How do Unintended Consequences Emerge from EHR Implementation? An Affordance Perspective

[Running headline]

Emergence of unintended consequences

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Abstract

Drawing upon an affordance-actualisation perspective, we aim to advance our knowledge of the emergence of unintended consequences from the implementation of Electronic Health Record (EHR) systems. Prior research has not yet deeply understood how these unintended consequences unfold. We investigate how the (non-)actualisation of affordances produces unintended consequences. Our exploratory case study of an EHR system implemented in Italy reveals four types of actions (flexing, bypassing, avoiding, and reorganising) through which different types of unintended consequences occur with the (non-)actualisation of affordances. We explain and theorise how interactions among technology features and psychosocial and organisational constraints/enablers contribute to users' perception of affordances and technological constraints. This, in turn, influences different types of user actions, leading to unintended consequences. Our findings and insights contribute to the literature on unintended consequences and help organisations better manage implementing new systems.

Keywords: affordance, actualisation, unintended consequence, Electronic Health Record, case study, qualitative research

1. INTRODUCTION

An Electronic Health Record (EHR) is a digital record of patient health information stored and exchanged securely among multiple authorised actors (Kohli & Tan, 2016). EHR systems are implemented to achieve the goals that the system designers and implementers set. When these goals are achieved, EHR implementations generate intended consequences, such as saving time (Feldman & Horan, 2011), reducing costs (Ayabakan et al., 2017; Yaraghi et at., 2019), improving care quality (Burton-Jones & Volkoff, 2017; Lin et al., 2017), and sharing information among health professionals (Strong et al., 2014). However, EHR implementations may also create consequences not planned initially or intended by the system designers or implementers. Such unintended consequences refer to *unforeseen, unanticipated, or unwanted outcomes that emerge from purposive social action aimed at creating change in complex social systems* (Baert, 1991; Merton, 1936). In the present study, we define unintended consequences from the perspective of EHR system designers and implementers. While unintended consequences can be determined by the perspective of different stakeholders, we follow prior research to adopt system designers' and implementers' views because their intentions are more clearly documented and communicated, and they plan and execute the system implementation. We define unintended consequences as outcomes that were not anticipated, planned, or pre-defined by the system designers and implementers. Unintended consequences could be not only undesirable outcomes but also desirable ones. Desirable unintended consequences are beneficial to users and organisations even though they were not originally intended by the system designers and implementers.

Unintended consequences can occur during the implementation and use of a highly complex system such as an EHR system due to intricate interdependencies of multiple socio-technical factors, such as various care actors and many layers of technology components (Giddens, 1984). Prior research shows that EHR systems could undermine doctors' emotional connection with patients (Kumar et al., 2022), deepen the age-based digital divide (Fox and Connolly, 2018), and increase nurses' technostress and turnover intention (Califf et al., 2020). Although most unintended consequences appear undesirable, EHR systems can also produce desirable or positive unintended consequences. For example, Petrakaki et al. (2012) found that digital transmission of prescriptions led pharmacists to expand their roles and increase their professional influence and boundaries. Given these profound impacts, developing a deep understanding of how unintended consequences emerge significantly advances the theories of information systems (IS) (Majchrzak et al., 2016).

Such a theoretical understanding is essential for healthcare organisations to prevent or minimize negative unintended consequences during the process of EHR systems implementation (Markus & Robey, 2004) and improve their ability to take advantage of unintended desirable outcomes. The lack thereof could cause increased user resistance, delayed rollout, and reduced benefits of new EHR systems (Boudreau & Robey, 2005; Strong et al., 2014), as well as missed opportunities.

Prior studies reported several unintended consequences resulting from IS implementations in healthcare, including user resistance (Kumar et al., 2022), low self-efficacy, lack of trust in information accuracy, privacy concerns (Fox & Connolly, 2018), low job satisfaction (Califf et al., 2020), increased workload (Bernardi & Exworthy, 2020; Davidson & Chismar, 2007), fragmented information sharing (Yaraghi et al., 2019), lower quality of the care actor's relationship with patients, and deteriorating work conditions (Kummer et al., 2017). Whilst these studies provide us with an initial understanding of unintended consequences from IS implementations in healthcare, most of them investigate only a particular aspect of the phenomenon without using a compelling theoretical lens. As a result, *we do not have a theory-based systematic understanding of different types of unintended consequences and how they unfold*.

To address these gaps in our literature, this study uses a typology based on the Diffusion of Innovation (DOI) theory (Ash et al., 2007) to classify unintended consequences. We then investigate how the (non-)actualisation of affordances influences the emergence of unintended consequences. Affordances refer to the possibilities of action that emerge from the relation of socio-technical components (Bernardi et al., 2019; Burton-Jones & Volkoff, 2017; Strong et al., 2014; Volkoff & Strong, 2017). Their actualisation is responsible for the outcomes resulting from the use of an IS. We adopt an affordance-actualisation perspective to address the following research question: *How do different types of unintended consequences emerge from the actualisation of an EHR system's affordances?*

We conducted an exploratory case study (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Yin, 2014) of the implementation of an EHR system in a northeastern Italian region. We interviewed different types of users and other stakeholders of the EHR system and obtained project reports and government documents. Our analysis reveals four types of actions – *flexing*, *bypassing*, *avoiding*, and *reorganising* – through which the (non-)actualisation of affordances leads to different types of unintended consequences. Importantly, we find that interactions among technology features and psychosocial and organisational constraints or enablers influence users'

perception of affordances or technological constraints. This, in turn, underpins the different types of actions through which affordances are actualised, leading to unintended consequences.

The remainder of the paper is organised as follows. The following section provides the theoretical background for unintended consequences, the DOI-based typology, and the affordance-actualisation theory. We then describe our research methods and present our analysis results and findings. We discuss this research's theoretical and practical contributions and conclude with limitations and future research directions.

2. THEORETICAL BACKGROUND

2.1 Unintended consequences of EHR systems implementation

Hospital management often implements EHR systems or other health IS to save time, improve workflows, and decrease costs (Ash et al., 2007). An information system usually involves many actors, each of whom can have different intentions concerning the system (Markus & Robey, 2004). Therefore, it is essential to clarify 'intended or unintended by whom' when investigating unintended consequences. In the present study, intentions refer to the common goals shared by the designers and implementers of the new system. Acting on their intent produces changes to the social system in which they are situated and generates certain consequences[1] (Rogers, 1983). When the users of the new system make progress towards the goals planned and defined by the EHR system designers and implementers, they realise the *intended consequences*. Prior research identified varying types of intended consequences, such as saving time (e.g., Jiang & Cameron, 2020), reducing costs (e.g., Yaraghi et al., 2019), improving care quality (e.g., Burton-Jones & Volkoff, 2017), sharing and integrating information (e.g., Strong et al., 2014), and empowering patients (e.g., Bernardi & Exworthy, 2020) (see Table A1 for a summary of the relevant studies).

When intended consequences are defined as positive progress towards the goals set by the system designers and implementers, any other effects produced by the new system are considered unintended consequences (Leslie, 2019). Unintended consequences emerge from complex interdependencies of multiple socio-technical factors (Giddens, 1984), such as interactions among care actors, goals, IT artefacts, and strands of affordances (Volkoff & Strong, 2013). Not all unintended consequences, however, are unfortunate outcomes – some can be desirable to users and

[1] Prior literature uses consequences and outcomes interchangeably.

organisations even though they were not originally planned, defined, anticipated, or intended by the designers and implementers. (Ash et al., 2004).

We reviewed fifteen prior studies that reported the unintended consequences of EHR and other health IS. Interestingly, our analysis suggests that only five studies have investigated unintended consequences as their primary research focus and grounded them on theory (see Table A2 for a summary of the relevant studies). Kumar et al. (2022) found that doctors demonstrated several forms of resistance (apathy, passive, aggressive, and active) as a conservation strategy when an Electronic Medical Record (EMR) system was introduced. Drawing on Bourdieu's social practice theory, they explained that the EMR system threatened doctors' medical dominance and social standing as the system made it difficult to build an emotional connection with patients. From the technostress view, Califf et al. (2020) found that techno-distress negatively impacted nurses' job satisfaction, increasing the likelihood of quitting their jobs or leaving their professional field altogether. Using protection motivation theory and social cognitive theory as theoretical underpinnings, Fox and Connolly (2018) showed that low self-efficacy and lack of trust in information accuracy combined with privacy concerns led older patients not to use the new system. Kummer et al. (2017) showed how technology-induced anxiety of care actors decreased their intention to use a medication support system because they perceived the system to reduce the quality of their relationship with patients and worsen their work conditions. Drawing on an agency view of technology, Petrakaki et al. (2012) explained how an Electronic Prescription Service transformed fundamental aspects of pharmacy practice and augmented the pharmacists' work by combining medicine dispensing with consulting roles.

The other ten studies reported unintended consequences as secondary findings or by-products of their primary research focus (see Table A3 for a summary of the relevant studies). Bernardi and Exworthy (2020) found that the perceived uncertainty about patients' safety increased care providers' workload, and doctors' expanded responsibility prevented the approval of a telehealth system. They also found that the managerial goal of cost-saving created tensions with medical professionalism. Bernardi et al. (2019) showed that introducing Health Information Systems increased the autonomy of local health authorities in planning and managing their health services. The new system empowered health records information officers by redefining their identity as health information experts and advisors. In their case study in geriatric telepsychiatry, Hansen et al. (2019) described how telemedicine distributed information and cognitive effort across

the care actors involved in the patient treatment through dynamic processes. This process increased care actors' clinical knowledge and simplified information processing tasks. Yaraghi et al. (2019) found that information disclosure raised information privacy concerns for patients. Mettler (2018) found that professional social networks were used unintendedly as "shadow IT systems" to discuss topics unsuitable for larger audiences or private conversations. Anderson and Robey (2017) showed that tweaks, workarounds, and unintended use might emerge due to users' limited skills and problematic system features within an adverse work context. Pouloudi et al. (2016) revealed that a combination of negative perceptions about technology, poor technological infrastructure, lack of perceived involvement in the policy and decision making for the new system, and concerns about data privacy, security, and confidentiality triggered users' dissent and resistance to technology-driven changes in health organisations. Strong et al. (2014) found that users could experience difficulties and unfamiliarity with the EHR system due to weak typing skills. As a result, the users perceived the system to undermine their professionalism and increase workload. Similarly, Davidson and Chismar (2007) showed that new technology triggered changes to care actors' roles, dyad interactions, tasks, and skills, increasing hospital staff's workload. Oborn et al. (2011) discovered that the digital transformation of patient record forms did not match the existing medical practices, resulting in increased, rather than decreased, diversity in practice and user opposition to the system.

Our review of prior literature reveals two important limitations. First, although a range of unintended consequences has been reported, few studies have used a theory-based typology for classifying those unintended consequences. A theoretically sound typology is useful for researchers to theorise phenomena relating to unintended consequences. We believe the DOI-based typology proposed by Ash et al. (2007) is useful for categorising unintended consequences. Second, prior studies generally lacked compelling theoretical explanations for the process leading to unintended consequences. We propose the affordance-actualisation theory as a valuable lens to investigate how the interactions of technology, users, and the environment generate unintended consequences.

2.2 Typology for unintended consequences

To develop an in-depth understanding of how IT implementations produce different types of unintended consequences, we first need to classify unintended consequences into theoretically meaningful categories. To this end, we use the classification framework developed by Ash et al. (2007), which is based on the DOI model (Rogers, 1983). The framework classifies the

consequences of an innovation such as an EHR system into a typology along three dimensions: intended/unintended, desirable/undesirable, and direct/indirect (Ash et al., 2007). Intended consequences are outcomes that were planned, expected, and pre-defined by the system designers and implementers, advancing their set goals. By contrast, unintended consequences are outcomes that were not planned, anticipated, or pre-defined by the system designers and implementers, regardless of their desirability. Sometimes, unintended outcomes are pleasant surprises, but other times, they are harmful or even devastating problems (Markus & Robey, 2004). Desirable consequences are the functional, positive outcomes, while undesirable ones are the dysfunctional, negative outcomes of system implementation from the perspective of system designers/implementers. Direct consequences (e.g., reduced wait time, lower processing cost) are the changes that typically occur to processes as an immediate response to a new system. In contrast, indirect consequences (e.g., customer loyalty, employee satisfaction) are at least one step removed from direct consequences. The former tends to be more measurable and more attributable to a specific cause. In contrast, the latter tends to be less measurable and less attributable to a particular cause due to possible confounding factors (Ash et al., 2007). As intended consequences are not the primary focus of the present study, we adapted Ash et al.'s typology to mainly represent unintended consequences from the perspective of EHR system designers/implementers (Figure 1).

The resulting typology distinguishes four types of unintended consequences. Let us describe them in the context of the implementation of an EHR system. *Unintended desirable direct consequences* are the consequences that are not intended by the system designers/implementers but create functional, measurable effects on immediate processes. Examples may include faster issue resolution, more environmentally sustainable processes, more time spent nurturing physician-patient relationships, new data uses, and more frequent process redesign. *Unintended desirable indirect consequences* occur when the system implementation creates unplanned positive organisational outcomes that are broader than process-level outcomes and were not intended by the system designers/implementers. Examples may include augmented user's role and social status, greater employee retention, improved institutional reputation, and enhanced market positions of previously disadvantaged organisations. *Unintended undesirable direct consequences* are the consequences that are not only unintended by the system designers/implementers but also create dysfunctional effects on relevant processes. Examples may include increased processing costs, botched transactions, and lower process consistency. Finally, *unintended undesirable indirect*

consequences are negative organisational outcomes that are above and beyond process-level impacts and are not intended by the system designers/implementers. Examples may include employee burnout, security breaches, reputational damage, deterioration in organisational culture, and lower revenue. In the next section, we discuss the affordance-actualisation theory as our primary lens to help investigate the emergence of unintended consequences from IT implementations.

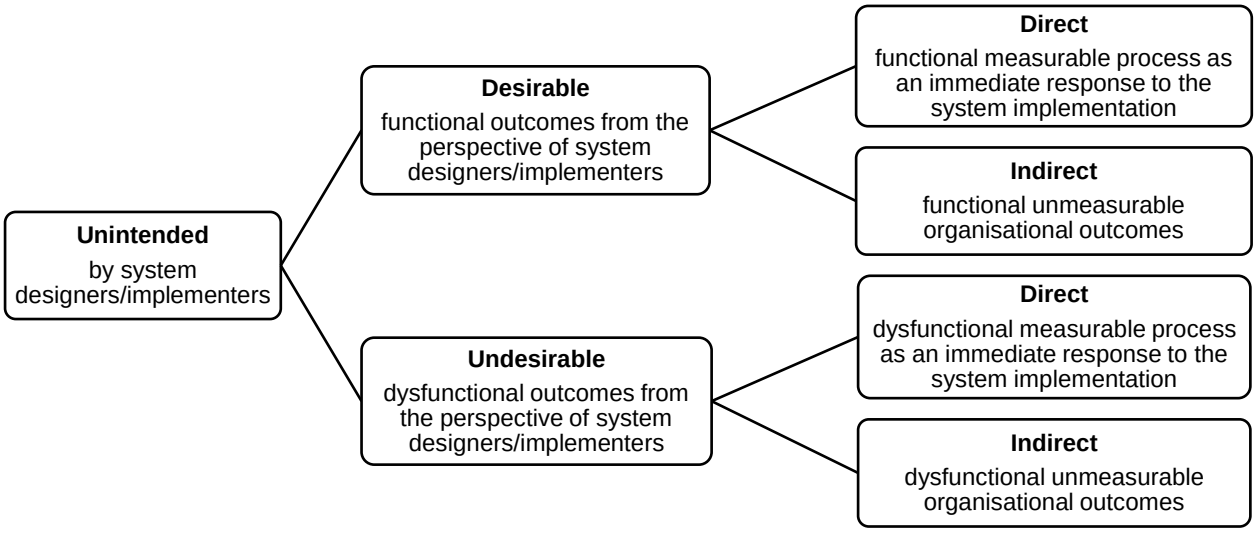


Figure 1 Typology of unintended consequences from the perspective of EHR system designers/implementers (adapted from Ash et al. (2007))

2.3 Affordance-actualisation theory

The concept of affordance has been widely studied to explain the relationships between actors, objects, and environments in various fields of study, such as psychology, sociology, and information systems. Gibson (1986) defines affordances as possibilities of action that an object provides or offers to a specific user in a particular context. Consistently with Gibson's affordance theory, we take a relational view of affordances, which links affordances to the relation between the material features of technology and the users' interactions with technology to achieve their goals (Markus & Silver, 2008; Volkoff & Strong, 2017). Therefore, affordances are related to but distinct from technology features and exist as potential uses of technology by its users. People choose how they use technology, depending on whether they perceive it to afford or constrain their goals (Leonardi, 2011, p. 154).

From a critical realist perspective, affordances can be both *real* and *actual*. An affordance is *real* and thereby exists in relation to any potential actors with the abilities to perceive it to pursue certain goals, independently from actors' actual perception of it (Strong et al., 2014; Volkoff & Strong, 2017). Yet affordances become *actual* when a specific actor actualises them as they interact with technology (Strong et al., 2014). According to *affordance-actualisation theory*, affordance actualisation refers to goal-oriented actions technology users take to achieve an outcome (Du et al., 2019). It is the actualisation of an affordance through users' interactions with technology that generates an outcome (Burton-Jones & Volkoff, 2017; Strong et al., 2014; Tim, et al., 2018).

Affordance-actualisation theory also suggests the existence of dependencies between affordances (Burton-Jones & Volkoff, 2017). The idea of dependencies between affordances helps analyse how groups of individual-level affordances relate to complex outcomes (Volkoff & Strong, 2013). Whether and how a group of users actualise an affordance or a bundle of affordances associated with specific outcomes is key for actualising other affordances and their associated outcomes (Burton-Jones & Volkoff, 2017; Leidner et al., 2018). The idea of interconnectedness between affordances and their outcomes is particularly significant in healthcare, where different parts of a multilevel system like EHR are interlinked. Suppose users in one part of the system do not actualise affordances needed by a group of users in another. In that case, the outcomes intended by the system designer/implementer may not be realised (Burton-Jones & Volkoff, 2017), and, instead, unintended consequences could be generated (Tim et al., 2018). According to Strong et al. (2014), affordance actualisation across individual actors varies and may occur at a different pace or generate different outcomes. When this happens, the immediate outcomes arising from affordance actualisation by multiple users may be misaligned with the outcomes that the system designer/implementer initially intended. This, in turn, may result in unintended consequences. Therefore, investigating affordance actualisation is an essential step towards understanding how unintended consequences emerge from the use of technology.

There are various reasons why affordance actualisation may lead to unintended consequences. First, consistent with the view of dependencies between affordances (Burton-Jones & Volkoff, 2017), unintended consequences may occur when one affordance's realisation (or incomplete realisation) may constrain the actualisation of another affordance (Volkoff & Strong, 2013). For example, if the affordance of "inputting patient data" into an EHR system is not actualised consistently by all care actors, other affordances, such as "visualising patient information

anytime/anywhere", may not be fully actualised. Likewise, the actualisation of the affordance of "saving patient records in read-mode only" may prevent other care actors from editing the patient record and, ultimately, may generate unintended consequences such as outdated patient information.

Second, affordances are not actualised in a vacuum but in an organisational context. Organisational rules, norms, and resources characterising a work environment (Strong et al., 2014) influence *whether* users perceive an affordance to be useful to achieve their goal (Bernardi et al., 2019) and may either enable or constrain the actualisation of affordances (Strong et al., 2014; Volkoff & Strong, 2017). In addition, variation in users' abilities may affect *whether* and *how* an affordance is actualised (Strong et al., 2014; Volkoff & Strong, 2017). While affordances exist in relation to any potential user, whether and how an affordance is perceived and actualised depends on the specific abilities of a particular individual who uses the technology (Anderson & Robey, 2017). Users' abilities to use IT are key enablers for the actualisation of affordances. By contrast, when users lack or have limited abilities to use IT, this may lead to incomplete or inappropriate affordance actualisation or cause users to fail to perceive an existing affordance (Volkoff & Strong, 2013). Therefore, organisational enablers/constraints, e.g., organisational rules, norms, and resources characterising a work environment, and psychosocial enablers/constraints, e.g., users' abilities to use IT, may affect users' perception and actualisation of affordances in unpredictable ways and produce outcomes not originally intended by the technology designer/implementer.

Finally, technological constraints may also affect affordance actualisation (Strong et al., 2014). *Technological constraints* refer to "ways in which an individual or organisation can be held back from accomplishing a particular goal when using a technology or system" (Majchrzak, 2013). A user may perceive a technological constraint when technology does not let them accomplish a goal-oriented action (Majchrzak, 2013) due to an affordance not being made self-evident (Anderson & Robey, 2017) or not being supported by a technology design either temporarily (system malfunction) (Leonardi, 2011) or permanently (missing affordance) (Volkoff & Strong, 2013). It is important to note that a technological constraint is different from the property of technology (Leonardi, 2011; Majchrzak, 2013), but like affordances, it emerges from the relationship between technological features and users' characteristics. For example, in Leonardi (2011), users started to perceive technological constraints not because the technology had changed but because their goals had shifted. Therefore, they perceived the technology to be a constraint to

the realisation of their goals. Hence, users perceive system malfunctions or missing IT functionalities to be technological constraints when these prevent them from achieving their goals. In the same way organisational enablers affect users' perception of affordances by shaping their goals (Bernardi et al., 2019), organisational constraints may also contribute to users' perception of technological constraints by influencing their goals. Furthermore, users' abilities to use technology are also users' characteristics. Therefore, while on the one hand, users' abilities to use technology (a psychosocial enabler) contribute to their perception and actualisation of affordances, on the other hand, users may perceive technology and its features as constraints to achieving their goals since they lack the abilities to use it (a psychosocial constraint). Therefore, a technological constraint emerges due to the impossibility of a goal-oriented action, given a missing functionality or a technical malfunction, or given certain technological features acting as constraints due to the lack of certain users' abilities. While organisational and psychosocial constraints are separate from technological constraints, they contribute to users' perception of technological constraints. When an affordance exists but cannot be perceived due to a temporal system malfunction or users' lack of ability to use technology (Volkoff & Strong, 2013), users are likely to perceive a technological constraint instead, resulting in a failure to actualise the existing affordance.

To conclude, interactions among technology features, organisational rules, norms, and resources of a work environment, and users' abilities influence affordance actualisation (Robey et al., 2013; Tim et al., 2020; Volkoff & Strong, 2017; Zheng & Yu, 2016), and its consequences. Our *affordance-actualisation* perspective builds on this premise to investigate how affordance actualisation generates the unintended consequences of an EHR system implementation. We argue that organisational enablers/constraints (e.g., organisational rules, norms, and resources) shape users' goals while psychosocial enablers/constraints (e.g., users' abilities) influence whether users have the abilities to use technology. The relation between users' characteristics (e.g., users' goals and abilities) and IT features affects whether users perceive an affordance or a technological constraint as they use the technology. Given certain IT features, organisational enablers/constraints might affect whether an affordance or technological constraint is perceived by influencing users' goals. Whether users perceive an affordance or technological constraint also depends on whether users have the abilities (psychosocial enabler) or lack the abilities (psychosocial constraint) to use certain IT features to achieve their goals. If they perceive an affordance, the following actualisation is also affected by users' abilities to use the technology under the influence of organisational rules,

norms, and resources. If an affordance exists but cannot be perceived due to a temporal system failure or users' lack of abilities, users might experience a technological constraint and the impossibility of actualising that affordance. Likewise, technological constraints resulting from missed affordances might prevent achieving an outcome that is significant for the actualisation of other existing affordances. The actualisation of affordances under the influence of psychosocial/organisational enablers/constraints or the failure to actualise affordances due to technological constraints might generate unintended consequences, e.g., desirable or undesirable outcomes that had not been initially intended by the designer/implementers of the EHR system (Figure 2).

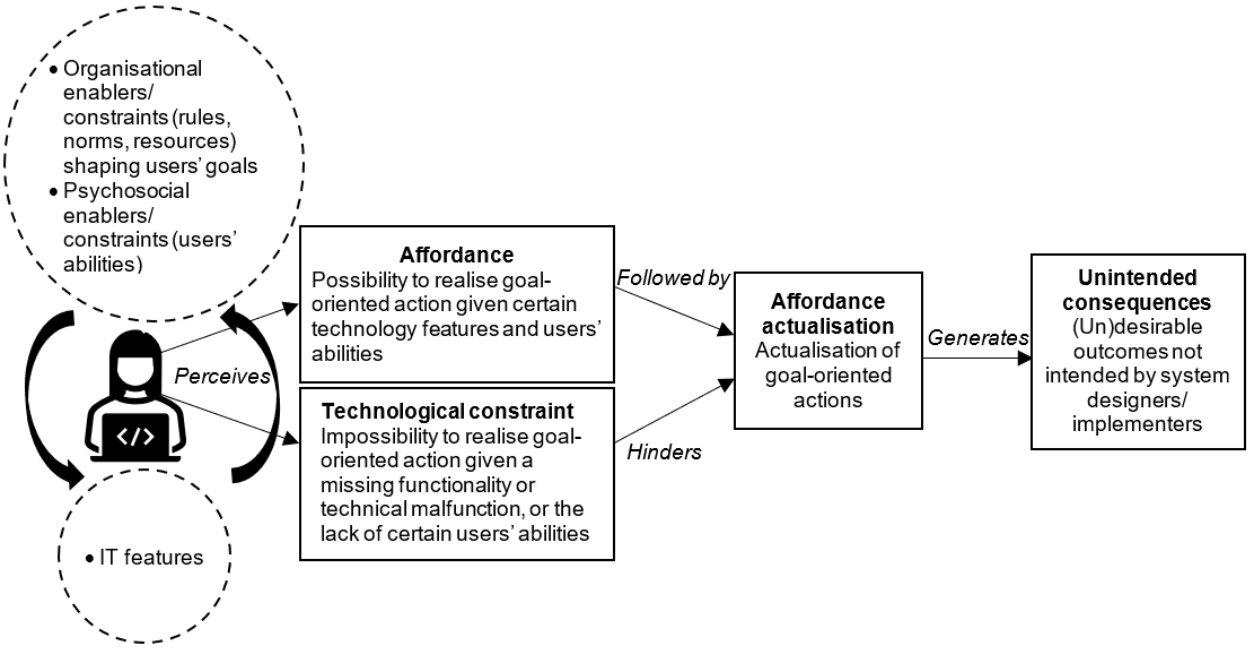


Figure 2 Affordance-actualisation perspective on the unintended consequences of IT use

3. METHODS

3.1 The research setting

We investigated the implementation of an EHR system in a northeastern Italian region using an exploratory case study approach (Eisenhardt, 1989; Sarker et al., 2018; Yin, 2014). The implementation was part of a broader project developed and launched at the national level to digitalise healthcare services with a patient-centred approach. In 2012, the regional government mandated connecting multiple healthcare organisations through digital systems and platforms. A

regional research and innovation centre for digital health was formed and assumed the responsibility for overseeing the implementation of the EHR system.

Our analysis focused on the implementation of the regional EHR system in primary and secondary care. The system comprised technical components such as clinical data repositories, digitised patient records, and decision support applications. It contained basic information (e.g., administrative data of the patient, pharmaceutical dossier), supplementary documents (e.g., prescriptions, vaccinations, medical certificates), and security/privacy forms (e.g., informed consent for exchanging personal medical data). The system aimed to seamlessly integrate previously fragmented data and applications and support evidence-based decision-making. This study focuses mainly on the two modules of the system: digital prescription and medical results delivery. These modules were relatively widely implemented and used within the system. Other modules, such as a digital booking system, digital reimbursement for pharmacies, and a mobile application, were added to the system later. However, they were still in the early development or pilot phase. Therefore, we excluded them from the scope of the present study.

3.2 Data collection

The primary source of our data is semi-structured interviews with different types of care actors, including general physicians, specialised physicians, hospital pharmacists, independent local pharmacists, the project manager, and patients. We also collected documents such as official documents published on the national/regional government websites and the national/regional laws defining the EHR system's goals and regulating its implementation and use. We obtained project reports and other project-related information from the system development and implementation team. They also provided us with the contacts of care actors for our study.

We contacted the study participants by email or phone. Before their interviews, all participants signed the informed consent form. Using the snowball sampling method, we asked the interviewees to provide us with the contacts of other care actors we could interview. We interviewed 31 respondents between November 2017 and June 2018 (Table 1). Each interview lasted about one hour.

Table 1 Field interviews by type of care actors

Role of Interviewee	Num. of interviews	Interview duration (h)	Period
General Physician	10	10	Nov-Dec 2017
Patient	8	6	Nov-Dec 2017
Independent Local Pharmacist	4	4	Nov-Dec 2017
Project Manager	1	2	Nov2017-June 2018
Hospital Pharmacist	2	2	Jan-June 2018
Specialised Physician	6	5	Jan-June 2018
Total	31	29	

In the first wave of interviews between November and December 2017, we interviewed the project manager, general physicians, patients, and independent local pharmacists. The project manager provided a comprehensive perspective of the EHR system in terms of objectives/goals, intended outcomes, historical evolution, and timeline. General physicians provided valuable information about the difficulties associated with the system implementation, how they used it, and the obstacles they faced when using it. We interviewed patients in the outpatient clinics about their experience with the system and how they used it. We interviewed independent local pharmacists who were not located within the hospitals but had agreements with the regional/national health systems to deliver care services in certain localities.

In the second wave of interviews between January and June 2018, we interviewed the project manager, hospital pharmacists and specialised physicians. We discussed the challenges that we identified from the first wave of interviews in greater detail with the project manager. We interviewed hospital pharmacists and specialised physicians in public and hybrid health organisations to understand how they used the EHR system and their experience with it. The interviews were audio-recorded and transcribed, totalling 284 pages and 91,573 words. The interviews were both retrospective and focused on the present. In either case, we constructed our interpretation of the events by corroborating across different interviewees and by using documentary evidence when relevant.

3.3 Data analysis

We followed a predominantly inductive approach to analyse the data collected (Corbin & Strauss, 2014), given that we aim to identify from the data what led to the emergence of unintended consequences from the implementation of the EHR system (Burton-Jones & Volkoff, 2017; Urquhart et al., 2009). Open coding helped us get deeply familiar with the data, fracture it, and

move toward identifying recurrent themes through a constant comparison process (Gioia et al., 2013). From our data, we extracted information about the actions performed with the EHR system and the outcomes, challenges, and benefits different actors experienced. We used the memoing method to reflectively formulate and refine abstract concepts related to consequences and actions and discover potential relationships among them. The memos helped us interpret the results by making an interpretive inference followed by validation (Agar, 1986). This process of writing and reflecting resulted in deeper insights from the data.

We first analysed the government documents, project reports, and the project manager's interview data to identify the EHR system's objectives and intended outcomes. These intended consequences were used as a baseline to validate unintended consequences later. After identifying a wide range of unintended consequences from the data, we classified them into different categories using the DOI-based typology. Next, we focused on uncovering how specific affordances, user actions, constraints, and enablers interacted to produce certain unintended consequences. Specifically, we identified the affordances that existed independently from users' perception or ability and then extracted the factors that enabled or constrained the actualisation of the affordances. We analysed how the intermediate outcomes resulting from the constraints/enablers of actions led to unintended consequences. Finally, we identified distinct actions by which affordances were actualised (or non-actualised) and unintended consequences produced.

4. FINDINGS

Our analysis of the government documents and the project manager's interview suggests that the intended consequences of the EHR system implementation in the northeast Italian region can be grouped into five themes: saving time, reducing healthcare costs, patient empowerment/self-management, information sharing/integration, and improved care quality. This result is mostly consistent with prior literature shown in Table A1.

Table 2 Users' actions through which affordances are actualised and unintended consequences emerge

EHR features / users	Affordances	Constraints / enablers	Intermediate psychosocial outcomes	Affordance actualisation		Unintended consequences
				Users' actions	Actualised affordances	
Digital prescription function General physicians, patients, pharmacists	Delivering digital prescription (1) Receiving, visualising digital prescription (2) Printing digital prescription (3)	**Technological constraint *** due to technical glitch (system malfunction) hinders the actualisation of affordances (1) and (2)	Patients feel anxiety and confusion and go to the doctor's office to collect a prescription	**Flexing** Users find ways to use the system despite constraints by actualising alternative affordances or by actualising affordances with delays	General physicians print digital prescription (3)	**Undesirable direct** Longer time to deliver medicines
Digital prescription function General physicians	Writing digital prescription	**Technological constraint** due to slow system response (system malfunction) delays affordance actualisation	General physicians' frustration		General physicians write digital prescription with delays	**Undesirable direct** Longer patient visits
Digital prescription function General physicians	Writing digital prescription (1) Printing digital prescription (2)	**Technological constraint** due to missing affordance for writing "medicine dosage" hinders the actualisation of affordance (1)	General physicians' frustration		General physicians print digital prescription (2) and add medicine dosage manually	**Undesirable direct** Additional paperwork
Digital prescription function General physicians	Writing and delivering digital prescription	**Technological constraint** due to missing pre-coded medicine information (missing affordance) compounded with rigid data management rules prevents affordances actualisation	General physicians' frustration	**Bypassing** Users are forced to bypass the system due to constraints, resulting in the non-actualisation of affordances	No system affordances are actualised (General physicians write a paper prescription instead)	**Undesirable direct** Longer patient visits and time to deliver medicines **Undesirable indirect** Increased data management problems
Digital prescription function General physicians	Writing digital prescription	**Technological constraints** due to slow system response (system malfunction) combined with weak typing skills (**psychosocial constraint**) prevent affordance actualisation	General physicians' frustration		No system affordances are actualised (General physicians write a paper prescription instead)	**Undesirable indirect** Decreased attention to patients
Digital prescription function Patients	Requesting digital prescription	**Technological constraint** due to no confirmation of prescription request (missing affordance)	Patients' anxiety and confusion for not receiving confirmation of prescription request		Patients request the digital prescription but faced with the impossibility of receiving a system confirmation they experience anxiety and contact their general physician to ask for confirmation of their prescription request	**Undesirable direct** Longer time to confirm prescription approval **Undesirable indirect** Increased workload to general physicians
Digital prescription function,	Requesting, receiving digital prescription (1)	**Technological constraints** due to the lack of digital literacy, confidence in the system, and	Patients are frustrated as they cannot access and		No system affordances are actualised (Patients	**Undesirable indirect** Increased dependence on patient's family

medical results delivery function Patients and their family	Retrieving medical results (2)	anxiety (**psychosocial constraints**) prevent affordances actualisation	use the online health services		ask their family members for help)	
Digital prescription function Hybrid health organisations, patients	Visualising digital prescription (1) Printing digital prescription (2)	**Organisational constraint** Hybrid health organisations' *unwillingness* to use the system prevents the actualisation of affordance (1)	Patients are frustrated since they cannot get medical visits without printed digital prescriptions	**Avoiding** Users refuse to use the system, avoiding the actualisation of affordances. This might hinder the actualisation of other affordances by other users	Patients print digital prescription (2)	**Undesirable indirect** Increased workload to patients
Medical results delivery function Hybrid health organisations, general physicians	Writing and delivering digital medical results (1) Retrieving patients' results (2) Scanning and saving patients' paper results (3)	**Organisational constraint** Hybrid health organisations' *unwillingness* to use the system prevents the actualisation of affordances (1) and (2)	Patients are frustrated since they have to collect the medical results of specialised visits in person and bring them to their general physician General physicians are frustrated since they cannot access the patient results online		General physicians scan and save patients' paper results in the EHR system (3)	**Undesirable indirect** Increased workload to general physicians
Digital prescription function General physicians, patients	Requesting digital prescription (1) Printing digital prescription (2)	**Psychosocial constraints** Patients' *unwillingness* to use the system prevents the actualisation of affordance (1)	General physicians are frustrated since they must meet with patients in the outpatient clinic to deliver the digital prescription		General physicians print digital prescription (2)	
Digital prescription function General physicians	Writing and delivering digital prescription	**Organisational enabler** Work flexibility enhances affordances actualisation	General physicians are excited by the possibility of doing administrative work anytime anywhere	**Reorganising** Users use the system to reorganise their work through the enhanced actualisation of affordances	General physicians write and deliver digital prescription (at home)	**Desirable indirect** New work routines conducive to higher productivity
Digital prescription function Personal assistants, general physicians	Writing digital prescription (1) Delivering digital prescription (2)	**Organisational enabler** Human resources availability and division of work enhance affordances actualisation	Personal assistants are excited by the possibility of taking on new roles and being more involved in the care system		Personal assistants write digital prescription (1) General physicians deliver digital prescription (2)	**Desirable indirect** Job enhancement for physician assistants
Digital prescription function Pharmacists	Visualising digital prescription (1) Delivering medicines (2)	**Organisational enabler** Technology investment and process change enhance affordances actualisation	Pharmacists are excited by the possibility of using an integrated system, serving customers efficiently and becoming competitive		Pharmacists visualise digital prescription (1) and deliver the medicine (2)	**Desirable indirect** New business opportunities for rural area pharmacies Job enhancement for pharmacists

* Users perceive technological constraints when a technology does not let them actualise a goal-oriented action due to an affordance not being supported by its design either temporarily (system malfunction) or permanently (missing affordance), or due to psychosocial constraints, such as the lack of abilities to use the system (e.g., poor IT skills).

We identified four distinct types of users' actions by which different types of unintended consequences emerged following the implementation of the EHR system. Figures 3-6 provide a high-level representation of our findings and depict how various constraints and enablers influenced affordance actualisation and collectively produced unintended consequences through a distinct type of action. We show how affordances, e.g., possibilities for a goal-oriented action that exist independently from users' perception, are actualised as goal-oriented actions performed by users.

The different ways in which users engaged with the system helped us to classify the four types of users' actions as *flexing*, *bypassing*, *avoiding*, and *reorganising* and to understand how the (non-)actualisation of affordances through these actions led to unintended consequences (see Table 2 for an overview).

4.1 Flexing

When care actors encountered a technical glitch, the affordances of "delivering and receiving digital prescriptions" were not actualised. The actualisation of these affordances was needed to realise the outcomes intended by the system designer/implementer (e.g., information sharing and integration). The physician, the pharmacist, and the patient often could not create or retrieve the digital prescriptions with the EHR system, even if they followed the procedures correctly. This led to anxiety for the patient, and, in the end, patients collected the prescriptions at their doctor's office:

> *Receiving the medical prescription is still a problem. Every time, I ask myself do I have to go to the doctor to get the medical prescription or will I find the medical prescription in the pharmacy.*

The care actors responded through *flexing*, e.g., they overcame the stress caused by technological constraints and found ways to use the system to get their job done. For example, general physicians printed digital prescriptions for patients and pharmacists. When patients could not receive their medicines from the pharmacy through the system, they would call their general physician, ask the pharmacist to reach the general physician, or even go to the outpatient clinic to receive the printed digital prescription. Hence, patients had to wait *a longer time to receive medicines*.

In other situations, physicians experienced delays in creating a digital prescription in the EHR system due to a slow system response. This technological constraint caused the physicians to feel frustrated and improvise to deal with such delays. Physicians would engage in activities such

as collecting information from the patient, taking notes, and scanning documents received from the patient and other care providers while waiting for the system to recover and start functioning again. This led to *longer patient visits*, as a general physician explained:

> *Sometimes, patient visits last longer because when I type the information into the system, it is slow, and I cannot do anything else until the data is loaded. But this takes more time especially when there are issues with the system, so I spend even more time to solve them in order to write the prescriptions.*

The EHR system aimed to digitise paper-based medical information fully. However, the system had design flaws that prevented the general physician from entering the medicine dosage on the digital prescription. The technological constraints arising from this "missing affordance" prevented physicians from completing the digital prescription. Physicians could thus actualise the affordance "writing digital prescription" only in part. Physicians responded to the frustration caused by this situation by printing the digital prescription, writing the dosage information on paper, and giving the paper prescription to the patient, thus causing *additional paperwork*. A general physician pointed out:

> *When prescribing antibiotics, acute cortisone therapy, with the digital system, patients no longer have instructions on how to take the medicine. So, I print the prescriptions and write a note about how to take those pills.*

To summarise, *flexing* occurred when technological constraints from system malfunctions or missing affordances hindered the actualisation of affordances essential for achieving outcomes intended by the system designers and implementers, such as saving time, information sharing, and integration. While dealing with the anxiety brought about by this situation, users were able to find ways to use the system by actualising alternative affordances (e.g., printing digital prescriptions) or by overcoming technological constraints and thereby actualising affordances even though with delays. Flexing allowed users to achieve their goals but also led to immediate dysfunctional outcomes from system use or undesirable direct consequences not intended by the system designers/implementers (Figure 3).

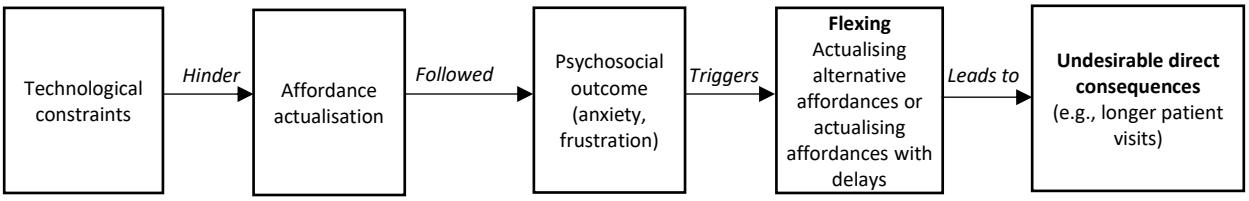


Figure 3 Flexing leading to undesirable direct consequences

4.2 Bypassing

The EHR system was aimed at digitalising and standardising prescription procedures. After opening the system, physicians would click on "create digital prescriptions", enter the necessary information such as patients' contact information, search for the proper pathology for the specific patient, and select and insert it in the prescription. This procedure was mandated by rigid data management rules, allowing users no or little flexibility. If the information for some diseases or medicines was missing in the system because the system was new, and some information was yet to be entered, general physicians could not write and deliver the digital prescription to the patient. For example, in a few instances, general physicians could not add a medicine code to the digital prescription since not all medicine information had been pre-coded in the system. The system would not allow general physicians to continue writing the digital prescription without filling this information. The impossibility of filling medicine information due to incomplete pre-coded data was a missing affordance, which, compounded with rigid data management rules built into the system, did not allow care actors to actualise the affordances of "writing and delivering digital prescriptions" at all. Facing the impossibility of writing and delivering a digital prescription to their patients, physicians felt a sense of frustration. They were forced to write a paper prescription, leading to *increased data management problems, longer patient visits, and time to receive medicines*, as a pharmacist pointed out:

> *The system needs more flexibility, for example, if the name of a medicine is not present in the system, the physician cannot prescribe it, but the patient needs that medicine. Someone must code that medicine and enter it in the database. Otherwise, the physician cannot prescribe that medicine, so he or she uses a paper prescription.*

There were instances where physicians experienced technological constraints not only due to a slow system response but also due to weak typing skills and the inability to type the digital prescription fast enough. This augmented their frustration and anxiety, which led them to bypass the system and write a paper prescription instead. Unlike *flexing*, *bypassing* was caused by doctors experiencing higher technological constraints due to a system malfunction (a slow system response) and psychosocial constraints (weak doctor's typing skills), which led to *decreased attention to patients.*

A specialised physician said:

> *Sometimes, the patient may have the impression that we think more about the computer because we wait until the information is loaded or we have to wait to look at the test results rather than looking directly at the patient. Now everything is traced you must always write everything, but it is not always easy to type all this data and upload it in the system. When it does not work, then I write paper prescriptions.*

In other situations, after "requesting a digital prescription," patients would not receive confirmation from the system that their request had been sent (a missing affordance), which caused them a feeling of anxiety and confusion. In response, patients bypassed the system and contacted their general physician to ask for confirmation of their prescription request. This led to a longer time to confirm prescription approval (an undesirable direct consequence) and an *increased workload for the general physician* (an undesirable indirect consequence). A patient lamented:

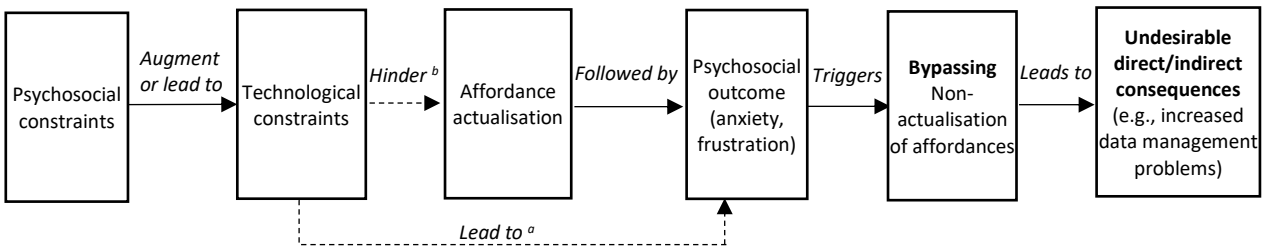
> *I always have the impression of being suspended. I would like to have something tangible that confirms that I made the request for the medical prescription successfully.*

Although general physicians told patients how to create their profiles and use the new system, patients experienced technological constraints due to psychosocial constraints, such as a lack of digital literacy, little confidence in the system, and anxiety. Some patients, mostly older senior adults, did not have an email for creating their EHR profile and/or did not have a smartphone to use the digital services offered by the regional health service. Thus, older patients often could not request the renewal of medical prescriptions, check active prescriptions in their accounts, or download the results of medical visits but were forced to ask their family members for help. This *increased patients' dependence on their family*, which had a negative influence on their self-esteem and independence. A patient revealed:

> *I am trying to do almost everything by myself because my children are already very busy with their work and their kids. When I need to go to the doctor, I go by myself, but when I have to use this [EHR] system and this app, I am always confused and anxious. I don't understand how it works; I prefer to go (physically) to the doctor. Sometimes, I get the medicines, but many times I don't, so I have to ask my children to do this, but I don't want to be a burden on them.*

To summarise, users could not actualise the affordances needed to achieve intended outcomes due to technological constraints emerging from technical malfunctions and psychosocial constraints, such as poor IT skills. With flexing, users could find ways to use the system despite technological constraints by actualising alternative affordances or by overcoming such technological constraints

and actualising affordances with delays. With bypassing, missing affordances (e.g., missing pre-coded medicine information) led to insurmountable technological constraints, and the system didn't offer alternative affordances users could actualise to achieve their goals. In addition, in contrast with flexing, technological constraints became insurmountable since they were not only arising from system delays but also from users' limited abilities to use the system, such as weak typing skills. As a result, users were unable to actualise certain affordances despite system delays. After experiencing anxiety and frustration, users were thus forced to bypass the EHR system, leading to undesirable consequences not intended by the system designer/implementer. A few of these consequences were immediate dysfunctional outcomes, e.g., direct undesirable consequences (e.g., longer patient visits). Yet the majority were undesirable indirect consequences as they were less measurable and often followed direct consequences (e.g., increased workload to general physicians) (Figure 4).



Note: The dotted lines indicate alternative paths: a technological constraint might lead to a psychosocial outcome either directly [a] or indirectly, by hindering the actualisation of another affordance [b].

Figure 4 Bypassing leading to undesirable direct/indirect consequences

4.3 Avoiding

The national health service makes agreements with private health organisations (e.g., hybrid health organisations) to satisfy the vast demand for public health services. Based on available spots, patients can take advantage of specialised medical consultations/treatment from hybrid health organisations for the same fee they would have to pay to public health organisations. Although hybrid health organisations had implemented the EHR system to facilitate their operations, they were often unwilling to use it because it created more work and was incompatible with their own systems. Besides, printing digital prescriptions incurred additional costs. This "avoiding" behaviour occurred when hybrid healthcare organisations were unwilling to use the EHR system, mostly due to organisational constraints. For example, several patients reported that they were often asked to bring physical printouts of the digital prescriptions since the hybrid health organisations

did not wish to incur the additional cost of printing the prescriptions. The printed prescriptions were used to manage the internal bureaucratic procedures, such as attaching unique codes and writing notes, which later were used to complete the payment of these services. There was even a notice at the entrance that only printed digital prescriptions were accepted.

Hybrid organisations' refusal to "visualise the digital prescription" was a source of frustration for the patients who had not printed the digital prescriptions but had to go outside the health organisation to find a copy centre. Upon reaching the copy centre, patients sent their digital prescription via email to have it printed by the centre employees, thus sharing private medical information with someone other than the authorised care actors, as a patient said:

> *I showed my health card to the receptionist, but she looked at me astonished and said she needed the printed version of the digital prescription to proceed with the appointment, but I did not have it. My general physician said go just with the health card, because they have already all the information. Instead, she showed me the notice on a white board confirming that they accept only printed digital prescriptions. So, I had to go to the copy centre, print it and come back. Now, I always print them to avoid this.*

After the medical visits, specialised doctors could write and save the results in the EHR system, which could be consulted by patients, their general physicians, and other physicians linked to patients' treatment anytime and anywhere. However, after each visit, specialised doctors would save the results in their internal health records systems rather than the EHR system. These were then printed, and patients were informed when they could collect a printed copy of their results at the hybrid health organisations. The unwillingness of the hybrid health organisations to use the system led to the non-actualisation of affordances (e.g., writing and delivering digital medical results) necessary to achieve intended outcomes such as information sharing/integration. This in turn became a constraint to the actualisation of other affordances (e.g., "receiving patient medical results") and a source of frustration for both the patient and the general physicians, who were forced to actualise alternative affordances to achieve their goals, such as "scanning and saving patients' paper results" in the EHR system. Thus, contrary to the expectations created by the EHR system implementers, general physicians and patients could not benefit from accessing patients' information provided by other care providers (e.g., *increased workload to general physicians/patients*).

We find another example of the avoiding behaviour from patients who did not want to engage with the new EHR system. Their unwillingness to request digital prescriptions online was

a cause of frustration for other users, such as general physicians or administrative assistants, who then had to actualise alternative affordances to accomplish their goals. One patient said:

> *I did that computer job at the hospital, where my husband was the first programmer. I worked with computers and programs all my life. When I retired, I said no technology anymore. I just didn't want to know any more about technology. I've never used the mobile app. I call or go directly to the physician to ask the renewal, then I go to the pharmacy.*

After she retired, this patient, who had worked with computers and technologies for many years, refused to use any IT systems. She preferred to call or go directly to the physician to request the renewal of the prescriptions. Consequently, the physicians dealt with this situation by meeting with the patient in the outpatient clinic, writing the digital prescriptions with the system, printing, and physically delivering them to the patient, who then went to the pharmacy to collect the medicines. This increased workload for general physicians, which was an undesirable indirect consequence.

To summarise, *avoiding* occurred when care actors were unwilling to use the EHR system due to organisational or psychosocial constraints. Their refusal to use the system undermined the actualisation of affordances that would realise intended outcomes. This constrained the realisation of the system's affordances by other users, who dealt with the negative psychosocial outcomes arising from this situation through *flexing*, e.g., by actualising alternative affordances to achieve their goals. Avoiding led to an undesirable indirect consequence not intended by the system designers and implementers (Figure 5).

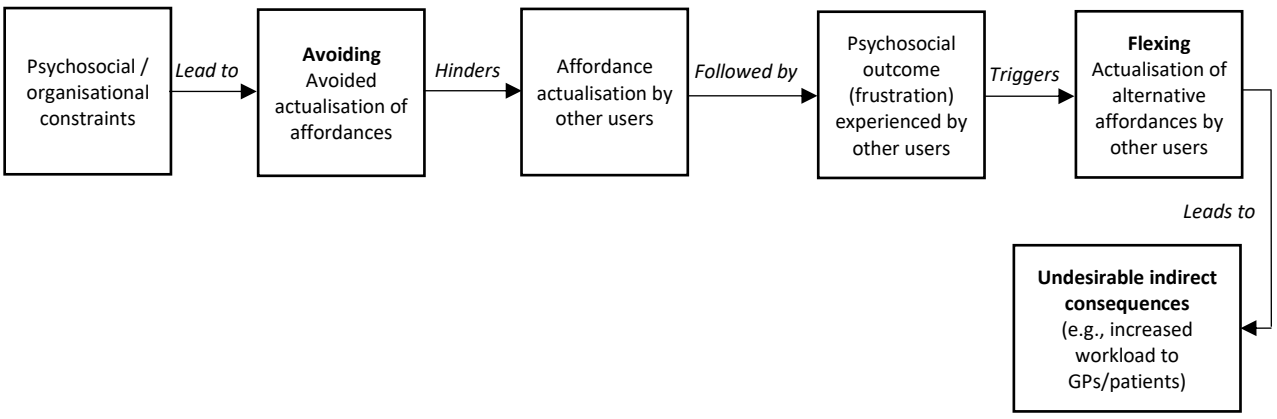


Figure 5. Avoiding leading to undesirable indirect consequences

4.4 Reorganising

Care actors could access patients' medical information anytime/anywhere if they were authorised users and could connect to the EHR system. Greater flexibility in organising the work (an organisational enabler) allowed general physicians to separate administrative work from care work. General physicians felt excited by the possibility of doing administrative work after patients' office hours. This allowed them to devote most of their time during the medical visits to the provision of care services while they managed patient data and monitored their health status outside the outpatient clinic at home, where they could write digital prescriptions. This *reorganising* of tasks led to *new work routines conducive to high productivity* since physicians could complete necessary tasks in a more focused way with uninterrupted use of their time. A general physician mentioned:

> *We certainly saw that in the waiting room in the clinic there are less patients for administrative requests, which I manage... at home. Instead of doing medical prescriptions here in the laboratory, I do that at home with less interruptions from the patients.*

Interestingly, the availability of human resources such as personal assistants (an organisational enabler) allowed general physicians to use the EHR to reorganise work in their practice. Physicians could free up some tasks during the patient's visit. At the same time, personal assistants were excited by the possibility of performing new tasks and being more involved in delivering care services. This motivated physicians and personal assistants to use the EHR to *reorganise* their tasks. For example, after receiving patients' requests for digital prescriptions during busy days, general physicians delegated the actualisation of the affordance "writing digital prescriptions" to their personal assistants, who inserted the necessary information in the digital prescription and saved it in the EHR system. Later, the physicians checked and delivered the digital prescriptions to the patients. This reorganising of tasks led to *job enhancement for physician assistants* by enabling the actualisation of affordances provided by the new system. A general physician explained:

> *The work of my assistant has changed a lot in the sense that in the past she was delivering lots of paper to all places all day long, but now this type of activity has dropped a lot. Now, she does more useful things. Sometimes I delegate my assistants to make the prescriptions…, they save them in the system, then I check them and directly send them to the patients.*

Moreover, before the use of digital prescriptions, patients received paper prescriptions from their general physicians and tended to go to the closest pharmacy to receive the prescribed medicines because they did not want to forget or lose the prescriptions at home or in other places. Thus, the pharmacies located in proximity of general physicians' outpatient clinics traditionally had more clients compared to those located in rural areas. The introduction of digital prescriptions opened *new opportunities for pharmacists located in rural areas,* a desirable indirect consequence. Since patients could receive digital prescriptions anytime (e.g., at home or work), they could visit any nearby pharmacy at any moment and receive the medicines by showing the digital prescriptions and their health card. A pharmacist asserted:

> *This system allows pharmacists like us in rural areas to have the same ability as pharmacists in big cities to satisfy customers' needs.*

In addition, pharmacists were excited by the possibility of serving customers more efficiently and becoming more competitive thanks to the process change they underwent after investing in the new EHR system (an organisational enabler). This motivated pharmacists to make changes in the way they served their patients. For example, when patients go to the pharmacy to get the prescribed medicines, the pharmacist can visualise the digital prescriptions with the barcode reader, deliver medicines more quickly, and have more time to consult their clients. This *reorganising* resulted in *job enhancement for pharmacists,* who felt that the local health system recognised the importance of pharmacists' work as one of them pointed out:

> *We save some time when all info is already in our system so we can talk with the clients, build a relationship. We often advise [patients] on which medicine is better among the general ones considering their allergies and other peculiarities. We also contributed to the name of the mobile app, this is rewarding because I feel appreciated by the local [health] system, I feel I am more part of it now.*

To summarise, users were excited by the possibility of using the system to improve their work thanks to organisational enablers such as work flexibility and the availability of resources. This motivated them to reorganise their work through the enhanced actualisation of certain affordances. This resulted in unintended desirable indirect consequences, such as higher productivity, new business opportunities, and job enhancement (Figure 6).

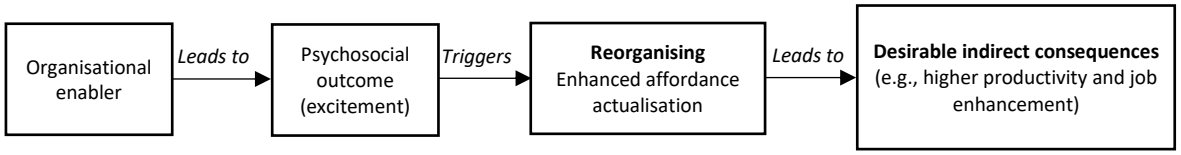


Figure 6 Reorganising leading to desirable indirect consequences

5. DISCUSSION

5.1 Integrative discussion of the findings

The objective of this study was to identify how unintended consequences emerge from the implementation of an EHR system. Through the lens of affordance-actualisation theory, we have identified four types of user actions – flexing, bypassing, avoiding, and reorganising – which are associated with different types of unintended consequences. The significance of revealing these types of actions is to provide a greater understanding of the underlying processes of generating unintended consequences, specifically how different socio-technical factors lead to the (non-)actualisation of affordances essential for achieving the outcomes intended by system designers or implementers.

Flexing and *bypassing* provide us with a greater understanding of the unintended consequences arising from technostress, a psychosocial outcome that has been widely studied in prior literature (e.g., Califf et al., 2020). First, we find that technological constraints are also a major source of technostress since users cannot actualise the affordances they need to achieve their goals. While the literature does not elaborate on the type of unintended consequences that could arise from users' responses to technostress, *flexing* and *bypassing* explain two possible types of unintended consequences.

Through *flexing*, users find ways to use the system despite constraints by actualising alternative affordances or by actualising certain affordances with delays. This results in dysfunctional immediate outcomes or undesirable direct consequences (e.g., delays in receiving medicines). By contrast, *bypassing* occurs when there are no comparable system affordances that allow users to achieve their goals in the face of insurmountable technological constraints emerging from a missing affordance (e.g., the lack of confirmation for a digital prescription request), or the lack of users' abilities to realise affordances supported by the system (e.g., patients having the will but lacking the skills and confidence to use the system), also in combination with a system malfunction (e.g., physicians' impossibility of writing a digital description due to system delays and poor IT skills). This leaves users with no choice but to find solutions to constraints by

bypassing the system. *Bypassing* is mostly associated with undesirable indirect consequences (e.g., increased dependence on patients' families).

Previous research has shown how tweaks, workarounds, and unintended use might emerge from different affordance actualisations due to limited users' skills and problematic system features (Anderson & Robey, 2017). The comparison between flexing and bypassing shows how similar technological constraints may lead to different actions responsible for unintended consequences depending on whether such constraints arise from system malfunctions only or from the interaction of system malfunctions and psychosocial constraints, such as poor IT skills. For example, through *flexing*, physicians could manage the anxiety arising from delays in writing a digital prescription due to a slow system response by juggling different tasks during patient consultations. This allowed them to write a digital prescription, albeit with some delays. By contrast, the combination of a slow system response with physicians' poor typing skills led to even further delays and anxiety to the point where physicians resorted to *bypassing* the system altogether and writing a paper prescription instead. Therefore, while bypassing occurs due to insurmountable technological constraints, such as those arising from missing affordances, in some cases, technological constraints may become insurmountable when emerging from system malfunctions in combination with psychosocial constraints. When lacking the abilities to use technology in the face of system malfunctions, users may experience even greater technological constraints, which are harder to overcome. The different nature of constraints users face explains the extent to which users manage to deal with technostress, whether *flexing* or *bypassing* is enacted, and what unintended consequences follow. Undesirable direct consequences are mostly associated with flexing since users can still realise their goals by actualising the system affordances, albeit with immediate dysfunctional outcomes. By contrast, all instances of bypassing were associated with *at least one* undesirable indirect consequence.

The next type of action is *avoiding.* In this case, hybrid healthcare organisations and some patients were *unwilling* to use the system mainly due to organisational and psychosocial constraints to using the EHR system. Avoiding differs from bypassing, in which users are *willing* to engage with the system but cannot actualise its affordances due to constraints. Avoiding reflects users' resistance to a system, an unintended consequence widely documented in the healthcare IS literature (e.g., Kumar et al., 2022). A major implication of *avoiding* is to show how the non-actualisation of affordances arising from users' resistance to a system constrains other users. Other users are then forced to deal with the stressful situation caused by this constraint by actualising

alternative affordances to achieve their goals. For example, because hybrid healthcare organisations refused to use the system, affordances that were essential to achieve intended outcomes (e.g., visualising digital prescriptions) were not actualised. This forced other EHR users to actualise alternative affordances (e.g., patients printing digital prescriptions) to achieve their goals. Avoiding led to an increased workload for general physicians and patients, an undesirable indirect consequence. This shows how negative consequences from users' resistance to a large-scale EHR system have wider ramifications for the actualisation of affordances by other users in other parts of the system. This, in turn, may result in further undesirable unintended consequences.

Our last type of action is *reorganising*. The actualisation of affordances through reorganising led to desirable indirect consequences above and beyond the outcomes intended by the designer and implementer. Users could actualise the affordances necessary to achieve intended outcomes thanks to organisational enablers. For example, instead of writing digital prescriptions during hospital work, some physicians took advantage of work flexibility and the possibility of separating administrative work from care work to actualise this affordance anytime (e.g., after patients' office hours) or anywhere (e.g., at home). Others exploited similar organisational enablers by delegating the actualisation of this affordance to their administrative assistant and subsequently delivering the digital prescription to patients themselves. The availability of extra organisational resources, such as administrative assistants, was a key enabler of this reorganisation of work.

An important implication of reorganising is to show how job augmentation and professionalisation opportunities from IT adoption (Petrakaki et al., 2012) depend on users' ability to creatively exploit a system's affordances to reorganise their work with the support of organisational enablers. By doing so, physicians succeeded in actualising the system's affordances and delivering digital prescriptions to patients while avoiding their care work being disrupted by a slow system response. This process contrasts with flexing, where users struggle to deal with disruptions caused by technological constraints by actualising alternative affordances or by actualising affordances with delays. This then led to immediate dysfunctional outcomes (or undesirable direct consequences). On the other hand, through reorganising, the enhanced actualisation of affordances resulted in desirable indirect consequences, such as job enhancement. The system designers and implementers did not originally intend these functional outcomes since their original aims were mainly to save time, reduce costs, and share information. Therefore, they

occurred as unplanned positive organisational outcomes broader than process-level outcomes. An overview of the four types of actions is provided in Table 3.

Table 3 Users' actions by which affordance actualisation leads to unintended consequences

Users' actions	Affordance actualisation	Unintended consequences
Flexing	Users find ways to use the system despite constraints by actualising alternative system affordances or by actualising affordances with delays	Undesirable direct consequences
Bypassing	Users are forced to bypass the system due to constraints, resulting in the non-actualisation of affordances	Undesirable direct/indirect consequences
Avoiding	Users refuse to use the system, avoiding the actualisation of affordances. This might hinder the actualisation of other affordances by other users	Undesirable indirect consequences
Re-organising	Users use the system to reorganise work through the enhanced actualisation of system affordances	Desirable indirect consequences

Note: Intended and unintended consequences are from the EHR system designers'/implementers' perspective

5.2 Implications for theory and practice

Our findings offer new insights for research investigating the unintended consequences of technological artefacts (Harris & Ogbonna, 2002; Leslie, 2019; Majchrzak et al., 2016; Parks et al., 2017; Tim et al., 2018). Extant literature has not provided sound theoretical explanations for how unintended consequences unfold. Drawing on affordance-actualisation theory, our study fills this gap by uncovering four types of users' actions through which unintended consequences emerge during an EHR implementation. The four types of actions provide an integrative understanding of how socio-technical constraints and enablers influence users' actualisation of affordances, which then generates different unintended outcomes. For example, previous research shows how users may either stop using an EHR system (Pouloudi et al., 2016) or use it through workarounds (Anderson & Robey, 2017) due to technostress (Califf et al., 2020; Kummer et al., 2017). Our study's contribution to this literature is to demonstrate how these different outcomes depend on the different nature of constraints to the actualisation of affordances. This explains whether users deal with technostress emerging from such constraints either through flexing or bypassing.

Our study also extends the practitioner-oriented literature. The literature has identified system complexity, hybrid paper and electronic records, and poor IT skills as some of the leading causes of unintended consequences from using health IS (Rohani & Yusof, 2023). Our research suggests that the true implications of these factors in generating unintended consequences can be

understood more clearly by tracing their impact on the actualisation of a system's affordances and users' workarounds (e.g., flexing or bypassing) in response to constraints to affordance actualisation.

The DOI-based typology is a useful theoretical framework that helps us classify unintended consequences identified from our data. This allows us to show how different types of actions for the actualisation of affordances are associated with different types of unintended consequences that are negative or positive. For example, flexing may lead to undesirable direct consequences since it allows users to still achieve their goals by actualising alternative affordances or by actualising affordances with delays, albeit with some immediate dysfunctional outcomes. Undesirable indirect consequences are more likely to happen through bypassing.

These findings respond to prior literature's call for exploration of the actualisation of affordances, the difficulties actors encounter during their actualisation journey, and the outcomes that emerge from this journey (Burton-Jones & Volkoff, 2017; Strong et al., 2014; Tim et al., 2018; Volkoff & Strong, 2013). Specifically, we advance the affordance actualisation perspective by showing how the (non-)actualisation of affordances essential for achieving intended outcomes may generate unintended consequences. *Flexing* shows the importance of alternative affordances and users' abilities in overcoming technological constraints, thereby enabling users to achieve their goals, even though with immediate dysfunctional outcomes. *Avoiding* shows the importance of dependencies between affordances (Burton-Jones & Volkoff, 2017; Leidner et al., 2018) to generate benefits across the health system. If one group of users does not actualise affordances needed by other users in another part of the system, then the benefits of the EHR remain unrealised across the whole health system (Burton-Jones & Volkoff, 2017). Our contribution is to show how some users' resistance to the EHR may induce other users to actualise alternative affordances. This allows them to reduce their dependence on other actors of the health system and reap the benefits of the system, if not in full, at least in part.

Our study also contributes to research on positive unintended consequences by revealing how IT affordances can enable job enhancement (Bernardi et al., 2019; Petrakaki et al., 2012). First, through the example of reorganising, we highlight the importance of organisational enablers such as organisational resources for achieving this outcome. Second, we show how achieving these positive but unintended consequences depends on users' effort to creatively exploit a system's affordances to reorganise their work and avoid potential disruptions.

Finally, our study contributes to a more refined conceptualisation of constraints within affordance theory in information systems research. Existing research has conceptualised technological constraints as emerging from the properties of technology hindering the realisation of users' goals (Leonardi, 2011). Technological constraints emerging from the lack of functionalities necessary for the realisation of users' goals have also been defined as missing affordances (Volkoff & Strong, 2013). While the literature has recognised that users might fail to perceive an existing affordance due to their limited abilities to use technology (Volkoff & Strong, 2013), how users' abilities relate to technological constraints, both conceptually and empirically, has never been addressed. Our study fills this gap by conceptualising limited users' abilities as psychosocial constraints which, together with users' goals, are part of users' characteristics and therefore contribute to users' perception of technological constraints. Furthermore, our case study shows the implications of psychosocial constraints in augmenting users' perception of constraints emerging from the properties of technology such as system malfunctions. With the example of bypassing, we show how the emergence of technological constraints from system malfunctions and psychosocial constraints is more likely to lead to undesirable indirect consequences.

This study has significant implications for practice. Practitioners should be aware that it is not uncommon for unintended consequences to occur when implementing EHR systems. Therefore, when planning and implementing an EHR system, they should seek to identify possible unintended consequences, assess their potential impacts, and be prepared to deal with them if they occur. Our comprehensive framework of the unintended consequences can serve as a framework for managers to communicate and make sense of those risks and develop strategies to cope with them. Managers need to address technological, psychosocial, and organisational barriers and address them to minimise the likelihood of unintended negative consequences. Managers should also be aware of and leverage positive unintended consequences to maximise the benefits of the system. This research informs practitioners that the outcomes of the same system implementation could be perceived differently by different users and stakeholders. Therefore, gathering feedback from all types of users is crucial to accurately evaluate the new system's benefits.

5.3 Limitations and future research

This study has several limitations. First, the generalisability of results from case study research is typically limited (Yin, 2014). Instead of generalising research findings to other contexts or populations, generalisation in case study research involves the development of a theory that helps

make sense of similar processes or situations (Huberman & Miles, 2002). We acknowledge that the patterns of relationships we have identified may not be exhaustive of the relationships that could be found in other case studies of EHR adoptions. For example, other case studies of EHR adoptions may find that technological constraints leading to flexing or bypassing result from organisational constraints rather than psychosocial constraints or technical malfunctions. Nevertheless, the four types of actions we have identified provide broader theoretical implications that can be generalised to other cases of EHR adoptions in healthcare contexts (Yin, 2014). The generalisability of our findings is also supported by other literature that has found similar patterns of relationships and outcomes. For example, technostress resulting from technological constraints has been widely studied as a source of workarounds and unintended consequences in the EHR/health IS literature (Anderson & Robey, 2017; Califf et al., 2020). Bypassing and flexing show that not all workarounds are the same and may lead to different outcomes regarding affordance actualisation and unintended consequences. We acknowledge that avoiding may not always lead to flexing. For example, there could be instances of avoiding that lead to other users bypassing a system. Nevertheless, the broader theoretical implications of avoiding are confirmed by the literature showing that the (non-)actualisation of affordances in one part of an EHR system may have implications for the actualisation of affordances in other parts (Burton-Jones & Volkoff, 2017). Specifically, we show how the unwillingness to use a system by some users may be a source of constraint to other users, who are then forced to either look for alternative affordances through flexing or, if the actualisation of these affordances is not possible, by bypassing the system to actualise their goals.

Second, our findings were mainly based on various stakeholders' perceptions of the EHR system implementation outcomes, even if project reports and government documents were also analysed. Although perception data offer important insights, objective data can offer additional insights through quantifiable, tangible evidence. For example, whether the EHR system reduced or increased time and cost can be measured objectively. However, such data were not available for this study. We encourage future research to use mixed methods combining perception data and objective data to corroborate the findings.

Third, we conducted our study shortly after the EHR system was implemented. Therefore, this study does not offer insights into how unintended consequences evolve and unfold in the long term. Longitudinal field research would be desirable to investigate the evolution of the unintended

consequences as the EHR system goes through a life cycle of implementation, adoption, use, modification, and maintenance.

Fourth, our study's focus on unintended consequences is limited to the perspective of implementers and designers. Considering users' and managers' perspectives may yield different results. For example, some patients might consider having to visit the doctor after experiencing system constraints as a desirable unintended consequence, while managers and doctors might consider this an undesirable unintended consequence. Future research should investigate the emergence of unintended consequences from the perspective of managers and users, particularly when stakeholders hold different expectations from system implementations.

Finally, although this research identifies different types of unintended consequences and uncovers the types of actions through which they unfolded in healthcare organisations, it does not directly address how organisations can remove or minimise negative ones. We call for research to further investigate why and how different users experience different types of unintended consequences and what actions organisations can undertake to address the types of users' actions – flexing, bypassing, and avoiding – that lead to unintended negative consequences.

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APPENDIX

Table A1 Prior studies on intended consequences of EHR systems implementation

Intended Consequences	Study	Method	Findings
Saving time	Jian and Cameron (2020)	Literature review	The automatic data sharing with IT-based self-monitoring for chronic care (ITSM) decreases the time necessary to review and create personalized treatment plans, shows health patterns over time, and tracks the achievement of patients' goals. ITSM provides feedback and suggestions in real-time, which elicits better supervision and reinforcement effects.
	Rodon and Silva (2015)	Case study	Catalan health systems enable physicians to prescribe medicines in real time, regardless of their location.
	Feldman and Horan (2011)	Case study	The exchange of information with EHR improved task coordination and decision making, which helped to reduce the time individuals waited for disability benefit determination.
Reducing healthcare costs	Thompson et al. (2020)	Retrospective study	With the use of IT and analytics, care providers can optimally match care resources with patients' needs during the treatment process. This reduces costs.
	Yaraghi et al. (2019)	Field survey	When patients agree to disclose their medical information on Health Information Exchanges (HIE) platforms, care actors can avoid medical redundances, which decreases the cost of healthcare services.
	Ayabakan et al. (2017)	Field survey	The use of health information sharing technologies is associated with lower duplication of radiology tests across hospitals.
Improving care quality	Burton-Jones and Volkoff (2017)	Case study	The effective use of the EHR improves interprofessional, interorganisational collaboration in and between hospitals and improves the quality of the health data and its interpretation.
	Lin et al. (2017)	Field survey	The EHR-driven Bayesian multitask learning (BMTL) attains an improved predictive performance. Accurate predictions of future adverse health events enable providers to make personalized interventions and improve care quality.
Sharing and integrating information	Kohli and Tan (2016)	Literature review	EHR fosters medical information sharing with care providers to increase the visibility of treatment plans. It also facilitates the integration of patient health history from multiple sources.
	Pouloudi et al. (2016)	Case study	The infrastructure for secure sharing of information allows secure online access to personal health and care information for numerous stakeholders and facilitates the integration with other related systems.
	Strong et al. (2014)	Case study	The availability of medical information across care sites and roles is one of the most significant benefits. EHR fosters the communication between care providers.
Empowering patients	Bernardi and Exworthy (2020)	Case study	Health IT innovations promote health self-management and home-based monitoring to support patient-centred care. Patients are empowered to make informed decisions and have more control over their own health.
	Liu et al. (2020)	Field survey	Physician-driven online health communities engage patients in their care treatment by providing evidence-based information, which contributes to patients' capacity to be responsible for their own health and to self-manage tasks related to their health. Patients' participation improves patient well-being and patient–physician relationship.
	Fox and Connolly (2018)	Mixed method	Governments support healthy aging strategies to empower older individuals to self-manage their health. The use of digital artefacts fosters the development of proactive patients.

Table A2 Prior studies investigating unintended consequences as a primary focus

Unintended Consequences	Study	Method	Theory	Findings/Insights
User resistance; Too much time for entering data and less time for patient care; Hindering an emotional connection with patients	Kumar et al. (2022)	Case study	Bourdieu' social practice theory	Electronic Medical Records threatened medical dominance and social standing because it challenged doctors to build an emotional connection with patients, which was fundamental to continue their social standing.
Technostress, job dissatisfaction; Increased turnover for nurses Burnout, anxiety	Califf et al. (2020)	Mixed method	Technostress process	Technology-induced anxiety decreased nurses job satisfaction as they perceived the systems as a barrier to their task accomplishment and were likely to experience high turnover intention.
Resistance from older adults; Unauthorised secondary use of data; Unwillingness to track sensitive health conditions; Inaccurate data	Fox and Connolly (2018)	Mixed method	Protection motivation theory, Social cognitive theory, Information privacy	Low mobile self-efficacy is a major barrier to m-health adoption and health information disclosure among older patients due to the sensitivity of health data. Health information privacy concerns, risk, and trust beliefs are interconnected and their influence reduced m-health adoption. Older patients need educational programs to improve their privacy literacy for protecting their personal information while using m-health.
Perceived technology threats; Technology-induced anxiety, Diminished usage intentions	Kummer et al. (2017)	Survey	Technology-induced anxiety	Nurses perceived the new support system as a way for worsening their work status by decreasing their decision power and appreciation. This created anxiety and increased workload rather than improving their efficiency.
Perceived inclusion to a larger health service network; Rise in responsibilities to make a professional judgement; Improved market position of marginalised pharmacies	Petrakaki et al. (2012)	Case study	Agency view of technology, Professionalisation	Digital transmission of prescriptions made the dispensing process temporally dispersed, which provided more autonomy to regulate labour and schedule workload of the pharmacists. They could dispense medicines faster and had more time to perform front-office clinical work and to increase pharmacists' professional power.

Table A3 Prior studies reporting unintended consequences as secondary findings

Unintended Consequences	Study	Method	Findings/Insights
Increased workload of primary and community care; Lack of safety of patients; Lack of doctors for monitoring the telehealth system	Bernardi and Exworthy (2020)	Case study	The telehealth project was not approved due to the tension between the logics of patient centred care, managerialism, and medical professionalism. Uncertainty of patient safety and lack of sufficiently trained health care professional to monitor telehealth would increase the heavy workload of primary, community care.
Augmenting one's role and improving one's social status	Bernardi et al. (2019)	Case study	Health Information Systems enabled the collection and analysis of electronic data to advise health managers. The systems augmented HIS Officers' role and deinstitutionalized the ineffective use of health information in the counties.
Increased clinical knowledge; Simplification of information processing tasks	Hansen et al. (2019)	Case study	Informed collaboration mechanism, where the distribution of work is a major obstacle to successful deployment. System moves towards resolution of collective objectives with a propagation mechanism.
Fragmented information sharing; Incomplete, incorrect medical histories; Restricted access to medical records to retain patients	Yaraghi et al. (2019)	Field survey	Privacy decision making in the Health Information Exchange is a two-stage sequential model, where medical provider influences patients' decision by offering recommendation. However, patients cannot use the system if the medical provider did not ask a patient consent. The patient considers not only the recommendation but also evaluates the risks and benefits of the consent.
Functionalities used for nonwork; Subgroups built for discussing internal, highly specialized topics	Mettler (2018)	Action design research	Health workers adopted unintentional usage patterns or expressed ideas outside the initial project scope because the other social media applications were blocked and due to the lack of adequate coordination mechanisms.
Tweaks and workarounds; Decreased attention to patients	Anderson and Robey (2017)	Case study	Differences in how system features were implemented and the variations of the abilities of real users in the actual context changed users' work practices. A range of actualisations across users, work environments emerged with tweaks and workarounds.
Clinical resistance; Poor performance; Concerns about lack of control; Lack of privacy and security	Pouloudi et al. (2016)	Case study	Concerns about security of patient data, lack of involvement in policy, poor technical infrastructure, and perceived concerns of lack of control triggered a high level of resistance to the national IT infrastructure.
Loss of productivity; Increase in documentation tasks; Unexpected use patterns	Strong et al. (2014)	Case study	Individual differences across roles created variation in EHR use, some of these productivity tools were not used because standardized templates were difficult to use, slow typing skills, which increased physician's workload. Care actors perceived loss of professionalism and time.
Increased diversity in practice; Oppositional tendencies towards unity across multidisciplinary team practice	Oborn et al. (2011)	Ethno-graphic study	The introduction of Electronic Patient Record resulted in mismatches between the system design and medical practices. The practices to accommodate the system in medical work prompted diversity in practice as the standardization process was problematic, satisfied only few specialists.
Increased workload; Procedural issues; Operational complexity and fragility	Davidson and Chismar (2007)	Case study	Institutionally and technology-triggered mechanisms change role structures and tasks which then increase procedural complexity and hospital staff workload undermining intended outcomes (e.g., cost-reduction).