the process of admission/discharge while the memory of the information was fresh, and users did not need to remember on Monday the details from the last week. Previously, on Mondays, the users might not remember pieces of information and would need to go back to the patient file to check some fields (for example a missing field, an unreadable handwritten diagnose or name), which was cumbersome and prone to errors. The quantitative analysis of data confirmed this by showing an increase on data accuracy. Some users also mentioned data being more complete when they used the tablet. *"When I do here (on the tablet), I report directly, and I don't have to come back. In the book… on Monday, I don't remember what I recorded… When I enter in the tablet it is fresh".* (Nurse supervisor)

Most users expressed greater trust in the weekly numbers generated by the automatic aggregation from the tablet than when manual calculations were used. *"I trust the tablet data more than the manual. We do it with attention most of the time but is very easy to miss information and I don't remember well the information".* (Nurse supervisor). However, some other felt that the aggregation results from both systems were equally reliable. *"Tally sheet I know by looking the book, and I make no mistakes. The result is the same; there are no errors in the tablets and no errors in the tally sheet".* (Nurse Supervisor)

The potency framework analysis for weekly reporting aggregation

In terms of **context**, the new solution only required the launch of an automatic process, which was done on the laptop at the project base office, far from the hectic activity of the ward in the facility. The manual aggregation was performed in the medical office at the hospital, where nurse supervisors were accessible and reachable to respond to any situation in the hospital ward which required their attention.

In terms of the **system features** and **user abilities** required, the tablet seemed to be the overall preferred solution, as it allowed for data being collected closer to the time of recording where the medical action happened and didn´t require any further steps more than clicking a button to trigger the automatic aggregation. This stood in contrast with the long manual process they had to perform without the tablet, which was very slow and prone to human errors. The time saved for health staff was the biggest benefit identified by all participants, who also felt the additional IT skills required were minimal.

Managing ward logistics

The registry book was a key component for day-to-day ward management. Its functions go beyond the original objective (having an easily accessible registry of admitted patients that helps to generate weekly aggregates for HMIS reporting). The register was used to follow up on patient movements in the ward, check every morning who was admitted and verify bed numbers, identify new admissions when they were not in the book, or even calculating the food required for patients or caretakers and the management of stock of bed sheets and mosquito nets. *"They follow the ward with the book… and the book with the ward… They also count the caretakers to estimate the food they need"*. (Project medical referent), *"… the register is almost 75 to 80% used for data, for HMIS. know the remaining 20%… it can help the nurse follow up the patients… whenever they are going to give the medication… they check the name of the patient …"* (Nurse supervisor*) "… If I count the patients in the book and the patients in the ward, I can know that there is a new admission…"* (Nurse supervisor)

On **comparing the book with the tablet,** users said that they felt less comfortable following up the ward on the tablet, as it was easier to have a quick overview of the ward for basic management by checking the patients in the book. Also, the registry book presents a snapshot of patient demographic, clinical and nutritional status, and data was easily accessible only by opening the book, while the tablet involved multiple clicks. *"… seeing the list in the book is easier than the list in the tablet… is better with the book, because is easier to read information in the book. I see more in the book"*. (Nurse supervisor)

The users highlighted that key information like the name of patients or the bed number, which are crucial for the ward management and patient follow-up, were missing from the tablet, making it impossible to replace the book. *"If we had the same information that we have in the book on the tablet, then you just need the motivation to do it"*. (Nurse supervisor). From the designers' point of view, this was deliberately omitted given that data like patient names or bed numbers was not required for epidemiological reporting and going through data security regulations would have added unnecessary complexities to the project.

Like other affordances, replacing the book with the tablet would imply the involvement of more staff in the digital data collection process, because of the night shifts or weekends involved. And again, we found reluctance to involve other medical profiles, like clinical officers into tablet use. *"… Not possible, I would not accept. Right now, there is more information in the book. The tablet might not be used by everyone, I want the COs (clinical officers) to work on the book. In my absence, they will work on the book, and I will update the tablet"*. (Nurse supervisor)

The potency framework analysis for managing ward logistics

Managing the ward with either the book or the tablet was done physically in the ward. Both systems operated under the same **contextual** conditions. Management-related activities were done several times during the day as part of the regular ward work practices.

In contrast with the previous affordances, the **features** of the book seemed to be more suited for supporting ward management. The book offered a clear list of patients admitted to the ward with bed number, name, and status (admitted, discharge), required to perform basic management actions. The tablet, however, displayed a list of patients that could be filtered based on their status (admitted, discharged) but did not have personal identification of patients (patient name) or the bed number.

In the book, all information was presented on one page of paper and could be viewed in one sight, for example, to see if patients were admitted or not by looking down one column. On the tablet, the list of patients did not automatically display that information and users had to apply a filter to see which patients were still admitted to the ward. Users felt more comfortable reading the information in the book than on the tablet.

In terms of **user abilities,** with the book the user only needed to open it, read, and make simple mental calculations. With the tablet, they needed to know how to use the application to filter the patients and feel comfortable compiling information on the digital screen, which was not often the case. The book answered better to the functional needs and users' skill sets.

Accessing patient historical data

The book helped users to find information about a patient who was re-admitted. Even though the book had very limited information compared to the patient clinical file, field staff admitted using the book and very rarely going back to the clinical file, because *"it was more difficult to find an old patient file than a registered entry. …also, we want to check the book sometimes when there is a readmission. Then we go to the book and check the name of the patient. That the patient is with us before. So, we check the book, and we check the diagnosis, and we compare it".* (Nurse supervisor)

Comparing **the book and tablet** for finding information on an old admission, the book was clearly preferred. The tablet did not have the patient's name, which made it useless for this purpose. In the book, data was written chronologically, and to search for past information you just needed to pass the pages looking for the previous ones. On the tablet, to look for old records the users needed to filter by date: *"I prefer the book because I can look for the patient. On the tablet, there is no name there. I cannot search for the patient".* (Nurse supervisor)

Access to information was also found to be a limitation since the tablet was not always in the ward. During the night shift and weekends, the tablet was at the project base*: "The book is important to search for past information. The tablet is sometimes taken to bravo (project base office) and then we will have nothing to record the patient. The book is always here".* (Nurse supervisor)

The potency framework analysis for accessing patient historical data

The lack of patient identifiable information like name, was a major limiting **feature** of the tablet. In addition, it required more IT-related **user abilities**, not only because it required the user to feel comfortable reading data/information on a digital device, but also because they needed to know how to perform a search based on dates to navigate past data. Both systems operated under similar **contextual** conditions, with this activity being done occasionally as part of the regular ward work practices, every time a patient was readmitted.

Discussion & Contribution

The main purpose of this analysis is to develop theoretical understandings of how humanitarian workers use and perceive digital technology when introduced into their everyday work routines. To do so, we analysed how new mobile technologies impact the data collection processes, in relation to existing paper-based solutions, an enduring aspect of humanitarian health work. New digital interventions must inherently contend with the "competition" provided by the existing manual systems, which remain deeply integrated into the work lives of the health staff. For this reason, we have studied users simultaneously exposed to both paper and the digital solution to answer the research question: *How do competing affordances of paper and digital technologies shape practices of data collection in humanitarian settings?*

Our analysis was informed by the perspective of "competing affordances" which allowed the study of, one, the nature of affordances enabled through the paper and mobile-based systems, and two, the situated potencies perceived by the health staff when both these systems played out in combination in the workplace. This analysis was based on comparing the potency of the competing situated affordances as they played out through the interaction of user abilities, the work environment, and the system features.

The four affordances identified through the information practices analysis were: (1) collecting data daily; (2) aggregating data weekly; (3) managing ward logistics and (4) accessing patient historical data.

To interpret the situated potencies of each affordance, we summarized the three determinants of potency – the abilities of the users, the system features, and the work environment- and interpreted them as "strong" or "weak" based on the perceptions of the staff gathered during the interviews and observations. We further compared the combined potency of these two systems as they played out in practice.

For the ***collecting patient data daily*** affordance, the strength of the potency was quite balanced, with the new system being valued and preferred over the paper.

Users found that entering data on the tablet on the same day when the medical event happened improved the quality of data because they clearly remembered the details, however in the paper-based existing system, they write down the information at the same moment. This means that information is equally fresh

for them, with the difference that with the paper-based system, they have to come back to the data on the following Monday to review and count all the information, for their weekly aggregated reporting. Digital data collection done closer to the context of the medical action was seen to be more "granular" because data was digitized at the individual patient level, instead of after the retrospective aggregation at the end of the week. Data took on a more "permanent" and trustworthy nature through the entering of it into the digital device, without requiring further manual processing. This process also enhanced perceptions of the completeness of data. Although both systems collected the same data at the same time (except details of patient identification which were only on the book), and no fields were configured as mandatory in the tablet, data was perceived to be more complete and accurate in the digital system. The quantitative analysis confirmed improvements in both completeness and accuracy of data. The need for IT skills or training was felt required to enable effective use of the tablet, but the potency for data collection outweighed the use of the paper system.

A significantly stronger potency of the mobile application was seen over paper concerning ***aggregating data weekly*** due to the ability to automate the aggregation process avoiding the need for retrospective manual aggregation using multiple tally sheets on Monday mornings. This was seen to be timesaving and more accurate, even though the tablet involved repeating the entry of patient details first in the patient book and then in the digital system. However, the gains through digital aggregations outweighed the double-time taken in entering individual patient records. Some users defended the process of manual aggregation, while project coordinators were unanimous in their trust of the digital process over the paper. This was confirmed by the data quality study, which showed more accuracy on data items that required complex calculations like bed occupancy rate, or the average length of stay. Overall, the potency of the digital system was superior to the paper, and even stronger acceptance was perceived of the higher value to be gained if the mobile devices would completely replace the paper-based system.

In **managing ward logistics** and **accessing patient historical data,** both the affordances were perceived to have inherent system-generated constraints, more for the new system. Since the digital system did not store key data on the patient's name or the bed number, not required for the weekly reporting of epidemiological data, it became cumbersome for users to retrieve patient data which was important for them to support their clinical work. Further, reading on a screen and using features of searching and filtering was not as comfortable and natural as scanning the paper on the columns having patient details and finding what was needed. While these two actions were not part of the data collection process itself, they were crucial in supporting the practice of everyday clinical work in the wards. There was thus negative or weak potency to these two affordances for completely replacing the manual process with the new digital system. A firm recommendation from users was for the further development of the mobile-based solution, to include this patient information.

Table 3 below, summarises the potency analysis per affordance and influencing factor. In summary, while the digital system showed strong potency for the more expected practices of data collection and aggregation, it was seen to be weak for unplanned and emerging practices of ward management and accessing patient records. This finding has important implications for the adoption of technology for strengthening humanitarian action, which by its nature is unplanned and emergent in context.

Affordance	Potency Factor	Paper- based System	Mobile-based System
Collecting data daily	System Features	Weak	**Strong**
	User Abilities	**Strong**	Weak
	Context	Same	
Aggregating data weekly	System Features	Weak	**Strong**
	User Abilities	Weak	**Strong**
	Context	Weak	**Strong**
Managing ward logistics	System Features	**Strong**	Weak
	User Abilities	**Strong**	Weak
	Context	Same	

Affordance	Potency Factor	Paper- based System	Mobile-based System
Accessing patient historical data	System Features	**Strong**	Weak
	User Abilities	**Strong**	Weak
	Context	Same	

Table 3 - Summary of Affordance Potency Analysis

We saw that the prevalent solution will always be that which requires a behaviour akin to that -from the original definition of affordances from ecological psychology- of an animal who perceives the object in terms of what it affords which does not require an explicit cognitive process (Gibson 1979). We observe that deploying new systems in humanitarian settings, similarly, needs to be friction-free and easy to use, just like an apple to be eaten by effortlessly being plucked from the tree. Maybe such a state of use is unattainable when compared to paper which naturally is intimately integrated into the work lives of the health staff on the ground. But the situated affordance potency, however, has been relevant to identifying important affordances and their respective potencies as seen by users. The "competing affordance potency" framework has revealed the importance of being "proximate" to such a routine use of the technology.

Our work contributes to IS research by engaging with the development of context-specific theorisation of IS use (Burton-Jones and Straub 2006, Hong et al. 2014). We do this by determining the potential actions the IT artefact enables for the actors and its actualisation in the situated settings (Burton-Jones and Volkoff 2017). This study provides two key theoretical contributions. One, we contribute to the affordance potency framework by assessing its feasibility for studying technology adoption within the context of humanitarian intervention and extending it through an application of a practice-oriented analysis of affordances. Two, we use the proposed framework to examine the notion of "competing affordances", which builds upon earlier studies where only one digital intervention is considered. This analysis is useful, as there are always processes of change involved from the old to the new, and competing affordances are inherent to the process. Bringing in the perspective of competing affordances, since paper is always here to stay, provides useful insights into IS research, which typically has focused on studying the affordances of the new system being introduced in isolation from what already exists. This then contributes to the broader research field of IT-enabled organizational change.

New technology may offer many opportunities for humanitarian action, but it also presents several challenges. Finding the balance between the introduction of these new systems to improve quality and facilitate accountability and, the capacity of the organizations to adopt them and add value is crucial. This work enabled the authors to provide insightful recommendations to the organization and helped build trust in mobile interventions for improving data collection processes. Our study shows how the introduction of this new technology overcomes the challenges presented. Users save time in collecting data that helps them devote more time to caring for their patients; the quality of data has improved, mainly impacting crucial indicators for the management of the medical wards, and overall, trust in data and technology as a trustworthy medium has increased.

The mobile data collection project has successfully evolved and, at the moment of writing this paper (April 2022), a second version of the system has been running for 11 months in the same setting. The new version includes improvements identified from this research such as incorporating patient data and making more intuitive actions required to filter and search patients. MSF Spain is, in a parallel process, assessing the feasibility of scaling this technology to their missions in other countries.

Conclusion and future work

The perspective of competing affordance potency in technology adoption is valuable in the context of humanitarian settings and revealed the importance of the natural use of technology. The variety and dynamicity of users in constant turnover, who are, in addition remotely based, raise particular challenges in technology adoption and value-adding needs (Kabra et al. 2017). If the use of technology does not fit smoothly into their day-to-day activities, it is likely that eventually users might find their own solutions and end up using a different software or not using technology at all (Kabra and Anbanandam 2016). Understanding how a strong potency can be provided increases the likelihood that users will actualize the existing affordances, hence, using the system for its purpose.

Limitations of this research are, firstly, the challenges and benefits described have been identified in a specific context of health services in the facility, with a moderate volume of patients and where data collection processes were already underway and therefore, its recommendation cannot be extended to other type of projects. The suitability of the competing affordance potency framework could be strengthened by further studies in services with a high volume of patients or emergency projects, where the urgency in the provision of medical care already competes with any other non-medical activity such as data collection; or in out of the facility projects such as community activities, where the data management processes are not as solid. Secondly, some of the benefits perceived by the users, such as time savings in data collection, could not be objectively quantified due to the nature of the work in the medical ward, where those in charge of entering data on the tablet were constantly interrupted to assist with the medical tasks. Lastly, one of the main potential benefits of using this tool, the collection of individual data as an electronic health record, was not studied as it was out of the scope of the field intervention.

Findings revealed a potential shaping of a hierarchical system among different medical roles when mobile devices were introduced in the ward. We also observed an apparently instinctive willingness to complete all the fields required in the form and to pay more attention to the data when digitally registered. The scope of our work did not allow us to further engage on such socio-technical aspects which we believe might also open a very interesting area for future contextualised research.

Walsham (1995) has argued that there exist different modes of generalization from interpretive work, where concepts, insights, and theories can be derived and applied in other settings. Walsham provides the example of Zuboff's insight of "informate" derived from an interpretive case study, which has found widespread use in different time, space, and work contexts. What we offer as a potential means of generalization from this study, is the insight of "competing affordance potency" and a possible methodology on how it can be interpreted, which we believe can help strengthen IS implementation work not only in other humanitarian settings but also other IS intervention sites, more broadly.

References

Altay, N., and Labonte, M. 2014. "Challenges in Humanitarian Information Management and Exchange: Evidence from Haiti," Disasters (38 Suppl 1), pp. S50-72.

Anderson, C., and Robey, D. 2017. "Affordance Potency: Explaining the Actualization of Technology Affordances," Information and Organization (27(2)), pp. 100-115.

Braa, J., and Sahay, S. 2017. "The Dhis2 Open Source Software Platform: Evolution over Time and Space," in Global Health Informatics. Principles of Ehealth and Mhealth to Improve Quality of Care. The MIT Press, p. 451.

Burton-Jones, A., and 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).

Chan, J. L., Nam, G., Marshall, A. G., and Purohit, H. 2019. "Trends in Humanitarian Health Information During the 2010 Haiti Earthquake," 16th ISCRAM Conference, Valencia.

Chaterjee, S., Moody, G., Lowry, P. B., Chakraborty, S., and Hardin, A. 2020. "Information Technology and Organizational Innovation: Harmonious Information Technology Affordance and Courage-Based Actualization," Journal of Strategic Information Systems (29), p. 101596.

Chemero, A., and Turvey, M. T. 2007. "Complexity, Hypersets, and the Ecological Approach to Perception-Action," Biological Theory), pp. 2:1-14.

Gibson, J. J. 1979. The Ecological Approach to Visual Perception. Boston: Houghton Mifflin.

Harvard Humanitarian, I. 2011. "Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Emergencies."

Hausvik, G., and Thapa, D. 2016. ""What You See Is Not What You Get" - Challenges in Actualization of Ehr Affordances," International Conference on Information Systems, Seoul.

ISO, I. O. f. S. 2008. "Iso/Iec 25012:2008(E), Software Engineering—Software Product Quality Requirements and Evaluation (Square)—Data Quality Model." Geneva, Switzerland.

Kabra, G., and Anbanandam, R. 2016. "Exploring the Challenges in Implementation of Information Technology in Humanitarian Relief Organisations in India: A Qualitative Study," in Managing Humanitarian Logistics. New Delhi: Springer, pp. 105-113.

Kabra, G., Ramesh, A., Akhtar, P., and Dash, M. K. 2017. "Understanding Behavioural Intention to Use Information Technology: Insights from Humanitarian Practitioners," Telematics and Informatics (34), pp. 1250-1261.

Kumar, M., Gotz, D., Nutley, T., and Smith, J. B. 2018. "Research Gaps in Routine Health Information System Design Barriers to Data Quality and Use in Low- and Middle-Income Countries: A Literature Review," Int J Health Plann Manage (33:1), pp. e1-e9.

Lewis, D., and Madon, S. 2004. "Information Systems and Nongovernmental Development Organizations: Advocacy, Organizational Learning, and Accountability," The Information Society (20:2), pp. 117-126.

Maiers, C., Reynolds, M., and Haselkorn, M. 2005. "Challenges to Effective Information and Communication Systems in Humanitarian Relief Organizations," IEEE International Professional Communication Conference.

Maxwell, D., and Watkins, B. 2003. "Humanitarian Information Systems and Emergencies in the Greater Horn of Africa: Logical Components and Logical Linkages," Disasters (27:1), pp. 72-90.

MEASURE-Evaluation. 2020. "Surveillance, Monitoring, and Evaluation: Online Course." Chapel Hill, North Carolina: University of North Carolina.

Mesmar, S., Talhouk, R., Akik, C., Olivier, P., Elhajj, I. H., Elbassuoni, S., Armoush, S., Kalot, J., Balaam, M., Germani, A., and Ghattas, H. 2016. "The Impact of Digital Technology on Health of Populations Affected by Humanitarian Crises: Recent Innovations and Current Gaps," J Public Health Policy (37:Suppl 2), pp. 167-200.

Miles, M. B., and Huberman, A. M. 1994. Qualitative Data Analysis: An Expanded Source-Book. Los Angeles: SAGE.

Moreno-Serna, J., Sánchez-Chaparro, T., Stott, L., Mazorra, J., Carrasco-Gallego, R., and Mataix, C. 2021. "Feedback Loops and Facilitation: Catalyzing Transformational Multi-Stakeholder Refugee Response Partnerships," Sustainability (13:21).

MSF. 2014. "Ocba Strategic Plan 2014-2017," MSF Spain, Barcelona.

Orlikowski, W. J., and Iacono, C. S. 2001. "Research Commentary: Desperately Seeking the "It" in It Research - a Call to Theorizing the It Artifact," Information Systems Research (12:2), pp. 121 - 134.

Sawadogo-Lewis, T., Keita, Y., Wilson, E., Sawadogo, S., Téréra, I., Sangho, H., and Munos, M. 2021. "Can We Use Routine Data for Strategic Decision Making? A Time Trend Comparison between Survey and Routine Data in Mali," Global Health: Science and Practice (9).

Sigala, I., Kettinger, W., and Wakolbinger, T. 2020. "Digitizing the Field: Designing Erp Systems for Triple-a Humanitarian Supply Chains," Journal of Humanitarian Logistics and Supply Chain Management (ahead-of-print).

Stoffregen, T. 2003. "Affordances as Properties of the Animal-Environment System," Ecological Psychology), pp. 15(12):115-134.

Strong, D. M., Volkoff, O., Johnson, S. A., Pelletier, L. R., tulu, B., Bar-On, I., Trudel, J., and Garber, L. 2014. "A Theory of Organization-Ehr Affordance Actualization," Journal of the Association for Information Systems (15:2), pp. 56-85.

Sykora, M., Elayan, S., Hodgkinson, I., Jackson, T., and West, A. 2022. "The Power of Emotions: Leveraging User Generated Content for Customer Experience Management," Journal of Business Research (144), pp. 997-1006.

Tafere, M. 2014. "Knowledge Management in the Humanitarian Sector: Challenges in Improving Decision-Making," in: Professionals in Humanitarian Assistance and Protection.

Tona, O., Crlsson, S., and Schultze, U. 2016. "On the Value of Mobile Business Intelligence: An Affordance Approach," in: Twenty-Fourth European Conference on Information Systems. Instabul, Turkey.

Tsohou, A., Karyda, M., Kokolakis, S., and Kiountouzis, E. 2013. "Managing the Introduction of Information Security Awareness Programmes in Organisations," European Journal of Information Systems (24), pp. 38-58.

Tusiime, E., and Byrne, E. M.-T. 2011. "Information Systems Innovation in the Humanitarian Sector," Information Technologies and International Development (7), pp. 35-51.

Vidgen, R., and Braa, K. 1997. "Balancing Interpretation and Intervention in Information System Research: The Action Case Approach," in Information Systems and Qualitative Research. Boston: Springer, pp. 524-541.

Walsham, G. 1995. "Interpretive Case Studies in Is Research: Nature and Method," European Journal of Information Systems (4:2), pp. 74-81.

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 institutional theory and affordance actualization 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, Fozdar, Abdelmagid, & Checchi, 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 global medical humanitarian organization, 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, Martinez, & Sahay, 2022) of one of its field interventions.

The core analysis is based on a contextualization of the theory for effective use drawing from concepts from affordance and institutional theories. 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, Recker, Indulska, Green, & Weber, 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.

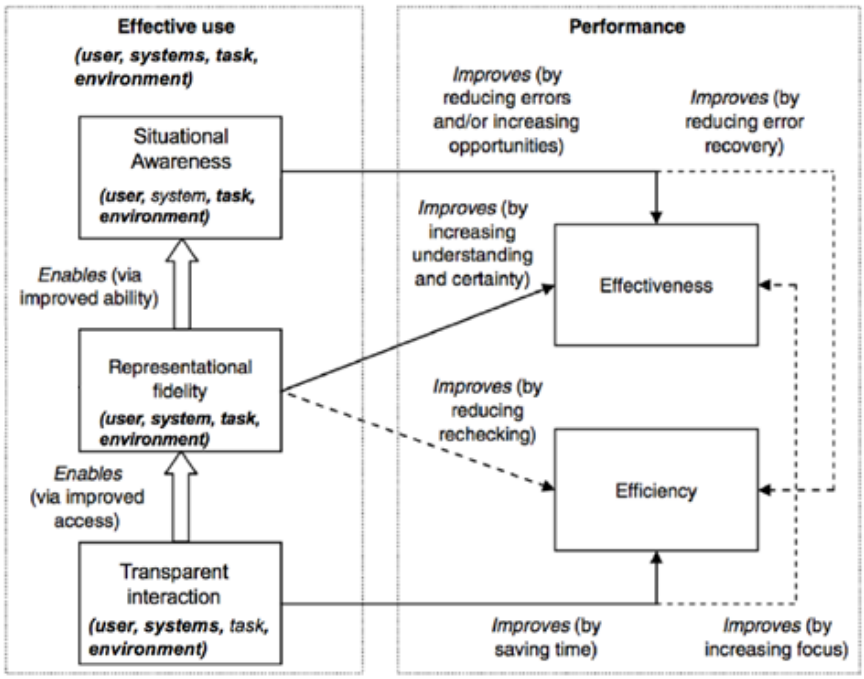

Figure 1 Effective Use model adapted for emergency management contexts (Bonaretti & Piccoli, 2018).

The theory of effective use has been used to guide research on IS implementations in a variety of domains, such as hospitals (Eden, Akhlaghpour, Staib, & Sullivan, 2018; Eden, Burton-Jones, & Donovan, 2019), educational providers (Eden, Fielt, & Murphy, 2020), enterprises (Trieu, 2013), banking (Haake, Mueller, Lauterbach, & Maedche, 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

This section presents an 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 governs the analytical framework guiding this research. The following sections develop each of the different phases enumerated above.

Understanding how a network of affordances supports the achievement of organizational goals.

This analysis builds upon the concept of network of affordances (Burton-Jones & Volkoff, 2017) and maps the individual affordances with the organizational objectives. The network of affordances is built upon outcome-units, which represent the relationship between each affordance and its potential outcome (Burton-Jones & Volkoff, 2017). These outcome-units collectively contribute to the overall organizational objectives. By analysing the interconnections between affordances, the network allows us to understand the interdependence, chronological sequence, and presence of affordances and outcomes across different organizational levels. Taking together the affordances 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.

Prior research has identified the operating affordances of an H-HMIS at the two levels of operation 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 Effective Use model adapted for emergency management contexts(Bonaretti & Piccoli, 2018).

Level	Affordance	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.

The organizational objectives to which the affordances 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 affordances contributing to this objective are mainly those operating at the project coordination office. Operationability allows

[1] The affordances 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 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 affordance 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 aggregability affordance 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 affordance 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 affordances 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 representation of the network of affordances presented below helps to illustrate the dependencies between affordances 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.

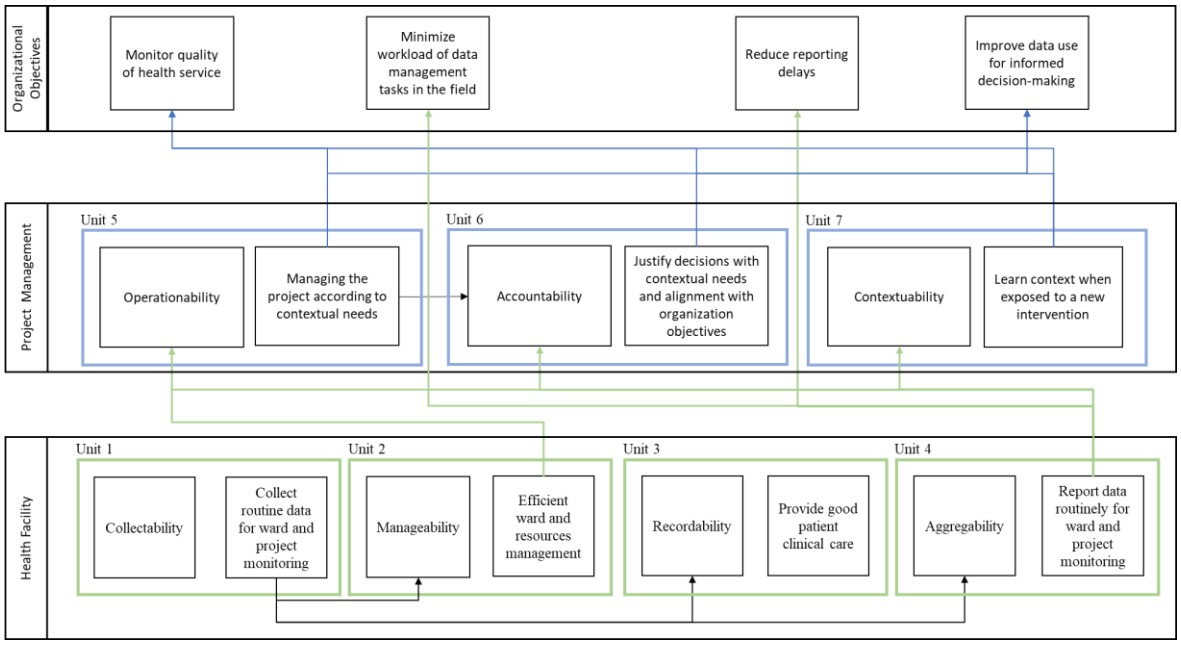

Figure 2. The network of affordances.

The network of affordances

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 affordances 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 affordance of accountability (Unit 6). The affordance of contextuability allows new staff members to familiarize themselves with the specific work environment (Unit 7). The three affordances 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 affordances are actualized

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

Understanding the organizational context

Institutional logics operate at a fundamental level with systemic influences on the overall information system structure, and not just to isolated parts of the system. The logics 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 logics governing routine health information system, stability, infrastructural dependency, and homogeneity (Vila-Pozo & Sahay, 2018).

To determine the potential impact of the institutional logics on achieving effective use, the next step involves analysing the operating contradictions. 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.

Deep structure: The H-HMIS evolves in a context where the institutionalized 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 operating logics and their impact in the system structures is represented in the figure below.

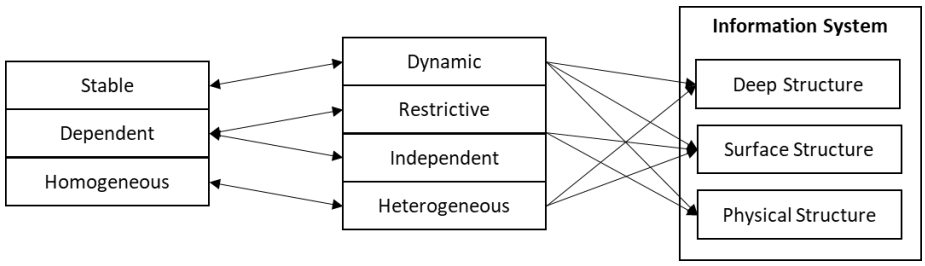

Figure 3. Conflicting logics and influence on system structures.

The environment, understood through institutional logics, affects all structures of the health information system, which in turn influence its implementation adoption and use. The operating logics shape both, the features of the system as well as the interaction system-user. These institutional logics operating in the humanitarian environment generate what is conceptualised as institutional conditions. The institutional conditions shape the actualization of

the affordances 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 institutional conditions shapes the actualization of affordances 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 affordances (Vila-Pozo & Sahay, 2019). The limitations in information and the work environment where always constraining and negatively affecting the actualization of affordances, 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 institutional 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 affordance actualization 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 institutional conditions identified at the work-place in the humanitarian intervention, the way technology is perceived and more importantly, its perceived usefulness, influence how technology affordances 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 Error! Reference source not found.

Figure 4 on the next page. 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 affordances 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.

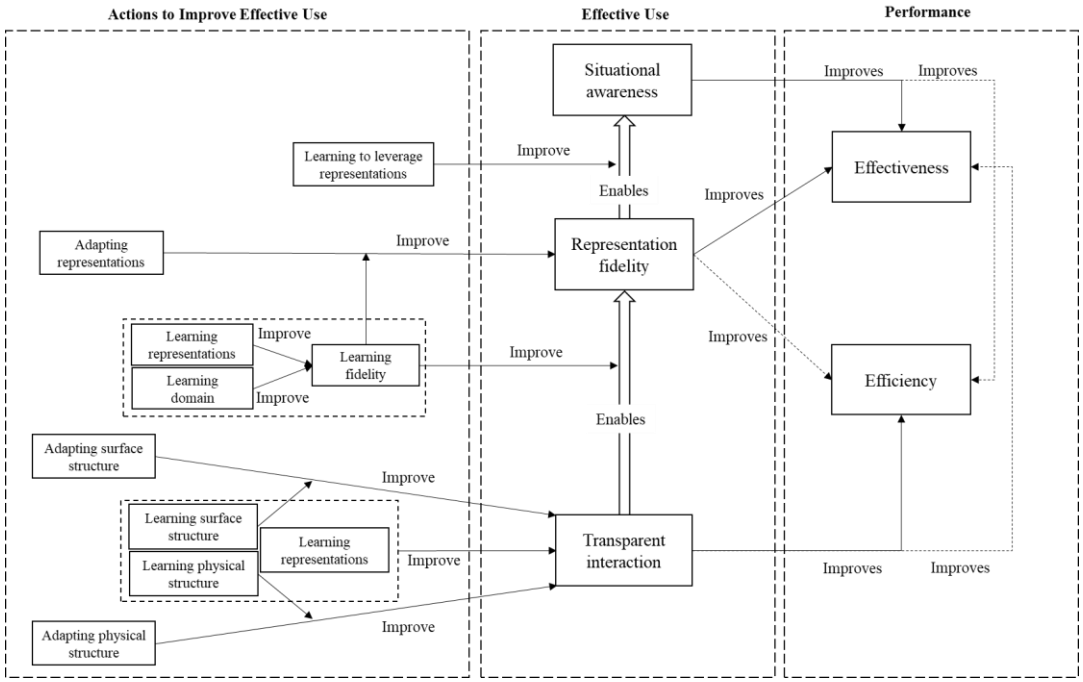

Figure 4. Representation of the TEU model (Burton-Jones & Grange, 2013) extended for emergency management (Bonaretti & Piccoli, 2018)

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 affordances 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 affordances associated with decision-making. In the context of this case study, it will also impact the affordance 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 affordance 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 affordance actualization required described a seamless experience of system use and a direct perception of usefulness of the system as pivotal conditions for realizing affordances 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 **Error! Reference source not found.**), t hese 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 has to 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 affordances 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. If we focus 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 are perceivable in an intuitive manner. Users would see that they can perform certain tasks, for example,

[2] Oxford English Dictionary

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). This conceptualization of affordances assumes the no need of an explicit cognitive process for the animal to actualize the affordance, affordances are perceived.

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 institutional logics operating in the context, 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 affordances 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 affordances 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 affordances, and the process of affordance 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. I hope this work and 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.

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 affordances enabling effective use in the field settings. Secondly, it entails studying the micro-level process of affordances 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.

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REFERENCES

(ENSURE THAT ALL REFERENCES ARE FULLY COMPLETE AND ACCURATE AS PER THE EXAMPLES)

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

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

Bonaretti, D., & Piccoli, G. (2018). *Effective Use of Information Systems in Emergency Management: A Representation Theory Perspective.* Paper presented at the 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. doi: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. doi: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. doi: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. doi: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.* Paper presented at the 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.* Paper presented at the International Conference on Information Systems (ICIS 2019), Munich, Germany.

Eden, R., Fielt, E., & Murphy, G. (2020). *Advancing the Theory of Effective Use through Operationalization.* Paper presented at the 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. doi:10.1518/001872095779049543

Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Boston, USA: 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.* Paper presented at the 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). doi:10.1186/s13031-021-00355-8

Magnuson, J. A., & Dixon, B. (2020). *Public Health Informatics and Information Systems*: Spinger Nature.

Mesmar, S., Talhouk, R., Akik, C., Olivier, P., Elhajj, I. H., Elbassuoni, S., . . . 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. doi:10.1057/s41271-016-0040-1

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

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.* Paper presented at the 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.* Paper presented at the International Conference on Information Systems (ICIS 2022), Copenhagen, Denmark.

Vila-Pozo, M. M., & Sahay, S. (2018). *Humanitarian Health Information Systems: Different challenges and responses.* Paper presented at the 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.* Paper presented at the 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.

An Affordance-based Approach for Assessing Effective Use of Health Management Information Systems in Low-Resources Context

Research-in-progress

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Abstract

Assessing effective use of health Management information systems (HMIS) in low-resource settings is critical to improving public health. However, mainstreaming information systems into daily practice can be challenging in dynamic, isolated settings where technology adoption is often not a priority. It is essential to design tools that address user needs and are deemed useful. In this paper, we propose a generic framework that applies effective use theory and affordance actualization theory to assess how HMIS are used efficiently in organizations and identify areas operational vulnerabilities. The proposed study uses a mixed-methods approach to data collection and analysis. This framework contributes to the information systems utilization literature by providing a method for contextualizing the assessment of effective utilization by giving relevance to specific information management tasks. From a practical perspective, it aims to guide information systems practitioners in low-resource environments in strengthening their digital organizational information systems.

Keywords Health Management Information System, Effective Use Theory, Affordance Actualization Theory, Affordance Network, Low-resource setting

1 Introduction

In its 2017 report, the United Nations Africa Renewal reveals that "while SDG 3 is the health-focused goal, intersectoral synergy and complementarity are essential for the health sector to meet its goal. Governments require new platforms to coordinate the social sector and health needs, including protecting the most vulnerable in their societies" (United Nations 2017). Policymakers and health system executives rely on actionable information for effective decision making in public health (Mbondji et al. 2014). Health Management Information Systems (HMIS) are key to store and retrieve such information, as long as they are being used effectively (Burton-Jones and Volkoff 2017). There is growing interest towards studying HMIS because of the positive effects that digital transformation brings to the healthcare industry, from structural, such as decrease in healthcare expenditures (Bao et al. 2020; Davidson et al. 2018), to medical practice ones, such as preventing medical and diagnostic bias (Agarwal et al. 2011). Therefore, it is necessary to uncover and define the different ways in which HMIS can bring value to the public health industry.

In low-resources contexts, information systems are often difficult to integrate with day-to-day practices (Kabra and Anbanandam 2016). Technology is often non-efficient in numerous developing nations, not supporting the enhancement of public healthcare services (Heeks 2006; Walsham 2020). Assessing the efficacy of HMIS requires a framework that delves into system utilization and the perceived advantages it offers to healthcare practitioners. A detailed assessment unveils how healthcare staff leverage features like data entry and reporting to enhance patient care (Ouedraogo et al. 2019). Moreover, when data is accurately captured and utilized, it empowers decision-makers with actionable insights. For instance, tracking the spread of a local malaria outbreak in real-time enables health officials to allocate resources more efficiently, showcasing the importance of such an assessment framework for informed decision-making and resource allocation. Understanding the actualization of system features is crucial. In a hospital scenario, an analysis on how medical staff employ the HMIS's data analytics feature to track disease outbreaks reveals potential areas for system design enhancement, aiming to better meet user needs and elevate healthcare delivery in resource-constrained settings (Farnham et al. 2023). Thus, it becomes of utmost importance to provide tools that not only respond to the needs of the users but does it in a way in which users can easily perceive the usefulness and intuitively figure out how to use it (Vila-Pozo et al. 2022).

Effective use is useful for understanding how to achieve greater benefit from an information system within an organization. Furthermore, it is even more significant because it enables the development of measuring tools when specific tasks, which motivate users to adopt the technology, are factored into the assessment. Integrating specific tasks into measurement elements delivers an insight into system behaviour, enabling it to best serve its intended purpose in a way that makes it easier for users to carry out activities. This guides us in formulating our research question as follows:

RQ: How can we design an assessment framework for improving effective use in low-resource settings that captures users' perception of usefulness?

Aiming to assess effective use within context and identify blind spots along the effective use continuum, we introduce in this research a generic framework that leverages its theoretical underpinnings on Theory of Effective Use (TEU) and Affordance Actualization Theory (AAT), to assess the extent to which the system is used effectively in an organisation, along with identifying definite vulnerabilities at an operational stage. The proposed framework embeds the network of affordances within the dimensions of effective use. An innovative approach that extends previous work by formally incorporating the user perceptions into measuring effective use complementing the qualitative analysis with a quantitative lens, as suggested by the authors (Burton-Jones and Volkoff 2017). Inherently, this work also extends the operationalization of effective use from Eden et al. (2020) by extending the level of granularity of the proposed measurement tool to incorporate the contextual usefulness of the system in the form of affordances.

Resulting studies will identify ways of improving effective use from two standpoints: pinpointing which dimensions pose the strongest challenges to effective use, and which tasks are less actualized. From a pragmatic standpoint, the research intends to supply prescriptive evidence for supporting information systems practitioners in reinforcing their digital organisational information systems. Thus, through our framework, we intend to enhance the growing literature on information systems use in low-resource settings by shedding new conceptual light on how health information systems can be implemented to empower users to efficiently perform their daily tasks. Furthermore, we intend to illustrate how

classifying affordances of actions / tasks influences health information system use, particularly on user's experience.

Our research is presented as follows: First, we describe the scientific rationale of our research, by expanding on a systematic and regimented narrative of theories that shape our approach. Next, we introduce the design strategy of our research framework, with a descriptive illustration of each step. Thereafter, we elaborate on the methodological background of our research, describing the research environment, participant and sample characteristics, as well as stages and rationale behind each process. Finally, we report on the expected theoretical and practical contributions of the research, while providing a description of the research project.

2 Theoretical Foundations

In this section, we present the scientific backbones of the research, which are Affordance Actualization Theory and Effective Use Theory.

2.1 Affordance Actualization Theory

Affordances are a concept that originated from ecological psychology and pertains to how animals perceive objects within their environment. It refers to the action possibilities that an object offers to an animal (Gibson 1979). This definition has evolved to suit the information systems (IS) context, in an open debate which concluded aligning positions around its conceptualization as a relational property (Chemero and Turvey 2007). Markus and Silver (2008) refined the concept by introducing the idea of functional affordances defined as "the possibilities for goal-oriented action afforded to specified user groups by technical objects." (Markus and Silver 2008, p. 622).

Building upon this relational conceptualization, Strong et al. (Strong et al. 2014) advanced the theory of affordances by introducing a mid-range theory known as Affordance Actualization theory (AAT), which specifically focuses on examining the organizational change processes that occur during the implementation of electronic health records (EHRs). The authors define affordances as “the potential for behaviours associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor or actors” (Volkoff and Strong 2013, p. 823). Accordingly, affordance actualization is defined as “the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals” (Strong et al. 2014, p. 70). At the individual level, the theory identifies three critical factors that contribute to the process of actualizing affordances. Firstly, an individual's own abilities, including their skills and knowledge, play a significant role in their ability to actualize affordances. Secondly, the features of the technology itself, including its design and functionality, also influence the ability of individuals to actualize affordances. Finally, the work environment in which the technology is used, including the social and cultural context, can either facilitate or hinder the process of affordance actualization (Strong et al. 2014).

The concept of affordances manifests on different levels of granularity, and a distinction can be made between lower-level and higher-level affordances. Lower-level affordances are linked to technology use and can be easily perceived, while higher-level affordances result from the actualization of lower-level ones. Volkoff and Strong (2017) have emphasized the importance of studying affordances on an adequate level of granularity in information systems (IS) research, and it is particularly relevant for the process proposed in this paper.

To facilitate the identification of affordances on different levels of granularity, Valbø (2022) proposes the Nested Affordance Process (NAP) model. The framework serves as a useful guide for researchers to identify and separate lower-level affordances from mid- and higher-level affordances, thereby providing a clearer understanding of how affordances operate at different levels of granularity. NAP separates affordances into three layers: Micro-level affordances, which are the affordances that describe direct use of technology; Mid-level affordances (Valbø and Sanner 2022), which are the affordances that arise from the actualization of lower-level affordances and are related with technology use, but do not imply direct technology use; and higher-level affordances, which arise from the actualization of mid-level affordances but operate at organizational level and are normally difficult to trace back to technology use.

Affordance actualization theory and the classification of affordances into different levels are key concepts for the proposed process for assessing Effective Use in context. The Theory of Effective Use is introduced next.

2.2 Effective Use Theory

The emerging literature on information system adoption has lengthy seen a number of studies that have developed, stretched, and contextualized systems acceptance paradigms. Part of this effort has been to unravel novel and insightful avenues for understanding users' intentions to engage with systems. With the increasing complexity of digital transformation in society, many critics have voiced their concerns regarding the vagueness of these theoretical frameworks and approaches, as they tend to quantify usage, fail to explore the breadth of system use and have limited reliability (Bagayogo et al. 2014; DeLone and McLean 2003; Sun et al. 2019). Through these criticisms, the IS literature on adoption has acknowledged that system use extends beyond maximizing productivity in the post-adoption phase (Deng and Chi 2012), and consideration should be paid to the scalability of system use, its implications, and the assurance of effective continuation (Burton-Jones et al. 2017).

Effective use of a system is defined as "using a system in a way that helps [to] attain the goals for using the system" (Burton-Jones and Grange 2013, p. 633). It is an aggregate construct comprising three interlocking dynamics: Transparent Interaction (TI), Representational Fidelity (RF), and Informed Action (IA) (Burton-Jones and Grange 2013). These three dynamics that form the theory are framed by a contingent logic. This contingent rationale holds that, to obtain any benefit from an information system (success in a task or process), a user must unavoidably access its representations through the system's surface and physical structures. TI "refers to the extent to which a user is accessing the system's representations unimpeded by the system's surface and physical structures" (Burton-Jones and Grange 2013, p. 642). Conceptualizing transparent interaction as unobstructed by its surface, means relating it to prominent concepts in the literature, such as ease of use, accessibility, usability. For example, by what mechanisms can one sort elements of a system to improve decision making and information processing (Yang et al. 2021). Using a HMIS, an effective user can transparently reach the representations of the HMIS, i.e., interrogate the system, carry out required analyses (Yang et al. 2021). RF is understood as "the extent to which a user is obtaining representations from the system that faithfully reflect the domain being represented" (Burton-Jones and Grange 2013, p. 642). This dynamic focuses on the system's contribution to users. In other words, what representational equality does exist between the user's actions, such as inputting data, handling those data, visualizing those handled data, as well as retrieving data that are processed by the system and the domain that the system portrays. Moreover, IA deals with "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" (Burton-Jones and Grange 2013, p. 642). Inherently, completing a task is the core of using a system if one refers to an organizational scenario. For this purpose, users engage with the system by utilizing the system's representations to perform and complete actions. Therefore, the greater the ease with which users can act on the "faithful representations", the greater their actions will be informed.

2.2.1 Operationalising TEU

Operationalizing the Theory of Effective Use to shift thoughts toward a holistic, dynamic and strategic understanding of systems is becoming a strong and emerging strand within the information systems literature. One of the seminal studies behind this conceptualization argues that "researchers need instruments to test the relationships in the EUT model, and practitioners need instruments to assess how effectively systems are being used" (Burton-Jones and Grange 2013, p. 653). Yang et al. (2021) applied the theory to map the antecedents of effective use of Hospital Information System by medical workers within a Chinese context using a post-adoption lens. Bao et al. (2020) explored the link between portal use and incidence of consecutive patient hospitalizations. The research revealed that portal use leads to improved patient results on multiple measurement variables such as hospital and emergency room visits, risk of readmission, and duration of stay. In medicine for seniors with comorbidities and advanced technology development, Abouzahra and Ghasemaghaei (2021) established an affordance network including activity tracking and activity planning that underlies effective use of wearable devices by the elderly. Eden et al (2020) also investigated how effective use could be operationalized and provided a survey instrument to assess effective use. The research thus drew on the metrics and guidelines proposed by Burton-Jones and Grange (2013) for validation.

2.2.2 Contextualizing TEU through AAT

Affordances are potentials for action provided by a system to a goal-oriented actor. To attain their goal, users must actualize these affordances. This inspired Burton Jones and Volkoff (2017) to propose that effective use involves the effective actualization of affordances. The authors suggest a bottom-up approach for contextualizing a general theory of information systems through an inductive process, combining principles from TEU and AAT. The approach focuses on two key concepts: affordance

actualization and affordance network. Affordance actualization is used to analyse the interactions of users and technology, while the affordance network addresses the expected outcome. The affordance network describes how the organizational level outcomes are achieved through the attainment of the user level individual goals. The hierarchical network is composed of individual affordances aimed at achieving organizational goals through effective actualization. This forms the core of our proposed method for assessing effective use in context.

The modelling framework is described next.

2.3 Modelling the Generic Framework

The originality which lies behind the modelling process proposed herein is based on combining two approaches as described above. The proposed framework is rooted in work pioneered by Eden (2020) in combination with the concept of affordance network as schematised by (Burton-Jones and Volkoff 2017). By bringing in the network of affordances into the generation of the measurement tool we aim at giving visibility to the individual tasks that users perform within the process of assessing the effective use of a system in a specific context. Previous research has documented two drivers for enhancing system use in low-resource, constrained environments. A user-technology interaction that emerges spontaneously within an exertion-free experience and that is enforced by an articulated sense of utility (Vila-Pozo et al. 2022). Elevating the user perception of usefulness into the assessment is the end goal of this process.

The process consists of four major interrelated steps that lead towards embedding context-specific tasks into the measurement items. As a result, the dimensions of effective use assessed not in the abstract, but connected with the tasks which are meaningful to the users (identified affordances), providing more granular and prescriptive results instrumental for practitioners on the task of enhancing effective use.

The first step is to build the network of affordances (Burton-Jones and Volkoff 2017) and its alignment with the organizational goals. This requires two steps: identifying the affordances and associate them with the organizational objectives. Identifying the affordances and objectives from a contextualized interpretive inquiry enables the mapping of users' day-to-day operations to be hierarchised and identify the dependencies between the different individual objectives contributing to the organizational goals.

From the network of affordances, the following step is to classify each affordance in granularity level, low, middle or high. Low-level affordances relate to “direct use of technology”, mid-level, are “not direct technology use, but tightly coupled”, and high-level are “technology facilitated, but detached from technology use” - NAP model (Valbø 2022). Avery simple illustrative example can be found in Table 1.

Low-level affordance	Mid-level affordance	High-level affordance
1 – Entering data	4 – Reading dashboard	6 – Adjusting budget
2– Creating chart	5 – Writing report	7 – Opening health service
3- Creating dashboard		

Table 1 - Illustrative example of affordance levels

Third step focuses on identifying the paths from low-level to mid- and high-level affordances. The overall objective of this process is to assess effective use of the digital system; hence it is important to map the process down to the affordances which imply direct interaction of the user and the technology: low and mid-level affordances. For this reason, is important to classify the affordances into levels. Because not all low and mid-level affordances necessarily lead to a high level one, but all high and mid-level affordances should be traced down to low-level affordances, where the actual technology interaction happens.

The fourth step builds upon the previous three to generate the measurement items for assessing effective use. To do so, we propose to combine the existing measurement tool (Eden et al. 2020) with the affordances based on their levels. The rationale is that dimensions for effective use play different roles depending on the level of the affordance. For instance, transparent interaction centres around enabling direct access to the system through the technology (lower-level), whereas informed action hinges on cognitive processing of system-represented information (mid and higher-level). The resulting measurement items are a combination of the existing items for each dimension, with the corresponding affordances based on their level. Applying the previous illustrative simple example Transparent

interaction and representational fidelity will play out for affordance 1, 2 and 3 while informed action will do in affordance 6 and 7, since it does not imply direct use of the system. To illustrate the method, Table 2 contains an example of how would result the combination of two measurement items of transparent interaction (TI1 and TI2) with one low and one mid-level affordances from our example.

Dimension	Measurement Items (Eden et al. 2020) combined with mid and low level affordances
Transparent Interaction	TI1.1: "When using the system, I have seamless access to ***enter data***". TI2.1: "When using system, I have difficulty ***enter data*** because of system interface". … TI1.5: "When using the system, I have seamless access to ***write a report***". TI2.5: "When using system, I have difficulty to ***write a report*** because of system interface".

Table 2 - Example of resulting measurement items

Thus, we introduce a generic research framework (Figure 1), which provides a comprehensive picture of the affordance network classified by level and encapsulated within the main constituents of effective use of an information system.

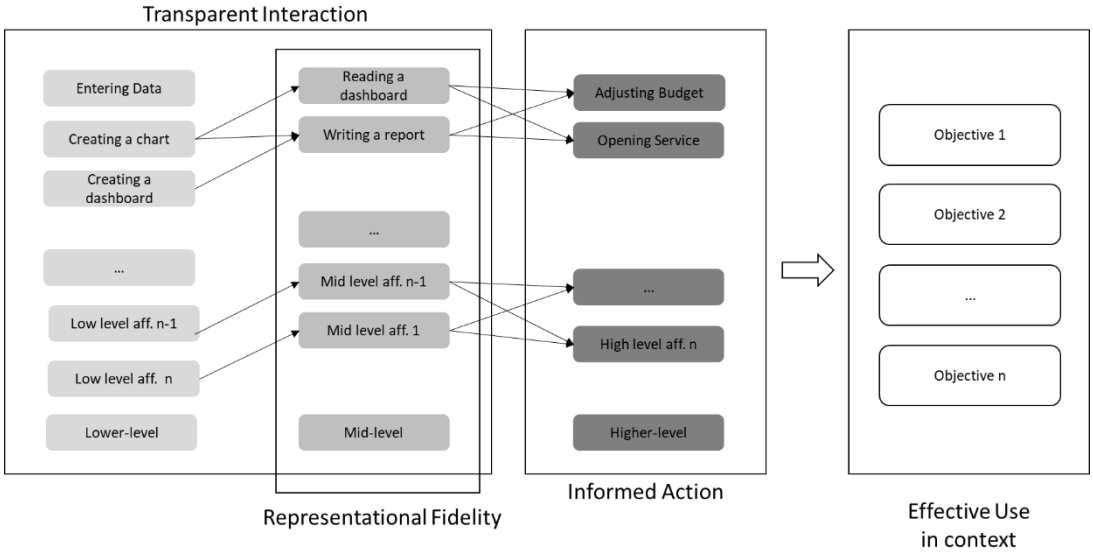

Figure 1 - Generic Framework for in-context Effective Use of an IS Artefact

2.4 Assessing the framework

This research is grounded in a multi-methodological framework, drawing on both Affordance Actualization Theory and the Theory of Effective Use, as well as health management information systems in the low-resources settings. Studies that have made use of the core theory of this research have typically been carried out through observation/surveys. Consistent with the research objectives, we expect to collect data from junior and senior managers who use Health Management Information Systems at different scales.

To build the measurement tool and assess the validity of the research framework, our study will utilize a mixed methods approach that incorporates both qualitative and quantitative techniques. The research design is structured in two phases where the qualitative phase of the study will provide the necessary information for building the research framework for the subsequent quantitative phase.

The qualitative phase will consist of performing semi-structured interviews with the selected participants. The purpose of the interviews phase is to gain understanding about the affordances which operate in the organization in relation to the use of the HMIS and the objectives of the organization to which the system contributes. Data analysis will follow an interpretive process. The interviews will be transcribed, and authors will analyse the set of data independently in two rounds following a thematic content analysis (Miles and Huberman 1994). The first round aims at identifying the key themes for analysis and the work practices in relation to the use of the HMIS conforming the affordances and objectives. The second round aims at identifying the interlinks between the affordances and the objective organization. Rounds will require moving iteratively from theory to data to inform the discussions that will enable building the network of affordances. At completion of each round the authors will convene their findings to identify common understanding. We foresee the possibility of identifying gaps in building the network of affordances and classifying them per granularity level. A second round of data collection through interviews will be performed in that case to complete our understanding of effective use of the HMIS in the context of study. After the network of affordances is completed, we will proceed to develop the measurement tool following the approach proposed in this research.

Consistent with the methodical reasoning, the quantitative component of our research will involve developing a survey. Our survey will be distributed primarily to managers who are at the heart of DHIS2-based decision making. We are gathering data from the ministry of public health and the national HIV program in Cameroon. The purpose of the survey is to consolidate the nomological design and the instruments drawn from the literature. To achieve this, our research will use a transversal, self-reported, and non-experimental method in the field.

A panel of specialists will be consulted to identify which departments should be surveyed to ensure a good match between the study's objectives and the participants involved. Prior research has documented the use of this approach (Riera and Iijima 2019). The modules comprising this line of work include the development of an investigative instrument (survey), a pre-test, and a pilot test. In the first phase, we adhere to the recommendations of Petter et al. (2007) to design and implement a survey instrument for our nomological framework. In this context, we will be reviewing extant and emerging literature on the research topic to pinpoint existent survey instruments which may be relevant for this research. If no prior studies have identified adaptive instruments for our research, the literature will be used to craft survey items tailored to the study's context. Upon development of the survey, a pre-test will be conducted. To decrease common method bias, the research will utilize an objective scale for task performance. The idea is to have experts evaluate the first responses received from the pre-test, thereby collecting empirical reactions from them, in order to estimate the appropriateness of the developed survey (Wang et al. 2008). Pretesting also allows for the refinement of the survey, and the exclusion of items that appear to be redundant.

The pilot test represents the final phase of the survey formalization process. The purpose of the piloting is to measure and define the feasibility of the survey. It also pinpoints any undetected ambiguities during the pre-test phase. Ambiguity includes unclear questions from the survey. Besides, Structure Equation Modelling (SEM) will be employed in this research for evaluating the conceptual, and structural nomological framework. Using SEM provides a stronger analysis, as it accommodates the random measurement errors intrinsic to behavioural research (Polites et al. 2012).

3 Conclusion

The effective use of health management information systems is emerging as an important agenda within the healthcare landscape of resource-constrained economies. At the operational level, technology is reshaping the health data input and output routines, driving governments towards a strategy of optimizing resource utilization while mitigating errors. Strategically, decision-making rooted in effective use of HMIS through data quality and related outcomes has significant implications for health system planning (Moukénet et al. 2021). In our research we aim to design analytical mechanisms to understand how an information system is effectively used within an organisation whilst mapping out vulnerabilities at an operational level of information system use.

4 References

Abouzahra, M., and G

hasemaghaei, M. 2021. "Effective Use of Information Technologies by Seniors: The Case of Wearable Device Use," *European Journal of Information Systems* (31), pp. 1-15.

Agarwal, R., Gao, G., DesRoches, C., and Jha, A. 2011. "The Role of Information Systems in Healthcare: Current Research and Road Ahead," *Information Systems Research* (22), pp. 419-428.

Bagayogo, F. F., Lapointe, L., and Bassellier, G. 2014. "Enhanced Use of It: A New Perspective on Post-Adoption," *Journal of the Association for Information Systems* (15:7), p. 3.

Bao, C., Singh, H., Meyer, B., Kirksey, K., and Bardhan, I. 2020. "Patient-Provider Engagement and Its Impact on Health Outcomes: A Longitudinal Study of Patient Portal Use," *MIS Quarterly* (44:2), pp. 699-723.

Burton-Jones, A., and Grange, C. 2013. "From Use to Effective Use: A Representation Theory Perspective," *Information Systems Research* (24:3), pp. 632-658.

Burton-Jones, A., and 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), pp. 468-489.

Chemero, A., and Turvey, M. T. 2007. "Complexity, Hypersets, and the Ecological Approach to Perception-Action," *Biological Theory* (2:1), pp. 23-36.

Davidson, E., Baird, A., and Prince, K. 2018. "Opening the Envelope of Health Care Information Systems Research," *Information and Organization* (28:3), pp. 140-151.

DeLone, W. H., and McLean, E. R. 2003. "The Delone and Mclean Model of Information Systems Success: A Ten-Year Update," *Journal of management information systems* (19:4), pp. 9-30.

Deng, X., and Chi, L. 2012. "Understanding Postadoptive Behaviors in Information Systems Use: A Longitudinal Analysis of System Use Problems in the Business Intelligence Context," *Journal of Management Information Systems* (29:3), pp. 291-326.

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

Farnham, A., Loss, G., Lyatuu, I., Cossa, H., Kulinkina, A. V., and Winkler, M. S. 2023. "A Roadmap for Using Dhis2 Data to Track Progress in Key Health Indicators in the Global South: Experience from Sub-Saharan Africa," *BMC Public Health* (23:1), p. 1030.

Gibson, J. J. 1979. *The Ecological Approach to Visual Perception*. Boston, USA: Houghton Mifflin.

Heeks, R. 2006. "Health Information Systems: Failure, Success and Improvisation," *International journal of medical informatics* (75:2), pp. 125-137.

Kabra, G., and Anbanandam, R. 2016. "Exploring the Challenges in Implementation of Information Technology in Humanitarian Relief Organisations in India: A Qualitative Study," in *Managing Humanitarian Logistics*. New Delhi: Springer, pp. 105-113.

Markus, M. L., and Silver, M. 2008. "A Foundation for the Study of It Effects: A New Look at Desanctis and Poole's Concepts of Structural Features and Spirit," *Journal of the Association for Information Systems* (9:10).

Mbondji, P. E., Kebede, D., Soumbey-Alley, E. W., Zielinski, C., Kouvividila, W., and Lusamba-Dikassa, P.-S. 2014. "Health Information Systems in Africa: Descriptive Analysis of Data Sources, Information Products and Health Statistics," *Journal of the Royal Society of Medicine* (107:1_suppl), pp. 34-45.

Miles, M. B., and Huberman, A. M. 1994. *Qualitative Data Analysis: An Expanded Sourcebook*. Sage.

Moukénet, A., de Cola, M. A., Ward, C., Beakgoubé, H., Baker, K., Donovan, L., Laoukolé, J., and Richardson, S. 2021. "Health Management Information System (Hmis) Data Quality and Associated Factors in Massaguet District, Chad," *BMC medical informatics and decision making* (21:1), pp. 1-10.

Ouedraogo, M., Kurji, J., Abebe, L., Labonté, R., Morankar, S., Bedru, K. H., Bulcha, G., Abera, M., Potter, B. K., Roy-Gagnon, M. H., and Kulkarni, M. A. 2019. "A Quality Assessment of Health Management Information System (Hmis) Data for Maternal and Child Health in Jimma Zone, Ethiopia," *PLoS One* (14:3), p. e0213600.

Petter, S., Straub, D., and Rai, A. 2007. "Specifying Formative Constructs in Information Systems Research," *MIS quarterly* (31:4), pp. 623-656.

Riera, C., and Iijima, J. 2019. "The Role of It and Organizational Capabilities on Digital Business Value," *Pacific Asia Journal of the Association for Information Systems* (11:2), pp. 67-95.

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

Sun, H., Wright, R. T., and Thatcher, J. 2019. "Revisiting the Impact of System Use on Task Performance: An Exploitative-Explorative System Use Framework," *Journal of the Association for Information Systems* (20:4), p. 3.

United Nations. 2017. ""Health Care System: Time to Rethink."," in: *Africa Renewal*. New York: Uniter Nations Department of Public Information, p. 15.

Valbø, B. 2022. "The Nested Affordance Process Model: Bridging Technology Use and Societal-Level Impact," *Annual Workshop of the AIS Special Interest Group for ICT in Global Development*, Copenhagen, Denmark.

Valbø, B., and Sanner, T. 2022. "Investigating Mid-Level It Affordances as Drivers for Societal Change: Addressing the Education Data Challenge in the Gambia," *International Conference on Social Implications of Computers in Developing Countries (IFIP 9.4)*, Online Conference, pp. 471-489.

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

Volkoff, O., and Strong, D. 2013. "Critical Realism and Affordances: Theorizing It-Associated Organizational Change Processes," *MIS Quarterly* (37:3), pp. 819-834.

Volkoff, O., and Strong, D. M. 2017. "Affordance Theory and How to Use It in Is Research," in *The Routledge Companion to Management Information Systems,* R.S. Galliers, Mari-Klara (ed.). New York: Routledge.

Walsham, G. 2020. "Health Information Systems in Developing Countries: Some Reflections on Information for Action," *Information technology for Development* (26:1), pp. 194-200.

Yang, H., Guo, X., Peng, Z., and Lai, K.-H. 2021. "The Antecedents of Effective Use of Hospital Information Systems in the Chinese Context: A Mixed-Method Approach," *Information Processing & Management* (58:2).

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