Scoping review of health system software literature: how has the concept been used?

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Preamble

Plagiarism declaration

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Preamble

Abstract

Understanding health systems as comprising interacting elements of hardware and software acknowledges health systems as dynamic, complex adaptive systems (CAS). The hardware represents the concrete components of systems, whereas the software represents the elements which influence actions and underpin relationships, such as processes, values and norms. As a specific call for research on health system software was made in 2011, we conducted a qualitative scoping review considering how and for what purpose the concept has been used since that time. As it has remained relatively under-researched, our overall purpose was both to synthesise current knowledge and to generate lessons about how to deepen research on, and understanding of, health system software. The review consisted of two phases: first, all papers which have explicitly used the concept of health system software were mapped; second, we explored how this concept was purposively used within research. The databases Pubmed, Scopus, EBSCOhost, Web of Science and Google Scholar were systematically searched using a strategy developed by a skilled librarian. In Phase 1, data were extracted from 98 papers to understand the scope of this literature. Our analysis revealed that a third of the papers used the software concept rather superficially; a third used it to conceptualise the importance of some software elements; and a third used it in relation to another aspect of health system experience, such as preparedness or resilience. In Phase 2, our analysis confirmed the value of pro-actively using the software concept within studies, demonstrating two patterns of use. However, limited understanding of how to investigate interactions amongst hard- and software elements was also revealed. Future health policy and systems research should purposively investigate hardware-software interactions, in order to gain greater understanding of the complex, adaptive nature of health systems.

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Acronyms and abbreviations

ART	Anti-retroviral Therapy
CAS	Complex Adaptive Systems
CHW	Community Health Worker
ELA	Expected Levels of Achievement
FHS	Faculty of Health Sciences
HCW	Health Care Worker
HIV	Human Immunodeficiency Virus
HPSR	Health Policy and Systems Research
HR	Human Resources
IPC	Infection, Prevention and Control
LMIC	Low- and Middle-Income Country
TB	Tuberculosis
UCT	University of Cape Town
UTT	Universal Test and Treat
WHO	World Health Organisation

Glossary of terms

Complex adaptive system	A system which is characterised by the relationships and interactions between their various components (Adam and de Savigny 2012)[1]. They are self-organising, and influence and are influenced by the context in which they are embedded (Russell et al. 2013)[2].
Health policy and systems research	A multidisciplinary field which "seeks to understand and improve how societies organize themselves in achieving collective health goals, and how different actors interact in the policy and implementation process to contribute to policy outcomes." (Gilson 2012, p.19) [3]
Health systems	The organisations, people and activities which aim to improve population health and health equity, provide responsive, efficient healthcare and protect people from social and financial risk associated to healthcare (WHO 2007)[4].
Health system software	The factors which guide actions and which underpin relationships within a health system, such as value, norms, processes and attitudes (Elloker et al. 2012[5]; Sheikh et al. 2011[6])
Health system hardware	The visible, infrastructural and concrete components within a health system, such as buildings and equipment (Elloker et al. 2012[5]; Sheikh et al. 2011[6])

[1] Adam T, de Savigny D. 2012. Systems thinking for strengthening health systems in LMICs: need for a paradigm shift. *Health Policy and Planning*, *27*, pp.iv1-iv3. http://www.jstor.org.ezproxy.uct.ac.za/stable/45090874

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[3] Gilson L. 2013. *Health policy and system research: a methodology reader: the abridged version*. World Health Organisation.

[4] World Health Organization. (2007). Everybody's business--strengthening health systems to improve health outcomes: WHO's framework for action. Geneva: World Health Organization.

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[6] Sheikh K, Gilson L, Agyepong IA, Hanson K, Ssengooba F, Bennett S. 2011. Building the field of health policy and systems research: framing the questions. *PLOS Medicine, 8*(8), e1001073. https://doi.org/10.1371/journal.pmed.1001073

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Part A: Protocol

Scoping review of health system software literature: how has the concept been used? A qualitative scoping review protocol

Introduction

Health systems seek to promote and improve health in a population. This is achieved through curative, preventive and health promotion services, as well as by impacting on social empowerment, health emergency preparedness and intersectoral action (Gilson 2013; Gilson et al. 2007). Therefore, health systems act as social determinants of health because they influence who, how and what type of health care population groups receive. Accordingly, health systems can either promote health equity, or inadvertently perpetuate injustice and social stratification by institutionalising health care arrangements “that create financial and geographic barriers to access for disadvantaged groups” (Gilson et al. 2007, p.viii).

There are varying and evolving understandings of health systems. The ‘systems thinking’ approach understands health systems as complex adaptive systems (CAS) (Adam and de Savigny 2012). CAS are characterised, in part, by the relationships and interactions between their various components (Adam and de Savigny 2012; Atun and Menabde 2008). In addition, CAS are self-organising, and influence and are influenced by the context in which they are embedded (Russell et al. 2013). Accordingly, systems thinking suggests that the components within systems should not be considered in isolation from each other. Instead, it is important to understand how the components of the system interact and influence one another in unpredictable and dynamic ways, to determine the behaviour of the system as a whole. This perspective enables a better understanding of the challenges that plague health systems, as well as the development of solutions to those challenges that account for interdependence between system components (Adam and de Savigny 2012). Recognition of these dynamic interactions is critical in understanding how health systems work and what influences progress towards health system goals.

One way of thinking about health systems that takes these dynamic interactions into account recognises that systems are comprised of interacting hardware and software elements. It views health systems as CAS and asserts that system capacity relies on the complex interactions amongst these elements (Elloker et al. 2012). The hardware represents the visible, infrastructural and concrete components of the system, while the software represents the factors which guide actions and which underpin relationships such as value, norms and attitudes (Sheikh et al. 2011).

History of Hardware-Software Conceptualisation of Health Systems

Health policy and systems research (HPSR) has long acknowledged that the hardware-software conceptualisation of health systems is important to overall health system performance (Elloker et al. 2012; Sheikh et al. 2011; Blaauw et al. 2003). However, HPSR have mainly focussed on the hardware components, neglecting health system software (Ramani et al. 2022; Bennett et al. 2011; Sheikh et al. 2011; Blaauw et al. 2003). This is likely related to the tendency within health system development, often driven by donor interests in observing measurable returns on investment, to focus on short-term operational needs such as specific health interventions or changes in hardware elements like buildings and equipment for example (Sheikh et al. 2011).

Focussing on the concrete and mechanical components of a health system might also be due to the dominant tendency towards a positivist paradigm within wider health research, because of the apparent value-neutrality of this paradigm. From this perspective, health systems are seen as "vehicles for technological solutions rather than being grounded in political and social contexts with underlying power structures, interests, and interdependencies" (Sheikh et al. 2011, p.4). In addition, software elements are assumed to be difficult to unpack and discuss, potentially sensitive and difficult to change (Ramani et al. 2022). The lack of conceptual clarity about what constitutes 'software' may itself, then, partly explain why the topic is often neglected (Sheikh et al. 2011).

Blaauw et al. (2003) provide other reasons for the neglect of software factors. Firstly, organisational theory (which is an important foundation for understanding complexity in organisations) is often considered to apply only to the private corporate sector. However, this is not the case as these theories have been developed to apply generically, across the public and private sectors.

Secondly, Blaauw et al. (2003) point out that health system researchers often take a macro perspective of the health system. By doing so, it is assumed that components 'higher up' in the health system structure can easily be rearranged. These 'higher up' components could be decisions made by actors far up in the hierarchy, such as new budget allocations to a specific intervention. However, as other authors note, for example Walt (1994), by assuming health system decision-making is a 'top-down' and linear activity, we fail to recognise the dynamic and continuous loop of decision-making, better represented in the 'bottom-up' approach. The bottom-up approach recognises the importance of actors 'lower down' in the health system, and acknowledges that these actors shape policies while implementing them. As such, the bottom-up approach takes a more micro-level viewpoint, acknowledging that individual behaviour and social dynamics at the local level are equally important in shaping health system performance (Blaauw et al. 2003).

This notion that actors at a local level are important is also demonstrated in street-level-bureaucracy theory. This theory acknowledges that frontline workers who engage regularly and directly with citizens (street-level bureaucrats) hold discretionary power, because they make decisions regarding the services received by citizens (Lipsky 2010). However, the tendency to take a macro-level view of the health system, has meant that the influence of individuals, social dynamics and the discretionary power of street-level bureaucrats have been neglected in health system debates, thereby ignoring critically important health system software.

In 2010, the First Global Symposium on Health Systems Research was held in Montreux. The symposium had a number of objectives, including to develop a global agenda within the field of HPSR to work towards universal health coverage. In response, following the symposium, three papers (Bennett et al. 2011; Gilson et al. 2011; Sheikh et al. 2011) were published that aimed to examine the challenges facing the field of HPSR, and to identify what was needed to support health system development and strengthening, especially in low- and middle-income countries. The three articles highlighted that research needed to be conducted on the social dimension of health systems, and called for theoretical development to understand the complex social contexts within which health systems exist (Bennett et al. 2011; Gilson et al. 2011; Sheikh et al. 2011). More specifically, theoretical development on health system software was called for, to develop foundations for future HPSR (Sheikh et al. 2011).

Taking Stock of Health System Software

Reviewing and taking stock of current literature is useful in building foundations for future research. Taking stock creates a synthesis of a topic which deepens understanding of the topic. It is suggested that "to take stock and analyse evolving landscapes" of various health system activities supports and better informs "further advancements in the field" (Shakarishvili et al. 2012, p.1).

Sheikh et al. (2011), for example, specifically called for the concept of software to be investigated in order to build a deeper theoretical understanding of the concept and so help deepen the foundations of HPSR. However, although the call for more research was made in 2011, no review has sought to investigate what research on software has been conducted since then.

Such a review could help researchers by, for example, considering the real world value of the concept and offering conceptual clarification about it. Both sets of insights would provide support for future HPSR explicitly considering health system software. For example, conceptual clarification could offer support for study design and for data analysis by making the hardware-software conceptualisation more accessible as a framework. Using frameworks enhances the rigour of qualitative research designs (Kegler et al. 2019), including by separating the interpretations of the researchers from the experiences of the participants, making the findings more transparent and credible (Ritchie et al. 2013).

Lastly, health system actors other than researchers may also gain value from such a review. For example, Nzinga et al. (2021) note that facility managers in Kenya gained value from learning about the hardware-software conceptualisation.

This study aims to review and take stock of how the concept of health systems software has been used since the call for more research by Sheikh et al. (2011) and also, to provide insights on how to use the software concept within future HPSR. The overall research question of this review is: How and for what purpose has the concept of health system software been used in HPSR since 2011?

Background: brief review of the literature on health system software

In this section, we discuss background research relevant to the concept of health system software. We begin by discussing the social perspective of health systems inherent to HPSR. This perspective underpins the hardware-software conceptualisation. Next, we review health system frameworks to position the hardware-software conceptualisation in the wider literature of HPSR.

The Social Dimension of Health Systems

Blaauw et al. (2003) suggest that three different perspectives can be taken on the human dimension of organisations: the mechanistic perspective, the economic perspective and the social perspective. These perspectives reflect different assumptions about human behaviour, and are rooted in different social science disciplines. The social perspective acknowledges the socio-cultural factors which are present within a health system. Blaauw et al. (2003) argue that while mechanistic and economistic assumptions have long dominated the discourse of public health research, these two perspectives neglect important social dimensions and so ignore an influential component of health systems. This is because social dimensions are argued to be a common source of health system problems and also, often the location of solutions for these problems.

In fact, "health systems are complex socio-cultural-political systems requiring sociological methods of enquiry" (Blaauw et al. 2003, p.11). The social perspective incorporates social complexity into conceptualisations of health systems' complexity. In this way, the social perspective extends our understanding of health systems as CAS, as Adam and de Savigny (2012) suggested, and helps make sense of the dynamic and unpredictable nature of health systems.

In addition, this social perspective is useful in understanding the relationships and influences amongst the various elements of a health system. Atun and Menabde (2008) describe health system outcomes as a result of interactions amongst the elements, rather than merely resulting from a change in one element. They emphasise that it is the interactions amongst elements which drive health system performance.

Together with interacting components, health systems are made up of people. People are social beings, and therefore there is inherently a social dimension within health systems (Sheikh et al. 2014). Health system actors shape decision-making, perform routine tasks, engage with one another, deliver the care and conduct the research (Gilson et al. 2011). They, therefore, interact with health system activities and influence them. Such arguments emphasise the importance of the social dimensions in health systems; social dimensions interact with health system components to influence health systems activity.

Blaauw et al. (2003) refer to the social interactions and relationships among health system actors when using the term 'social dimensions'. We extend its meaning to refer to the complexity of human nature which agents bring with them into a health system context. This complexity can arise through the values, norms, culture and emotions, for example, which human beings inherently introduce into health systems.

The Concept of Software

Within HPSR, the need to focus on the social dimension of health systems was first identified by Blaauw et al. (2003) and later on by Gilson et al. (2011) and Sheikh et al. (2011). Blaauw et al. (2003) introduce the term 'software' to address aspects of this social dimension. While system 'hardware' represents the technology, infrastructure, and economics of health systems, 'software' refers to the social components underpinning behaviours and actions of the people within the system, such as values, norms and relationships. Blaauw et al. (2003) argue that giving more focus to the 'software' could improve initiatives aimed at improving health system performance.

Similarly, Sheikh et al. (2011) call for more research to be conducted on the social dimensions of health systems in order to build theoretical foundations for understanding health systems. Sheikh et al. (2011) specifically use the term 'software' to conceptualise the underlying social dynamics, such as power and trust, which guide actions and underpin relationships within the health system. Elloker et al. (2012) also suggest that a health system's capacity to perform relies on this 'software'. They further distinguish tangible or intangible software, where the former consists of knowledge, skills and processes while the latter consists of relationships, values, norms, and forms of communication. While there are nuanced differences in the way Blaauw et al. (2003), Sheikh et al. (2011) and Elloker et al. (2012) use the term 'software', they ultimately refer to a similar set of concepts.

Health System Frameworks in relation to a Social Perspective of Health Systems

A preliminary review of health system frameworks and conceptualisations demonstrates the extent to which social dimensions of health systems has been relatively neglected in thinking, albeit with a few important exceptions.

The World Health Organisation's (WHO) widely applied building blocks model suggests that a health system is comprised of six elements, including service delivery, health workforce, health information systems, access to essential medicines, financing and leadership/governance (WHO 2007). However, WHO acknowledges that this framework does not consider the factors that drive health system actors to behave in certain ways. WHO also acknowledges that the social and economic determinants of health are not considered in this framework, despite being important features of health systems which have an impact on health outcomes (WHO 2010). Sheikh et al. (2011) describe the building blocks framework as trying to define a health system by its functional and instrumental mechanisms only, thereby neglecting the social dimensions of health systems.

Anand and Bärnighausen's (2012) framework highlights the vital role of the health workforce in meeting the goals of the health system, and draws attention to the interdependence between the health workforce and other health system elements. The authors argue that health workers should be placed at the core of a health system because "health workers perform most of the activities critical to the functioning of the health systems" (Anand and Bärnighausen 2012, p.190). These authors argue that while the building blocks model identifies health workers as merely one of the six 'building blocks', alongside service delivery, in reality service delivery is largely dependent on health workers. Anand and Bärnighausen (2012), therefore, argue that health workers should be centred in conceptualisations of health systems, because they are crucial to achieving health system goals. In other words, their framework places people (health workers) at the core of a health system.

Anand and Bärnighausen's (2012) conceptualisation is supported by Gilson et al. (2011), who note that health systems are "constructed through human behaviour and interpretation rather than existing independently of them" (Gilson et al. 2011, p.2). This highlights the importance of acknowledging health system actors as being central to health systems because they shape decision-making, perform routine tasks, engage with one another on a daily basis, deliver healthcare and conduct research (Gilson et al. 2011).

Although the Anand and Bärnighausen (2012) framework centres health workers, it does not fully explain how social dimensions affect health system activities. The framework indicates that health workers can be motivated and incentivised through financial or non-financial factors, but does not conceptualise the drivers of health worker behaviour or activities. In addition, it does not consider health system actors other than health workers, such as policy makers, advocacy groups, patients or the community at large who hold the power to influence health system activities. In short, the framework usefully suggests that health workers should be placed at the centre of a health system, but does not fully conceptualise the social factors which underly these actors' behaviours and activities, nor consider other influential health system actors who are not health workers.

Another conceptualisation of health systems which does explicitly acknowledge this social dimension is the health system dynamics framework by Van Olmen et al. (2012). This framework suggests that

a health system is made up of ten elements that interact dynamically, including goals and outcomes, values and principles, service delivery, the population, the context, leadership and governance, finances, human resources, infrastructure and supplies, and knowledge and information. The interaction amongst these elements is a result of health systems being made up of actors who play various roles. Because they are made up of people, "health systems are in essence social systems" (Van Olmen et al. 2012, p.4), in which actors interact in complex and unpredictable ways.

Van Olmen and colleagues also consider values and principles as factors shaping other health system elements. For example, values may influence whether health is seen as an economic good or a social good within a particular society, which in turn determines how health-care is accessed (Van Olmen et al. 2012). Ultimately, the Van Olmen et al. (2012) framework demonstrates the various interacting dimensions of a health system, and emphasises the complex interactions between elements, which themselves are influenced by health system actors and by wider societal values and principles. Unlike the building blocks model, this framework depicts the complexity of social systems by recognising values and principles as overarching influences on other elements. However, values and principles are just two examples of social elements which influence human behaviour. Therefore, the health system dynamics framework does not entirely capture the various ways that social dimensions influence health systems.

Hardware-Software Conceptualisation of Health Systems

The discussion of health system frameworks and whether they sufficiently incorporate social complexity leads us to the hardware-software conceptualisation as it offers one lens through which to capture this complexity. As already noted, Elloker et al. (2012) (see Figure 1), highlight three system dimensions. They categorise various parts of a health system as either hardware, tangible software or intangible software. They define tangible software as the "knowledge, skills and processes of decision making" (p.162) and intangible software as the "relationships, communication practices, values and norms" (p.162). Elloker et al. (2012) argue that organisational capacity rests on the interaction between hardware and software dimensions. This conceptualisation of health system capacity is drawn from Ortiz Aragón (2010), who posit that an organisation has 'hard' and 'soft' capacities and the interaction between them influences the ability of the system to achieve its objectives.

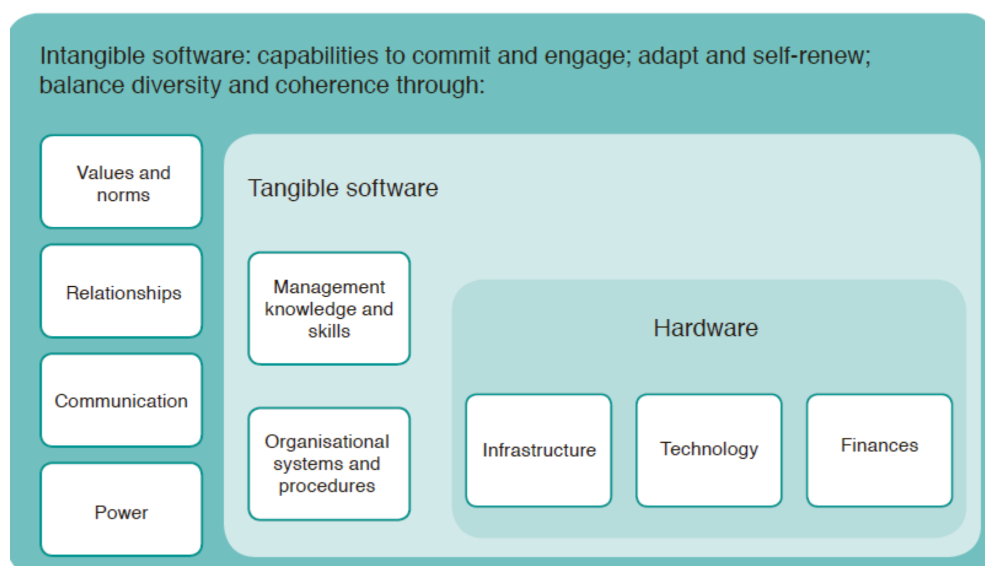

Figure 1. Hardware-software conceptualisation of health systems (Elloker et al. 2012)

As discussed previously, Blaauw et al. (2003) argue that health systems are complex systems because they are made up of "reflective, reactive and socially connected human beings," (p.8) and use the term 'health system software' to represents this human and social dimension of health systems. Sheikh et al. (2011) also use the term 'software' to refer to ideas, interests, values, norms and forms of power that guide actions and underpin the relationships within health systems. Like Blaauw et al. (2003), Sheikh et al. (2011) use 'software' in relation to 'hardware' (the visible, infrastructural, tangible and concrete components of health systems), and suggest that hardware and software interact, to influence health system performance. Elloker et al. (2012) also emphasise the importance of hardware and software interactions to health system capacity, although further categorising software as either tangible or intangible.

These papers (Elloker et al. 2012; Sheikh et al. 2011; Blaauw et al. 2003) use the term 'software' in similar ways to refer to social dimensions of health systems. While there are nuances in interpretation of using the term, software can be broadly conceptualised as the underlying components within a health system which drive relationships, behaviours and actions. These include values, norms (Ramani et al. 2022; Elloker et al. 2012; Sheikh et al. 2011), relationships, knowledge, skills (Ramani et al. 2022; Elloker et al. 2012), ideas, interests and affinities of power (Sheikh et al. 2011).

Usefulness of Research on Health System Software

The call for exploration of health system software is based on the notion that theories need to be developed which seek to explain the fundamental drivers of health system performance. Sheikh et al. (2011) argue that software factors are an important consideration for these explanations. A better understanding of how software factors influence health systems, therefore, could provide ideas about how to strengthen health systems towards improved health outcomes (Sheikh et al. 2011).

This point is reiterated by Elloker et al. (2012), who suggest that understanding the influence of software on policy implementations is important in considering how to achieve policy objectives. Gilson and Daire (2011) concur, arguing that structural change (that is hardware change) is insufficient in changing organisational culture within a health system. Rather, achieving policy goals requires embedding new values to bring about changes in organisational culture. In short, software factors are vital to the process of implementation, and therefore to achieving policy goals.

Systems theory suggests, moreover, that health systems are defined by the relationships between actors and system elements (Stacey et al. 2000 cited in Blaauw et al. 2003, p.36). Research on health system software, which improves our understanding of these relationships, can, therefore, aid our understanding of the factors that guide actors' behaviour and relationships, and is therefore critical to better understanding the dynamics of health systems.

With respect to HPSR, having a deeper understanding of software of health systems will help to gradually shift the focus away from research that ignores the social complexity of health systems (Bennett et al. 2011; Sheikh et al. 2011). Understanding the complex socio-cultural factors that drive health systems takes time and much thought, and may be a less direct approach to health system change than focussing on the hardware components (Bennett et al. 2011). However, understanding what drives health system performance, and how to approach the social complexity which is characterised in health systems may inform long-term solutions.

Initial review of Health System Software

A very preliminary search of the literature addressing 'health system software' since 2011 suggests that no review on the concept of software in HPSR has so far been conducted. Furthermore, the search suggested three ways in which the concept of software appears to be being used in HPSR, all of which are worthy of further examination.

Firstly, the software concept seems to be used simply to acknowledge that software factors are important to consider when thinking about health systems, or to acknowledge the hardware-software conceptualisation within broad health systems discussions. Secondly, the software concept may be used to justify a focus on a particular software element, such as trust (Aivalli et al. 2018) or power (Hirose et al. 2015). When using the term for this reason, authors justify looking at a phenomenon by conceptualising it as software. For example, Aivalli et al. (2018) argue that trust was worth investigating because it is a software element and therefore underlies human behaviour. The third use of the term initially noted, has been to explore how software influences various other aspects of health system experiences in HPSR, such as health system preparedness (Moussallem et al. 2022; Tshitenge and Nthitu 2022; Palagyi et al. 2019), resilience (Gooding 2021; Nzinga et al. 2021; Barasa et al. 2018; Barasa et al. 2017; Gilson et al. 2017), implementation (Magadzire et al. 2017) and performance (Topp et al. 2015).

Methodology

This qualitative review addresses the following research question: How and for what purpose has the concept of health system software been used in HPSR since 2011?

It will answer the question in two phases. The first phase consists of a scoping review of health system literature using the concept of health systems software. The second phase involves a more detailed synthesis of selected papers to explore how the software concept has been used to inform research designs. This will be done to gain knowledge and learnings from current research to inform future HPSR. The two review phases are described separately.

Phase 1: Scoping Review

In Phase 1 a systematic scoping review will be conducted to map the range of ways the concept of health system software has been used. Scoping review methods can be used to map the key concepts surrounding a topic and provide an overview of the existing literature (Munn et al. 2022; Peters et al. 2015; Arksey and O'Malley 2005). In addition, scoping reviews are useful for mapping a broad range of available material on a given topic (Arksey and O'Malley 2005).

A systematic scoping review uses a well-defined approach to review literature on a given topic. The study approach is explicitly described in detail, to ensure transparency and replicability (Butler et al. 2016). The Arksey and O'Malley (2005) framework will be used as to guide this scoping review to achieve in-depth descriptions of how and for what purpose the concept of health system software has been used. The framework consists of five steps:

1. Identify the research question
2. Identify relevant literature
3. Study selection
4. Data extraction
5. Data analysis

The first step, identifying the research question, has been presented. The subsequent steps will be discussed in more detail below. A summary of the scoping review methodology is presented in Figure 2.

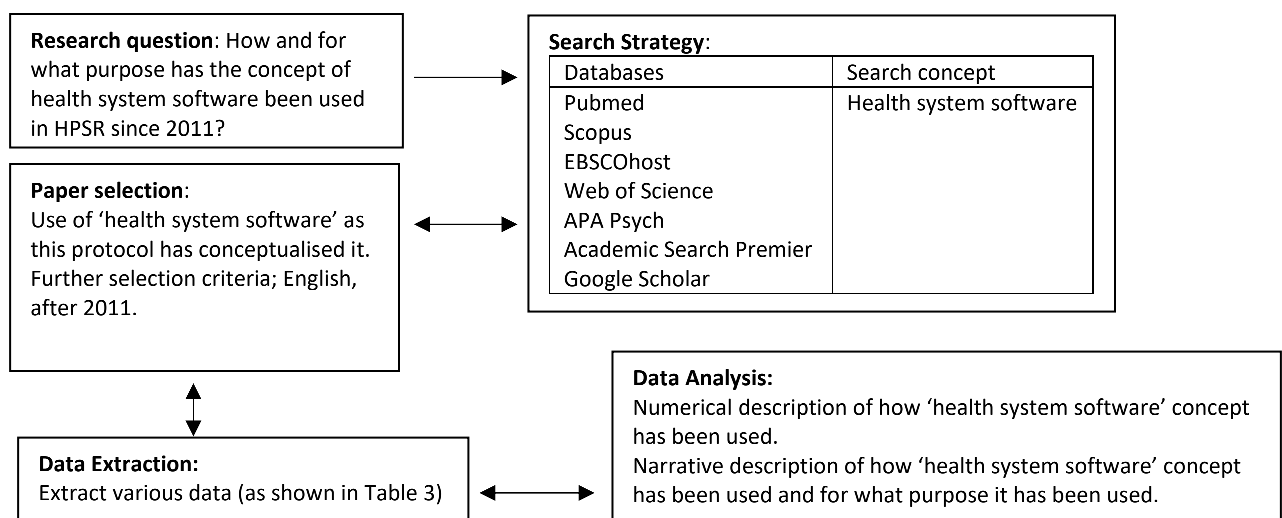

Figure 2. Summary of Phase 1 methodology (Source: Author)

Search Strategy. This step is critical to identify all relevant literature. Relevant databases, such as PubMed, Scopus, EBSCOhost, Web of Science, APA Psych and Academic Search Premier, will be searched to identify health systems software literature. These databases were recommended as relevant to this topic by a University of Cape Town (UCT), Faculty of Health Sciences (FHS) librarian. Supplementary searches on Google Scholar will be conducted. These databases will be searched using variations of the term 'health system software', identified in collaboration with a UCT FHS librarian, displayed in Table 1. The search strategy purposefully excludes computer software and information software which is informed by the preliminary search during the literature review phase of this research.

Table 1. Search Strategy (Source: Author)

Query	Criteria
Concept search	"health system software" OR "health systems software" OR "intangible software" OR "tangible software" OR "software of a health system" OR "software of health systems" OR "health software" NOT comp* software NOT info* software NOT digi* software
Filter	2011 – 2022
Filter	English

The search will be limited to articles in English because translation of non-English articles is beyond the scope of this study. Additionally, the search will limit publications from 2011 onwards, to identify research conducted since the publications of Bennet et al. (2011), Gilson et al. (2011) and Sheikh et al. (2011).

Due to budgetary constraints, only literature which is freely accessible through UCT or by contacting the corresponding author will be considered for this review. Because this research is being conducted to fulfil the minor dissertation component of a Master of Public Health degree, there are no financial means to purchase access to literature.

All papers identified in the search will be exported into Rayyan software. Rayyan is a widely used tool for systematic reviews, as it allows researchers to include and exclude papers based on the various inclusion and exclusion criteria. Rayyaan allows for initial screening of abstracts and keeps track of reasons for excluding papers.

Paper Selection. Literature searches for scoping reviews often yield a large number of irrelevant articles. A scoping review methodology allows for the inclusion and exclusion criteria to be developed after the initial searches (Arksey and O'Malley 2005). Through the initial searches, the researcher gains "increasing familiarity with the literature" (Arksey and O'Malley 2005, p.26) which informs more appropriate search criteria. This approach is particularly appropriate for qualitative studies (Robson 2002). We will therefore refine the search strategy as the initial searches are conducted.

Butler et al. (2016) note that developing inclusion and exclusion criteria is critical for systematic reviews because it sets boundaries on the literature that will undergo analysis, to ensure that only relevant papers are analysed. These criteria will be applied by screening the abstracts in Rayyaan.

Where the abstracts are insufficient to make a judgement about the use of the term 'software', the full text will be investigated. This will be done by searching for the word 'software' and making a judgement about its use. Table 2 summarises the inclusion and exclusion criteria for this study which is informed by the initial searches within the literature review. A flowchart will be used to visually present the inclusion and exclusion criteria applied during paper selection.

Table 2. Inclusion and Exclusion Criteria (Source: Author)

Inclusion criteria	Exclusion criteria
• Published papers • Relevant theses or dissertations • Make use of the concept "health system software" at least once	• Use term 'software' differently; for example, computer software and information software. • Non-English papers • Papers without full text.

Usually, during the stage of reviewing the literature a quality appraisal needs to be conducted to ensure the rigour of the included studies (Butler et al. 2016). Such quality appraisal is conducted to ensure that the included studies are free from methodological issues which, if present, would inaccurately explain phenomena in their real-life contexts. This would impact on the findings of a review (Butler et al. 2016). However, because this research seeks to explore how the concept of health system software has been used, the quality of the studies is not relevant. It does not seek to explain phenomena in their real-world context. Rather, it seeks to describe the broad terrain of the phenomenon and map the literature on the concept. Therefore, even if methodological biases are present in the included studies, those studies are still relevant and provide insights towards the research question.

Data Extraction. In order to synthesise the literature, relevant data needs to be extracted from the selected literature. Arksey and O'Malley (2005) call this charting of data, which means organising the relevant data according to key themes. The types of data to be extracted will be guided by the research question. Data extraction forms (see Table 3) will be used to record and organise the extracted data. This phase of the research will be assisted by the supervisor of this research, to ensure and check that the extracted data is appropriate.

First, data pertaining to the type of paper will be captured, in other words, whether the paper is for example reporting empirical research, is a commentary or a review paper. For empirical papers, details of the setting where the concept is being applied as well as the study design will also be captured. Extracting these details will provide evidence of the broad terrain of literature speaking to health system software. These categories are reflected in rows 2 to 4 in Table 3.

Secondly, a very preliminary search revealed three initial broad categories of how the concept has been used in the available literature. These three categories will inform data extraction. We will manually search for the word 'software' within selected articles and classify how it has been used according to the three categories (as shown in row 5 in Table 3). Where relevant, the use of the concept may be classified against more than one theme. Finally, if an article uses the concept of health system software differently from the three predetermined themes, then the use of the concept will be further described.

The data extraction forms (Table 3) will ensure meticulous records of data are kept. This will aid in the transparency of the research process to ensure rigour. Mays and Pope (1995) suggest that the collected data, the framework applied, and the interpretations of the data should be clearly distinguished when presenting the results to minimise researcher bias. Because qualitative data analysis relies on the integrity of the researcher, clearly demonstrating the evidence used in the findings of the research, as in Table 3, is vital. Whereas Row 1 to 4 in Table 3 capture descriptive data from the paper, Row 5 to 7 rely on the researcher's interpretations of data. The data extraction table includes an extra column for Rows 7 and 8 to allow the researcher to distinguish between their interpretation and the evidence which supports it. Point 2 in Row 6 specifically requires the researcher to make use of a framework when identifying whether a software element is a tangible or intangible software factor. The framework to be used is presented in Elloker et al. (2012), who define tangible software as the "knowledge, skills and processes of decision making" (p.162) and intangible software as the "relationships, communication practices, values and norms" (p.162).

Table 3. Data Extraction Table for Phase 1 (Source: Author)

	Paper name		
1	Year		
2	Type of paper *For example; empirical research, commentary, editorial, review.*		
3	Country/setting investigated (if relevant)		
4	Was the concept used within study design or identified in data analysis? (if relevant)		
	Elaboration on use. *For example; was it used as a framework informing design?*		
	Pre-determined themes; how the concept was used	Interpretation	Evidence for interpretation
5	<u>Classify as;</u> 1. Acknowledgement of concept importance 2. Conceptualisation of software element/s 3. Concept used to explore a health system experience 4. Other		
6	<u>According to classification in Row 7, if classified as;</u>		
	2. 'Conceptualise importance of software element', then; ➔ What software element? (examples; trust, norms, power, processes of decision making) ➔ Tangible or intangible software?		
	3. 'Concept used to explore a health system experience, then; ➔ Which health system experience? *(for example; preparedness, resilience, implementation, performance).* ➔ How was software concept used in relation to this experience?		
	4. 'Other', then; ➔ Explain use of the concept		
7	Any other remarks or notes.		

Data Analysis. Descriptive numerical analyses will be conducted based on the first four rows of Table 3 to describe the papers in which the concept is used, and broadly how it was used in these papers. These analyses will inform a narrative account of the scope of literature on health system software.

Data from Rows 5 and 6 (Table 3) will also inform a numerical and narrative description of the way in which the concept has been used, considering both the three pre-determined themes and any further themes identified during extraction. This particular data extraction process (Rows 5 and 6) somewhat overlaps with data analysis because the pre-determined themes are used to categorise and analyse the use of the software concept during data extraction. This overlap is demonstrated by the multi-directional arrow between data extraction and analysis in Figure 2. This analysis will yield a synthesis of the specific software elements considered in the literature, and whether they are tangible or intangible software (linked to the second categorisation: 'Conceptualise importance of

software element'). From the third categorisation, a mapping of which health systems areas of work have been considered in relation to software will also be developed. Following, any other uses of the software concept will be described. In the final write-up, examples will be drawn from the relevant papers to provide descriptions of the various uses of the concept. Again, the supervisor will check this data analysis to ensure that the analysis is representative of the selected papers.

Phase 2: Deeper Exploration of Software Concept use within HPSR

The overall purpose of this research is to gain insights into how the concept of software has been used within the health systems literature since 2011. The initial scoping review will provide a descriptive overview of literature which uses the concept of health system software. The second phase of the study seeks to consider in more detail how the concept has been used in developing the study designs for research projects which the concept has been purposefully investigated. This will inform future researchers, and possibly other health system actors, how to make use of the software concept within HPSR.

Sheikh et al. (2011) urge that there is a "need to enhance clarity and consensus on research methods, and deepen the theoretical foundations of the field" (p.5) and call for greater use of the hardware-software conceptualisation of health systems. By exploring how this conceptualisation of health systems has informed various research studies, we can deepen these "theoretical foundations of the field" by demonstrating how the concept can purposively inform study designs. By exploring studies which use the concept within their designs, knowledge and learnings can be generated around how to use the concept of software within future HPSR.

Paper Selection. The sub-set of papers categorised in the first phase as "using the concept to explore a health system experience" will be analysed further in phase 2. We will also analyse all papers that explicitly use the hardware-software conceptualisation to inform the design decisions made. The data extracted in phase one pertaining to where the software concept is used within the studies will be used to identify papers which used the concept within study design. Papers which are classified as "using the concept to explore a health system experience" and are studies using the concept within the study designs will be selected for further review in phase 2.

If the number of papers meeting these criteria is too large to analyse effectively, papers that are particularly rich in relevant content will be purposefully sampled for further analysis. Purposive sampling is an appropriate way of selecting a sample of papers during a qualitative systematic review (Ames et al. 2019; Downe et al. 2019).

Data Extraction. In addition to bibliographic information, four categories of data will be captured from the included studies in phase 2, again using a data extraction template (see Table 4). Firstly, an interpretation will be made about how the concept of software was used within study designs and this will be recorded in the extraction table (see column 3 in Table 4). For example, whether the conceptualisation was used as a coding framework or perhaps whether it was used to inform data collection will be recorded. Secondly, data which reveal the overall conclusion which the authors made about the value of investigating software will be extracted (see column 4 in Table 4). This will be the respective authors' judgements, likely made in the concluding remarks of the papers.

These judgements will allow consideration of whether or not there is value in investigating and exploring the software of health systems.

Thirdly, an interpretation will be made and recorded around whether and how the studies investigated, specifically, hardware and software interactions (see column 5 in Table 4). Elloker et al. (2012) suggest that the organisational capacity within a health system depends on the interactions amongst hard- and software elements. Thus, by exploring how these interactions have been investigated and presented, we aim to demonstrate how the interactions amongst hardware and software can be researched. Finally, we will also record which health system experience (for example, resilience or preparedness) was considered in relation to health systems software (see column 6 in Table 4).

Table 4. Data Extraction Form for Phase 2 (Source: Author)

1	2	4	3	5		6
Authors	Year	Description of use within study design	Overall conclusion of the influence of software on health system experience	Interactions between hardware and software looked at		Health system experience investigated (e.g. resilience, preparedness, performance)
				Yes/No?	How?	

Data Analysis. Thematic analysis will be used to analyse extracted data. Thematic analysis is a qualitative data analysis technique which allows the researcher to develop detailed interpretations of the data by identifying themes arising from the extracted data (Braun and Clarke 2006). Braun and Clarke (2006) provide a six-step process of conducting a thematic analysis, including 1) familiarising oneself with the data, 2) coding the data, 3) searching for themes, 4) reviewing the themes, 5) defining and naming themes, and 6) writing the report. These steps will be used to analyse the extracted data, under the guidance of the study supervisor.

Rigour

To ensure rigour, detailed, in-depth methodological descriptions will be presented to ensure transparency (Mays and Pope 1995). Detailed notes will be kept throughout the study process to ensure replicability of the review findings. In addition, as noted above, a UCT FHS librarian assisted with developing the search strategy for the scoping review. This will help ensure that there is no bias in data collection. Furthermore, the data extraction and data analysis will be checked by the study supervisor to minimise the potential of reviewer bias. Finally, the use of data extraction forms will also help to ensure that the collected data, the applied frameworks and the interpretations are kept separate to minimise researcher bias (Mays and Pope 1995).

Ethical Considerations

Seeing as this study is a systematic review, no human subjects will be involved. As such, the study does not require ethics approval. The data used in this review will be accessed through publicly available databases.

Study Limitations

There are some limitations to this study. Firstly, data extraction and data analysis for this study will be conducted by one researcher. Usually, these steps in a systematic review should be undertaken by at least two researchers, to allow for varying conclusions to be drawn from the data (Mays and Pope 1995). Although this is a limitation, the data extraction and data analysis will be checked by the study supervisor of this research.

Secondly, the papers which will be included in this review introduce study limitations. Only publications in English, and publications freely available through UCT's library and online database will be included in the review. Furthermore, only papers which explicitly use the term 'health system software', and the varying forms mentioned in Table 1, will be included in this review. This tight focus is appropriate because the review's intention is to examine how the specific term is being applied in the field. However, this also means that papers addressing elements of software, without using the term 'health system software', have been excluded. Although a limitation of this review, the exclusion of this literature is also inherent to the sequence of methods used in this review. The first phase will identify the specific elements of software being considered in the literature currently. Therefore, this review provides a basis for a more extensive review which may include these varying elements of health system software.

Timeline

Table 5 demonstrates the timeline of this study.

Table 5. Timeline of Review (Source: Author)

Mini-thesis section	Section component	Date to be completed
Part A: Journal article	Protocol draft Protocol edit	Mid-November End of November
Part B: Journal Article	Literature search Data extraction Data analysis Journal write-up Journal Edits	Beginning of December Mid-December Beginning of January End of January Beginning of February
Final submission	Edits Submission ready	End of February End of March

Budget

Given that this study is a systematic review, few costs are associated with this research which is demonstrated in Table 6. These costs will be covered personally by the primary author of this review.

Table 6. Estimated Budget for Review (Source: Author)

Item description	Cost (Rand)
Printing of selected papers for Phase 2	500
Stationery	150

Total	650

Dissemination

The findings of this study will be shared with the University of Cape Town's open access database and will be formatted as a Master of Public Health minor-thesis submission. This format includes a full protocol and journal styled manuscript. This will be done with the intention of disseminating findings to a larger audience.

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Part B: Journal Manuscript

Scoping review of health system software literature: how has the concept been used?

Targeted journal: Health Policy and Planning[1]

Nicola Burger[2]

Abstract

Understanding health systems as comprising interacting elements of hardware and software acknowledges health systems as dynamic, complex adaptive systems (CAS). The hardware represents the concrete components of systems, whereas the software represents the elements which influence actions and underpin relationships, such as processes, values and norms. As a specific call for research on health system software was made in 2011, we conducted a qualitative scoping review considering how and for what purpose the concept has been used since that time. As it has remained relatively under-researched, our overall purpose was both to synthesise current knowledge and to generate lessons about how to deepen research on, and understanding of, health system software. The review consisted of two phases: first, all papers which have explicitly used the concept of health system software were mapped; second, we explored how this concept was purposively used within research. The databases Pubmed, Scopus, EBSCOhost, Web of Science and Google Scholar were systematically searched using a strategy developed by a skilled librarian. In Phase 1, data were extracted from 98 papers to understand the scope of this literature. Our analysis revealed that a third of the papers used the software concept rather superficially; a third used it to conceptualise the importance of some software elements; and a third used it in relation to another aspect of health system experience, such as preparedness or resilience. In Phase 2, our analysis confirmed the value of pro-actively using the software concept within studies, demonstrating two patterns of use. However, limited understanding of how to investigate interactions amongst hard- and software elements was also revealed. Future health policy and systems research should purposively investigate hardware-software interactions, in order to gain greater understanding of the complex, adaptive nature of health systems.

Keywords: Health system software, health system hardware, health policy and systems research, complex adaptive health system

Key messages

- Conceptualising health systems as being made up of interacting hardware and software elements is useful.
- We need to deepen descriptive, exploratory and explanatory research to deepen the theoretical foundations of health policy and systems research.
- We need to conduct research on the interactions between hard and software elements.
- Health system actors outside of research can also gain value from learning about the software concept.

[1] See Appendix E for journal manuscript submission guidelines.
[2] For the purpose of this thesis, the student is the first and sole author of this review.

Introduction

Health systems seek to promote and improve population health through curative, preventive and health promotion services, as well as by impacting on social empowerment, health emergency preparedness and intersectoral action (Gilson 2013; Gilson et al. 2007). There are various ways of understanding health systems. A systems thinking approach suggests that they should be understood as complex adaptive systems (CAS), in which the system is characterised, in part, by the relationships and interactions between their various components (Adam and de Savigny 2012). Recognition of these dynamic interactions is critical in understanding how health systems work and what influences progress towards health system goals.

One conceptualisation of health systems that takes such interactions into account recognises that health systems are comprised of interacting hardware and software elements, asserting that system capacity relies on the complex interactions amongst these elements (Elloker et al. 2012). The hardware represents the visible, infrastructural and concrete components of the system, while the software represents the factors which guide actions and underpin relationships, such as values, norms and attitudes (Sheikh et al. 2011). Elloker et al. (2012) further suggests that software can be distinguished between tangible forms, formal processes, knowledge and skills, and intangible forms, such as values, norms, power and relationships (see Figure 1).

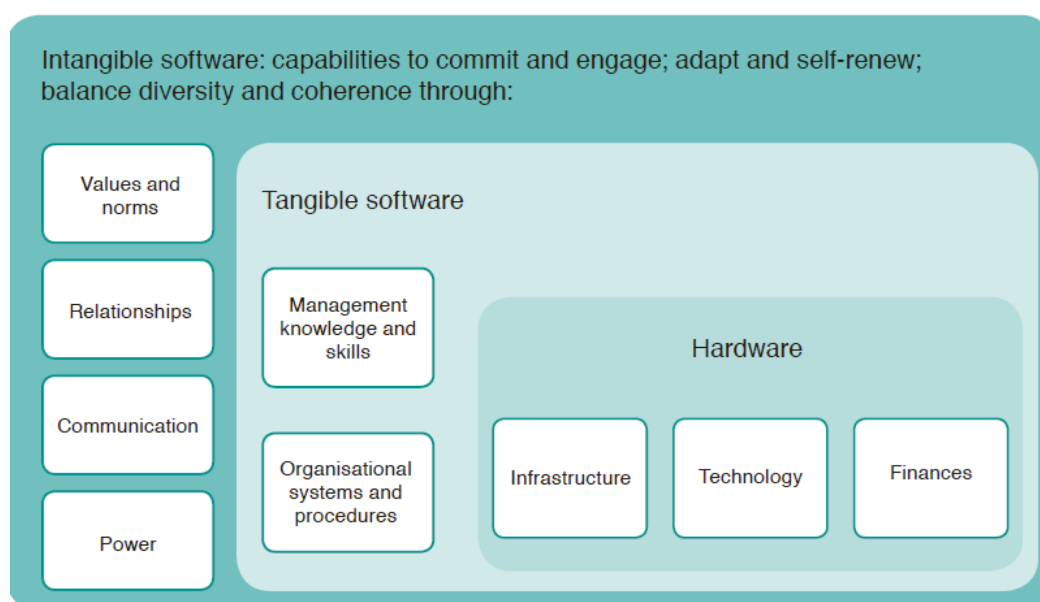

Figure 1. Hardware-software conceptualisation of health systems (Elloker et al. 2012)

Health policy and systems research (HPSR) has long acknowledged that this hardware-software conceptualisation of health systems is important (Elloker et al. 2012; Sheikh et al. 2011; Blaauw et al. 2003). However, research has largely neglected the software components, tending to focus more on health system hardware. Sheikh et al. (2011) suggests that this is likely related to the tendency, often driven by donor interests in observing measurable returns on investment, to focus on short-term operational needs such as specific health interventions or hardware investments, such as in buildings and equipment within health system development.

Focussing on the concrete and mechanical components (hardware) of a health system might also be due to the dominance of a positivist paradigm within wider health research, because of the value-neutrality this paradigm claims to have. From this perspective, health systems are seen as “vehicles for technological solutions rather than being grounded in political and social contexts with underlying power structures, interests, and interdependencies” (Sheikh et al. 2011, p. 4). The lack of conceptual clarity about what constitutes ‘software’ may itself also explain why the topic is often neglected (Sheikh et al. 2011).

In 2010, the First Global Symposium on Health Systems Research was held in Montreux. The symposium had a number of objectives, including to develop a global agenda within the field of HPSR to work towards universal health coverage. In response, following the symposium, three papers (Bennett et al. 2011; Gilson et al. 2011; Sheikh et al. 2011) were published that aimed to examine the challenges facing the field of HPSR, and to identify what was needed to support health system development and strengthening, especially in low- and middle-income countries (LMICs). The three articles highlighted that research needed to be conducted on the social dimension of health systems, and called for theoretical development to understand the complex social contexts within which health systems exist (Bennett et al. 2011; Gilson et al. 2011; Sheikh et al. 2011). More specifically, theoretical development on health system software was called for, to deepen understandings of the concept and so, develop the foundations of HPSR.

Although the call for more research was made in 2011, no review has as yet sought to take stock of what research on health system software has been conducted. Taking stock creates a synthesis of a topic and deepens understanding. It is suggested that “to take stock and analyse evolving landscapes” of various health system activities supports and better informs “further advancements in the field” (Shakarishvili et al. 2012, p. 1).

A review on health system software can, specifically, help researchers consider the real world value of software. It might for example, be useful for understanding policy processes, given that policy processes are non-linear, and continuously influenced by actors (Walt 1994). A review can also assist in offering conceptual clarity; and both sets of insights can provide support for future HPSR.

Overall, this study aimed to review and take stock of how the concept of health systems software has been used since the call for more research about it was made by Sheikh et al. (2011); and also, to provide insights on how to strengthen consideration of the concept within future HPSR. The overall research question of this review is: How and for what purpose has the concept of health system software been used in HPSR since 2011?

Methods

This review answered the research question in two phases. The first phase consisted of a systematic scoping review of HPSR around the concept of health system software. The second phase involved a detailed synthesis of selected papers to explore how the software concept was used to inform the research. These two phases are described separately.

Phase 1: Scoping Review

A qualitative scoping review methodology was used. Scoping reviews are useful to examine the range and nature of research activity on a topic by aiming to synthesize all relevant literature to create an overview of the topic (Arksey and O'Malley 2005). The Arksey and O'Malley framework for conducting scoping reviews was used. This method was chosen because it would synthesise the scope and range of HPSR which speaks to health system software: a purpose of this research. This framework consists of five steps: identifying the research question, identifying the relevant literature, paper selection, data extraction and data analysis. The research question has been discussed. The next four steps are described below.

Search Strategy. The searches for the scoping review were conducted on 6 December 2022. Pubmed, Scopus, EBSCOhost, Web of Science were systematically searched using various forms of the health system software concept (see Table 1). Google Scholar was also used as a supplementary search. These databases and the various forms of the software concept were recommended by a University of Cape Town (UCT), Faculty of Health Sciences (FHS) librarian. Within the database searching, the searches were refined and further limited according to the tools available in the respective databases. Within the Scopus and Web of Science searches, various subject areas were excluded such as engineering, computer science, physics and astronomy, materials science and robotics and so forth (see Appendix 1). The search was limited to English articles because translation of non-English articles was beyond the scope of this study. Additionally, the search was limited to publications from 2011 onwards.

Table 1. Search Strategy (Source: Author)

Query	Criteria
Concept search	("health systems software" OR "health system software" OR "intangible software" OR "software of a health system" OR "software of health systems") NOT ("computer software" OR "computational software" OR "information software" OR "informational software" OR "digital software" OR "mobile software" OR "mobile health software" OR "mobile health application" OR "mobile health apps")
Filter	2011 – 2022
Filter	English

Paper selection. Once the searches were conducted, the papers were exported into Rayyan for further screening. Rayyan is a tool for systematic reviews which allows researchers to include and exclude papers based on the various inclusion and exclusion criteria and it allows for initial screening of abstracts and keeps track of reasons for excluding papers. The abstracts of articles were screened, and papers were included or excluded based on the inclusion and exclusion criteria listed in Table 2. If it was not obvious that our conceptualisation of the term 'software' was being used within the paper, the full text was retrieved and the use of the term was investigated before deciding whether or not to include. If full-text articles were not available freely through Google Scholar or UCT's online library, the first authors were contacted and access to these publications were requested.

Table 2. Inclusion and Exclusion Criteria (Source: Author)

Inclusion criteria	Exclusion criteria
• Published papers • Relevant grey literature such as theses or dissertations	• Use term ‘software’ differently from our conceptualisation; for example, computer software and information software. • Non-English papers

Data extraction and analysis. The year of publication, the type of paper and the country/context referred to was extracted for all selected papers. Where in the empirical papers the software concept is used was also considered; for example, whether it was used in the methodology section, results section and so forth. Furthermore, the way the software concept was used was deductively categorised according to three predetermined themes during data extraction. These three themes were: acknowledgement of concept importance, using concept to explain software elements, and using concept to explore a health system experience. These three themes were derived from a preliminary investigation of some health system software literature. Depending on a paper’s classification according to these three themes, additional data was extracted. This included the software elements described, if classified as ‘using concept to explain software elements’; and the health system experience as well as how it was used in relation to it, if classified as ‘using a concept to explore a health system experience’.

This extracted data was recorded in a pre-prepared template (see Appendix B). This extraction template aided the transparency of the research process by distinguishing the actual data and our interpretations of that data, so avoiding potential bias and enhancing the rigour of the research (Arksey and O'Malley 2005).

Numerical analyses were conducted on extracted data to describe various aspects of the terrain of health system software literature. Data pertaining to the three predetermined themes was further analysed to inform a numerical and narrative description of how the concept has been used.

Phase 2: Deeper Exploration of Software Concept use within HPSR

The overall purpose of this research was to gain insights into how the concept of software has been used within HPSR since 2011. Following an initial scoping of the broad use of the concept, the second phase of work sought to answer the research question in more detail by investigating research projects which used the software concept explicitly to influence their study’s design. We sought to understand how this conceptualisation of health systems had informed research studies to contribute to deepening the “theoretical foundations of the field” as called for by Sheikh et al. (2011). We specifically considered the value of considering software, the research approach used in its investigation, and whether or not hardware-software interactions were considered. Elloker et al. (2012) argue that a specific intention of the conceptualisation is to acknowledge and explore the interactions between the hard- and software elements.

Paper selection. The sub-set of papers categorised in phase 1 as ‘using the concept to explore a health system experience’ were used as a pool of papers for further review in phase 2. From this group of papers, we further selected only those papers which used the hardware-software

conceptualisation to inform the design decisions made within the study reported in the paper (excluding those papers that only used the concept within the background rationale or discussion sections).

Data extraction. In addition to bibliographic information, four categories of data were captured from the selected papers for phase 2 (see Appendix C). Firstly, an interpretation was made about how the concept of software was used within the study designs. For example, whether the conceptualisation was used to inform data collection or as a framework to inform data analysis. Secondly, the paper authors' judgement of the overall conclusion about the value of investigating software was recorded. Thirdly, we made an interpretation around whether and how the studies investigated the interactions between hardware and software. Lastly, we recorded the other health system experience in relation to which the software concept was considered.

Data Analysis. The extracted data were thematically analysed, following the Braun and Clarke (2006) six-step process. These steps included familiarisation with the data, coding the data, searching for themes, reviewing the themes, defining the themes and writing the report. This analysis considered how the concept informed study designs, the value of investigating software and how the interactions amongst hard- and software was investigated.

Results

The database and supplementary Google Scholar searches yielded a total of 279 articles in the first phase of the research. Rayyan identified 96 duplicates which were subsequently removed. 82 articles used the term 'software' in ways that did not align with our conceptualisation and were therefore excluded. One paper used the concept of health system software in its reference list only, in relation to a paper already included in the review; and therefore this paper was excluded. Two papers were not published in English, and were also subsequently excluded. Finally, 98 articles were included in the review. The flowchart presented in Figure 2 summarises the selection of papers.

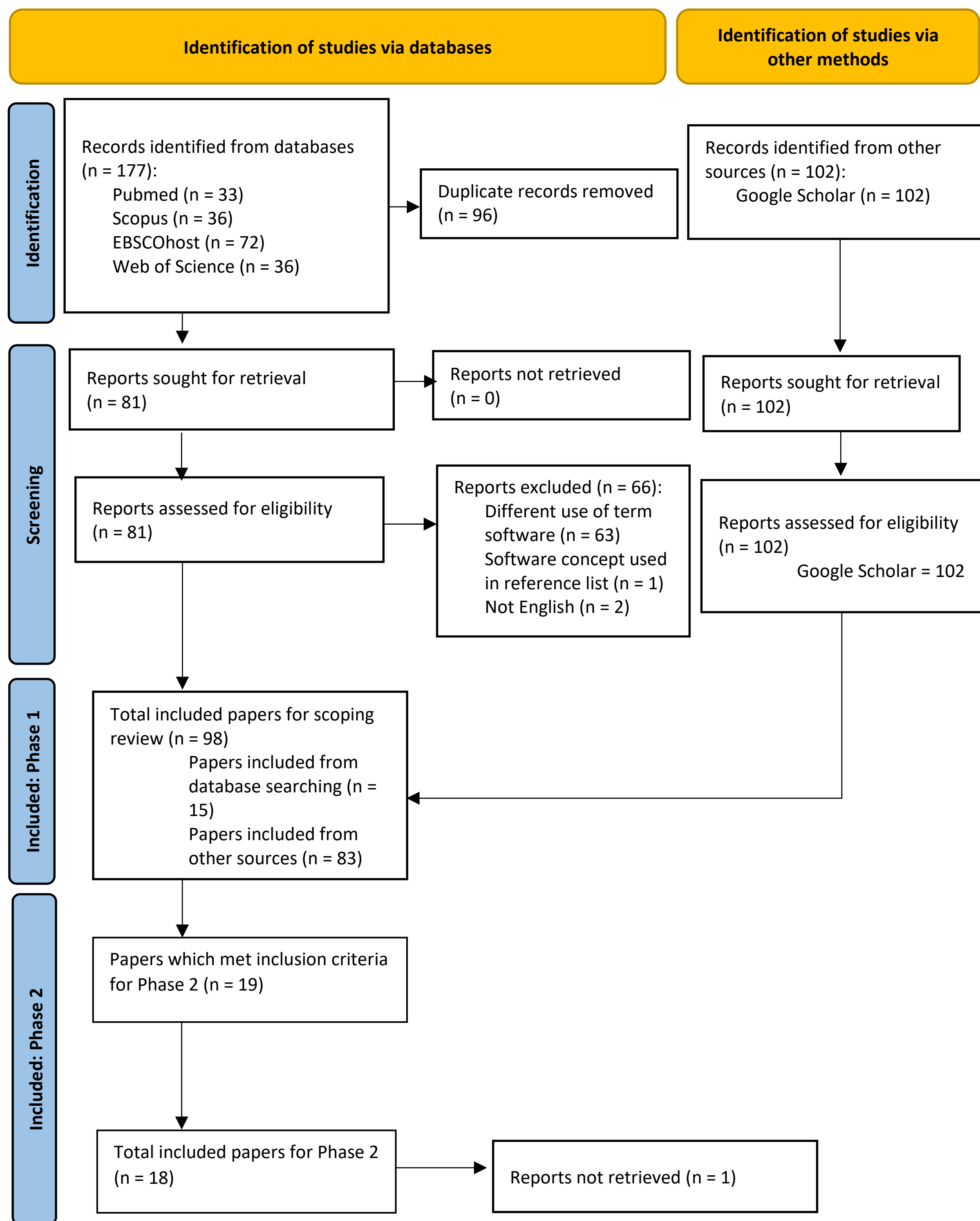

Figure 2. Flowchart of paper selection (Source: Author)

There has been a recent increase in the number of publications which explicitly speak to the specific concept of 'health system software'. 85% of all the publications included in this review were published in the latter half of the 12 year period considered. Figure 3 illustrates this distribution, showing the growing use of the conceptualisation, acknowledging that health systems are complex entities and comprise more than just the material hardware.

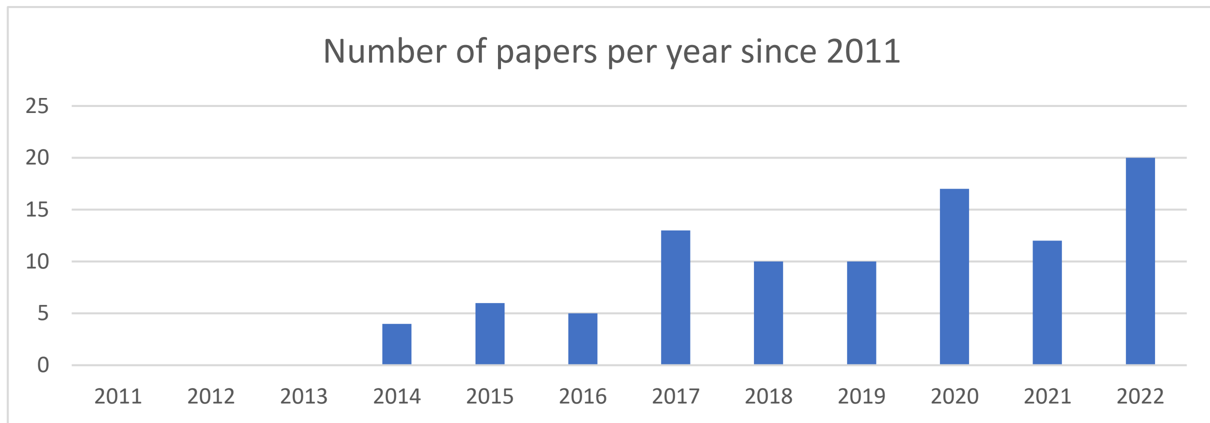

Figure 3. Number of included papers sorted by publication year since 2011 (Source: Author)

A high number of included papers were reporting empirical studies (44%). A small portion of the papers were reviews (20%) and there were a few commentaries (13%). The rest of the included papers took the form of working papers, or book chapters, for example. These proportions are demonstrated in Figure 4.

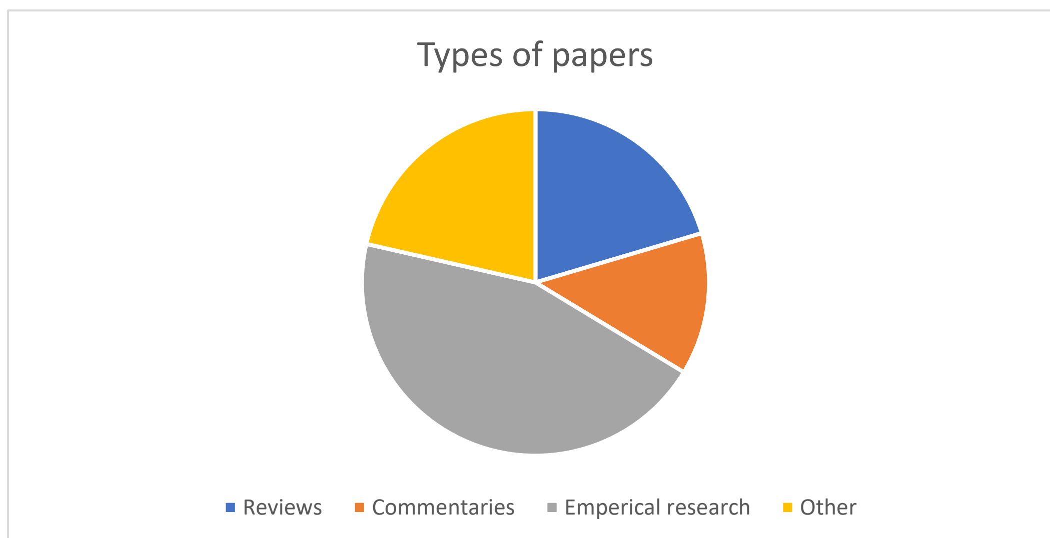

Figure 4. Pie chart showing the types of publications of selected papers (Source: Author)

Many papers investigated specific contexts and settings. Half (50%) of the papers investigated an African country or region, whilst a quarter (24%) looked at LMICs in general, or at a country outside the African continent that was classified by the World Bank as an LMIC, such as Pakistan or India. Almost 75% of the papers purposively referred to an LMIC context.

Use of the concept

Using pre-determined themes, the papers were classified as using the concept in three distinct ways; although some reported an approach that did not fit into any of these themes.

Acknowledgement of concept importance. Most papers (40%) used the concept simply to acknowledge the recognised importance of health system software within HPSR or public health

debates. This point was often presented in the background discussion or introduction of the paper. For example, in a paper which discussed social accountability within the health system in Zambia (Schaaf et al. 2017), the concept of software was used in the paper's introduction when highlighting the importance of norms in health systems.

> . . . focus on norms echoes increasing acknowledgement of the import of health systems "software," such as norms, values and power in shaping health service delivery (Schaaf et al. 2017, p. 848)

This extract reflects the many papers which briefly referred to health system software. Another example of using the concept to validate the core issue addressed by the paper is:

> . . . global health advocates and researchers call for attention to informality, such as the crucial role that health systems "software". . . play in shaping services (Joshi et al. 2022, p. 2)

Although these papers acknowledged the concept, it was not actively used in shaping the specific concepts of enquiry within the research discussed, nor directly examined in that research. Many papers used the concept once or twice only.

Using the concept to describe specific software elements. A quarter of the papers (24%) used the concept to justify looking at a particular phenomenon, defining the phenomenon of focus as a software element. The software elements which were investigated by these papers provide us with detailed examples of the overall scope of what is currently regarded as health system software, as summarised in Table 3. The table categorises these elements as either tangible or intangible software, using the distinctions established by Elloker et al. (2012, p. 162). Furthermore, we have sub-categorised the various tangible and intangible elements within Table 3 to further synthesise the various elements which the papers identified as 'software'.

One paper suggested that 'governance' had both tangible features, such as committees, guidelines and protocols and also intangible features such as power relations, social hierarchies, collegiality and normative practices within the governance structure (Arakelyan et al. 2022). It is presented in both columns of Table 3. This contrasts with the notion within the World Health Organisation's (WHO) building blocks framework, that sees governance only as hardware, "organizational structures and legislation for example" (Sheikh et al. 2011, p. 2).

Table 3. Summary of software elements described in included papers (Source: Author)

Tangible software	**Intangible software**
Governance, leadership and management structures and processes Formal rules within governance structure (George et al. 2019) Governance of public policy during COVID-19 (Moussallem et al. 2022) Committees, guidelines, and protocols (Arakelyan et al. 2022) Distribution of power and process of decision making within governance structure (Barasa et al. 2018)	Health worker behaviours and practices Provider behaviour (professionalism) (Hamon et al. 2022) Bad attitudes of health workers (Topp et al. 2017) Staff motivation (Barasa et al. 2018; Boydell et al. 2017; Nyikuri et al. 2017) Staff commitment (Barasa et al. 2018) Informal payments (Boydell et al. 2017) Performing out: manipulation or inflation of data to create a false impression of meeting performance targets (Das et al. 2022)
Formal processes Adequate planning (Mwamba et al. 2018) Audit style performance accountability processes (Das et al. 2022)	Governance and leadership Inclusive decision making as a process (Reddy et al. 2022) Governance as a force binding or repelling actors, relationships, and resources (George et al. 2019) Informal rules within governance structure (George et al. 2019) Leadership practices such as creating a clear and shared vision (Reddy et al. 2022; Barasa et al. 2018)
Managerial processes Role of human resource management (Boydell et al. 2017) Management capability to anticipate and cope with shocks (Gooding et al. 2020) Management practices of: operations, performance monitoring, targets, people and autonomy to make these decisions (Powell-Jackson et al. 2019)	Behavioural drivers Incentives within service delivery system (Boydell et al. 2017) Communication (Reddy et al. 2022) Emotions (van Niekerk 2022) Ideas (Kok et al. 2017) Interests (Kok et al. 2017) Values (Whyle and Olivier 2020; Kok et al. 2017; Hernández 2014) Norms (Kok et al. 2017) Political and social contexts (Hirose et al. 2015)
	Cultures Culture of performing out within facilities (Das et al. 2022) Organisational culture (Walmisley et al. 2022; Bozorgmehr et al. 2020; Gooding et al. 2020; Barasa et al. 2018; Mbau and Gilson 2018; Mphaphuli 2017; Topp et al. 2017) Institutional logics which are broader belief systems : For example a national identity logic and a development logic within a country (van Niekerk 2022)
	Power, trust and relationships Power relations and social hierarchies (Arakelyan et al. 2022) Power dynamics (Kok et al. 2017; Topp et al. 2017; Hirose et al. 2015) Interpersonal trust, institutional trust, trust in colleagues, trust in supervisor, trust in employer (Topp and Chipukuma 2016) Trust in government among people (Moussallem et al. 2022) Trust between researchers and managers (Nyikuri et al. 2017) Trusting relationships (Kok et al. 2017) Trust in providers (Hamon et al. 2022)

	Patients trust in medicines and health services (Aivalli et al. 2018) Relationships (Reddy et al. 2022; Wanyama et al. 2022; Kok et al. 2017; Hernández 2014) Peer networks (Reddy et al. 2022; Wanyama et al. 2022) Social ties (Wanyama et al. 2022; Whyle and Olivier 2020) Shared experiences (van Niekerk 2022) Community relationships (Gooding et al. 2020) Emotional support through peer networks (Reddy et al. 2022)
	Skills and abilities Team socio-cognitive skills (non-technical human skills) (Wanyama et al. 2022) Everyday innovation (shifting of resource flows, social routines and cultural values to address a systemic health challenge) (van Niekerk 2022) Population's ability to self-care, self-help and self-responsibility with regards to health (Mathpati et al. 2020)

Use of concept to explore another health system experience. The concept of software was also used in a third of the included studies (36%) to investigate another aspect of health system experience. In these papers, the hardware-software conceptualisation of health systems was often reported as purposively informing the research design, rather than, as in the first two themes, being used only to comment on its importance or to rationalise looking at another concept. The various experiences which were explored included preparedness, resilience, governance, responsiveness, accessibility, implementation and performance (see Figure 5). The last column in Figure 5 represents multiple other experiences, such as: organisational change, judicialization of access to medicines, integration, social innovation, adaptive capacity and priority setting.

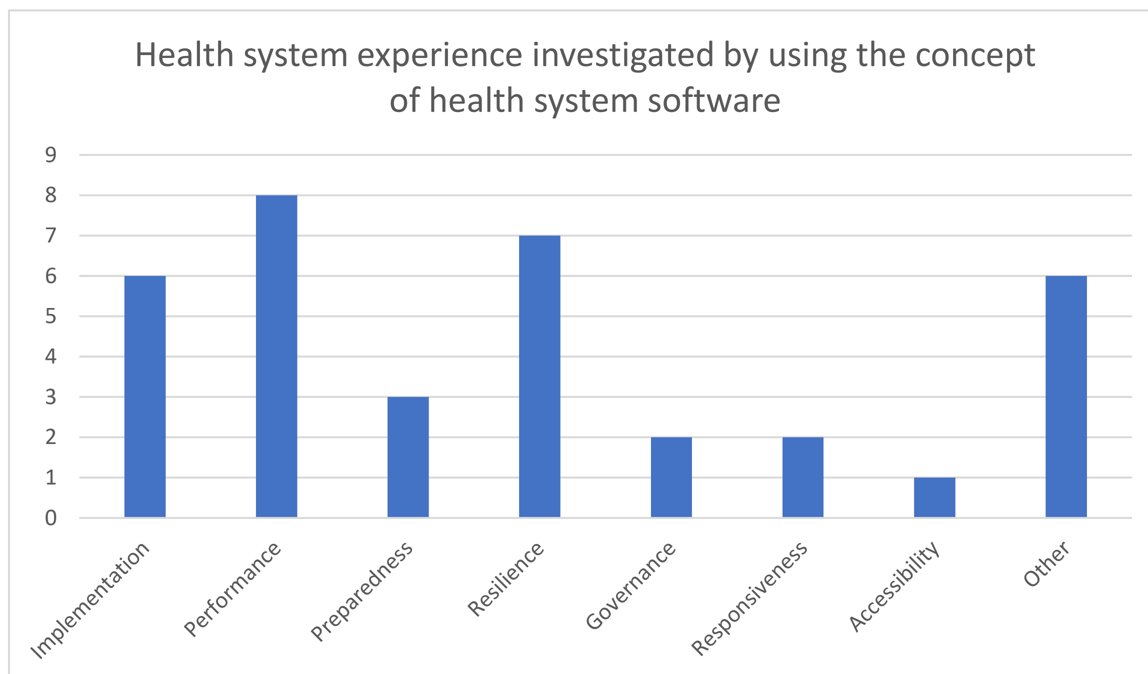

Figure 5. Use of software concept to investigate other health system experiences (Source: Author)

In many papers, software elements were used to investigate what was influencing the other health system experience of focus. Some papers used the concept as a framework to inform the data analysis, as discussed further in presenting the findings of phase 2 of this review.

Whilst some papers examined both hardware and software, some sought only to investigate software elements which impacted or influenced another health system experience, thereby excluding hardware. For example, a protocol for empirical research presented its aim as:

> . . . to explore how, why, for whom and in what circumstances, features of health systems 'software' (e.g. values, norms, relationships) between health workers of all cadres caring for neonates in Kenyan hospitals, influence quality of care being targeted by improvement efforts (Wanyama et al. 2022, p. 6)

However, other papers again primarily used the software concept as a discussion point to elaborate further on findings about what may have influenced the other health system experience. One paper which did this explained in their discussion section that "to accomplish health system preparedness

for any infectious disease outbreak, one should consider the uniqueness of software components of the health system that hold the hardware together" (Tshitenge and Nthitu 2022, p. 5). These papers did not, then, use the software concept to inform the study design, but rather to analyse their findings in relation to a specific health system experience.

Other uses of the software concept. A few of the selected papers (11%) used the concept in ways which do not clearly fit into one of the three pre-determined themes. Some papers again used the concept primarily as a discussion point, whilst referring to health systems in a broad sense.

Some review papers identified the concept during data analysis, such as Vargas-Peláez et al. (2017) who then discussed in their results how hardware and software is needed "in order to recognize the complexity of the health systems" (p. 172).

One commentary discussed the practical realities of rewiring the intangible software within a health system (Ramani et al. 2022). This was the only paper included in the review which specifically focussed on 'how to' reform software in order to improve health system performance; it offers useful advice for health system managers.

Exploration of papers using concept in study design and in relation to a health system experience

Nineteen papers met the criteria for the second phase of this review. The full text for one of these papers was not available and was subsequently excluded (see Figure 2).

Use of concept within studies*.* The thematic analysis of these papers revealed two patterns in how the hardware-software conceptualisation has been used within the studies. First, it is used as a coding framework in analysis; second, it is used to pre-determine which hard- and software elements should be further investigated within a context, rather than inductively investigating a range of elements.

Using conceptualisation to code influences. Ten of the papers selected for more detailed assessment used the hardware-software conceptualisation to frame/code influences on another aspect of health system experience, such as preparedness, resilience, an issue within a particular setting or the implementation of a programme, sometimes considered within a particular setting such as a specific disease programme in a given country. This was useful, as a well-established theoretical foundation (hardware-software conceptualisation) was used to analyse the research findings. Table 4 presents all the papers which used the concept in this way, also showing which experiences and country/context were considered. A few papers which used the concept like this will be discussed to demonstrate this use.

Zwama et al. (2021) mapped the influences on tuberculosis (TB) programme implementation in LMICs and used the hardware-software conceptualisation in data analysis to code these influences, including interactions among hardware and software. The authors conclude that particular attention needs to be paid towards health system software, emphasising the importance of software within implementation of TB infection, prevention and control (IPC).

Kagwanja et al. (2020) investigated the everyday stressors experienced within the Kenyan health system, within an analysis of the system's everyday resilience. These authors specifically used the hardware-software conceptualisation to frame the stressors as either hard- or software, and to

consider ways of responding to them. They judged that the hardware-software conceptualisation "was useful to demonstrate different types of strategies and the role of organizational capacities in nurturing (or building) everyday resilience" (p.532). In other words, it enabled deeper understanding of the nature of everyday resilience.

Mwamba et al. (2018), similarly, sought to identify what was influencing patients who decided to disengage from anti-retroviral therapy (ART) in Zambia, categorising these influences as either hard- or software. They concluded that "health system 'hardware' (resourcing) and 'software' (clinic operating practices – including work norms and patterns and HCW [health care workers] attitudes) often interacted and amalgamated to influence patients' decisions to engage or disengage in care" (p. 8). Again, the value of actively considering hardware, software and their interactions in analysis lies in deepening understanding of health system experiences.

Table 4. Papers using concept to categorise influences on various other areas of health system experiences (Source: Author)

Paper	Health system experiences considered in relation to software	Country/context
Das et al. (2022)	Problem of performing out (manipulation or inflation of data to create a false impression of meeting performance targets)	India
Topp and Chipukuma (2016)	Trusting relationships	Zambia
Topp et al. (2015)	Mechanisms of accountability	Zambia
Arakelyan et al. (2022)	Implementation of TB- infection, prevention and control measures	South Africa
Zwama et al. (2021)	Implementation of TB-IPC programmes	LMIC
Myburgh et al. (2021)	Accessibility to ART	South Africa
Palagyi et al. (2019)	Emerging-infectious disease preparedness	LMIC
Mayhew et al. (2020)	Integration of HIV and sexual and reproductive health services	LMIC
Kagwanja et al. (2020)	Everyday resilience	Kenya
Mwamba et al. (2018)	Problem of patients' decisions to disengage from ART.	Zambia

Using suggestions from other research to inform which software elements to explore. Six of the papers selected for phase 2 used the conceptualisation to inform which hard- and software elements should be investigated in relation to another aspect of health system experience. These papers used the findings from previous research to inform which hardware-software elements to look at more explicitly in their own study (see Table 5).

Moussallem et al. (2022) sought to investigate what was impacting on Lebanon's preparedness for the COVID-19 pandemic. They investigated various hard- and software elements, namely: surveillance, infrastructure, medical supplies, workforce, communication mechanisms, trust and governance. Their rationale for investigating these factors was that the interconnectedness of these hard- and software factors had been identified in an earlier review paper (Palagyi et al. 2019) as enabling LMICs to achieve and maintain such preparedness.

Topp et al. (2019) aimed to examine the feasibility of universal test and treat (UTT) services within correctional facilities in South Africa and Zambia. This study drew on previous work (Proctor et al. 2011) that suggested a range of hard- and software factors associated with UTT feasibility. The factors investigated were: "willingness of . . .[health system actors] to participate; the perceived appropriateness and convenience of the intervention; availability of appropriate resourcing; and logistical systems required to support the intervention" (p. 191). Topp et al. (2019) confirmed that these hard- and software factors played an important role in the feasibility and sustainability of UTT services in correctional facilities.

Zawolo et al. (2022) used the concept to frame which hard- and software factors should be investigated in relation to community health worker (CHW) motivation and support in Liberia. This study used a previously developed framework by Kok et al. (2017) (discussed further below) to investigate CHW utilisation, management and performance. The issues raised in the CHW framework specifically informed which software elements to focus on.

However, it was not necessarily clear exactly how these elements were used within these studies (Moussallem et al. 2022; Zawolo et al. 2022; Topp et al. 2019), other than by being chosen as elements to investigate.

One study provided more clarity on how the software concept informed the study's methods. Schneider et al. (2014) report that the concept of software informed the interviews and checklists used to collect data within a programme evaluation of primary health care outreach teams in South Africa. The authors state that the 'software' of implementation consisted of "actor knowledge and ownership of the policy, and changing roles and relationships" (Schneider et al. 2014, p. 4), but did not clarify the source of this judgement.

Reddy et al. (2022) and Wanyama et al. (2022), meanwhile, used the concept to frame which software factors impact on, respectively, quality of care in neonate Kenyan hospitals, and provider behaviour and experience of maternity care in LMICs. However, it was not specified who argued that these elements were worth looking at in relation to these health system experiences.

Table 5. Papers using concept to suggest elements to undergo further investigation (Source: Author)

Paper	**Phenomenon**	**Country/context**
Zawolo et al. (2022)	Community health worker performance	Liberia
Moussallem et al. (2022)	COVID-19 Preparedness	Lebanon
Topp et al. (2019)	Implementation of HIV UTT services in correction facilities	South Africa and Zambia
Wanyama et al. (2022)	Quality of care	Kenya
Reddy et al. (2022)	Provider behaviour and experience of maternity care/respectful maternity care	LMICs
Schneider et al. (2014)	Implementation of primary health care reform	South Africa

Other uses of conceptualisation. Two papers used the software concept quite differently from other papers selected for phase 2 review. One paper reported on the experience of supporting leadership development through on the job training (Nzinga et al. 2021). Within this training, health managers were taught about complex health systems, including the notions of hard- and software and, in terms of software, values, belief systems and relationships.

Nzinga et al. (2021) found that the health managers showed enthusiasm towards the software concept, as evidenced by the fact that these concepts were most often mentioned by them when reporting on the value of the CAS course. This alludes to health managers' interest in viewing health systems as CAS made up of hard- and software factors. Managers reported that appealing to the values (software) of nurses helped them "reassure and motivate some nurses to continue providing care" (Nzinga et al. 2021, p. 1030) during nursing strikes.

The second paper used the conceptualisation in a systematic review of literature to develop a framework (itself used by Zawolo et al. 2022, discussed above) which incorporates hard- and software as influences on CHW performance (Kok et al. 2017). Presented in Figure 6, CHW performance is placed at the centre of the framework, where hardware and software are suggested to be "influencing factors" (p. 2). The black arrows demonstrate the interactions amongst the hard- and software.

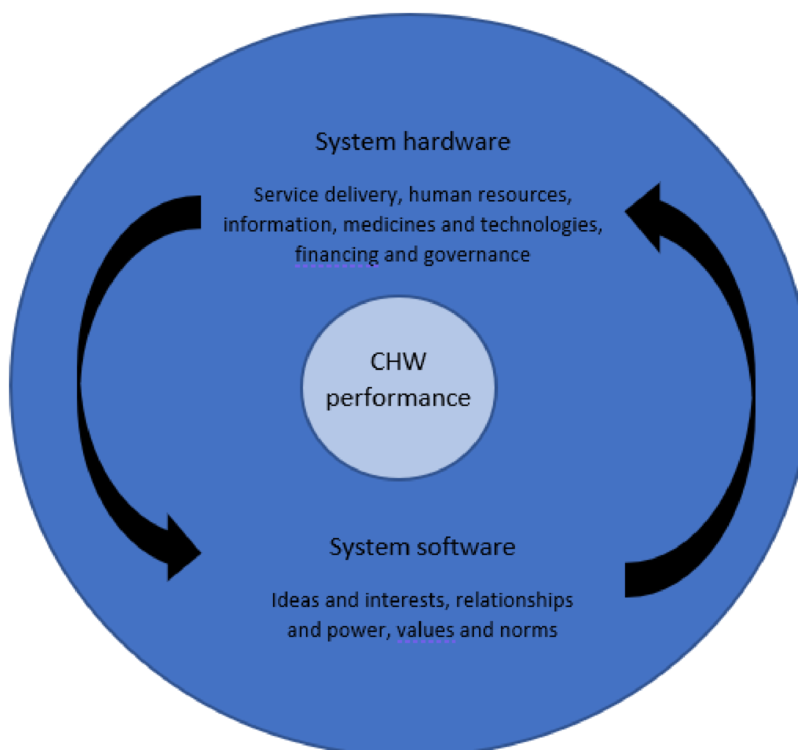

Figure 6. Summarised CHW performance framework (Adapted from Kok et al. (2017))

Interactions between hardware and software. Of the eighteen papers which were selected for further analysis in the second phase, five intentionally outlined and investigated interactions between hardware and software. This relatively low number was somewhat surprising, seeing as

these interactions are a fundamental feature of this conceptualisation (Elloker et al. 2012). The papers which did not explore interactions merely described influences over the selected health system experience as either hard- or software. They often commented that interactions were important to look at, but did not actually look at them.

The papers which did discuss the hardware-software interactions within the research did so in various ways. One paper described how interactions amongst hard- and software elements influenced patient disengagement from HIV care in Zambia (Mwamba et al. 2018). However, it did not describe the nature of these interactions. These authors discuss that hardware and software interacted to influence these patients' decisions, however, the exact nature of the interaction, such as which element was influencing which other element and in which direction, was not made clear. For example, was a lack of resourcing causing health workers to use discretionary operating practices which ultimately steered patients away from engaging in care? Or were health workers using discretionary operating practices which was impacting on the resources available within the setting, thereby causing patients to disengage from the services?

Kagwanja et al. (2020), similarly, only alluded to interactions between hard- and software, but did not examine them in detail. For example, they stated that in Kenya "HR [human resource] management issues (tangible software) coupled with resource constraints (hardware) created dissatisfaction among HCW leading to frequent HCW strikes" (Kagwanja et al. 2020, p. 527).

Das et al. (2022) and Topp et al. (2015), however, directly explored interactions amongst elements, more fully describing them in their studies' findings. For example, in their study, Das et al. (2022) outline the interactions amongst elements and demonstrate the overall impact they had on 'performing out' (that is the manipulation or inflation of data to create a false impression of meeting performance targets) in two Indian health facilities. They judge that "the mechanisms through which ELAs [expected levels of achievement] are managed, monitored and reported evoke formal and informal power" (p. 4) and this power caused workers to be submissive and targets of exploitation. Furthermore, these authors suggest that;

> …using a CAS framing, we demonstrate how these individual behaviours emerge from the dynamic interaction between underlying system elements of chronically deficient hardware, audit-style performance accountability approaches (tangible software), and an organisational culture that validates 'performing out' (intangible software) (Das et al. 2022, p. 9)

Topp et al. (2015) also describe hard- and software interactions in a study which explored what was impacting on accountability mechanisms in Zambian primary health centres.

> Structural human resource shortages (a hardware factor). . . contributed to a high burden of work and pressure to complete tasks quickly, which compounded in some cases by a lack of capacity, contributed to data-entry errors, shortcuts or shirking of these duties altogether (Topp et al. 2015, p. 10)

These human resource shortages (hardware), therefore, caused health workers to describe "the time pressure they experienced" (p. 10) (software) that resulted in poor quality of data collection within the health centres. This impacted on health workers' clinical and administrative performance,

and had consequences for their personal performance reviews (accountability system). Topp et al. (2015) further state that:

> The findings confirm the relevance of the Sheikh et al.'s (2011) hardware-software model and demonstrates how the original framework may be adapted to achieve greater analytical and explanatory power by examining first, the way hardware-software interactions act positively or negatively on particular mechanisms of accountability, and though these, health system performance (Topp et al. 2015, p. 498)

Finally, Arakelyan et al. (2022) use the hardware-software model to frame the various influences on TB-IPC measures in South Africa, explicitly investigating the interactions (themselves categorised as tangible and less tangible) amongst influences. These authors created a concept map to demonstrate these complex interactions visually (Figure 7), explaining that this is useful to "indicate what dynamics must be considered when studying the implementation of TB-IPC, or indeed IPC practice more generally" (Arakelyan et al. 2022, p. 17).

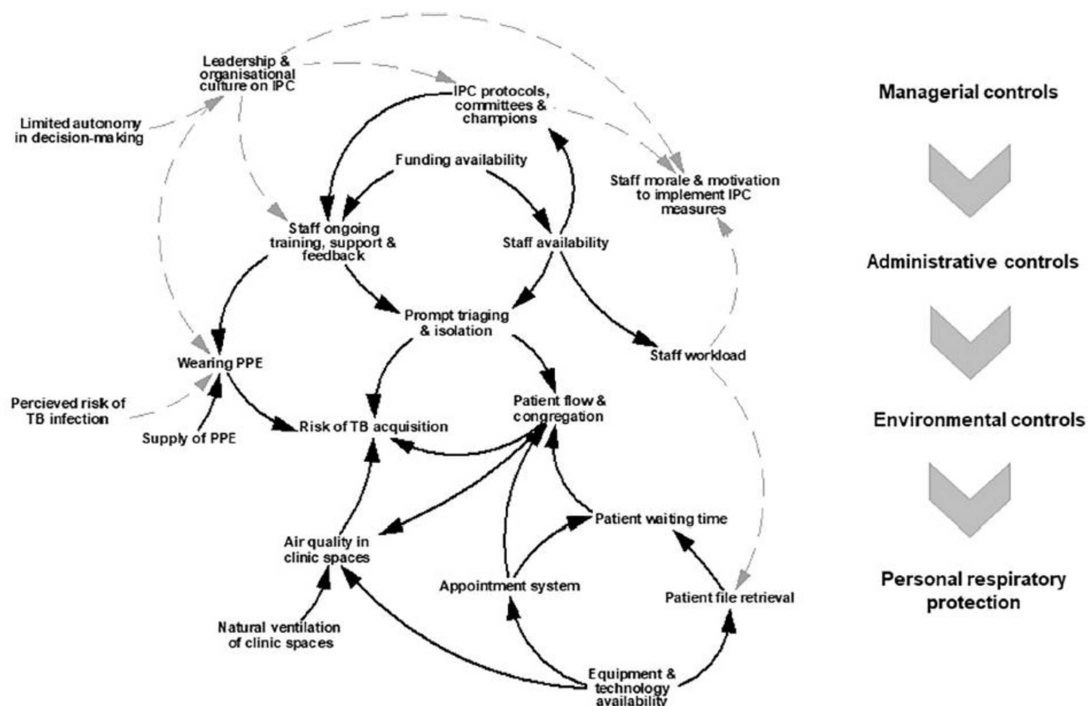

Figure 7. Key interactions between health systems hardware and software components across the hierarchy of TB-IPC controls. (Note: **Figure 7.** Key interactions between health systems hardware and software components across the hierarchy of TB-IPC controls. Black arrows show tangible interactions between health system hardware components. Dashed grey arrows show less tangible interactions between health systems software and hardware components) (Source: Arakelyan et al. (2022))

Reviews

Five of the papers selected for phase 2 were reviews. These aimed to map the influences on various other health system experiences, coding the influences as either hard- or software. The papers considered TB-IPC programmes (Zwama et al. 2021), integration of sexual and reproductive health services with HIV services (Mayhew et al. 2020), expanding ART access (Myburgh et al. 2021), respectful maternity care (Reddy et al. 2022), and emerging infectious disease preparedness (Palagyi et al. 2019). They demonstrate that the hardware-software conceptualisation is a useful way to understand the scope of influences on a range of health system experiences.

Discussion

This scoping review aimed to map how the concept of health system software has been used since 2011, in order to inform future HPSR and provide insights on how to do so (see Figure 8). However, as summarised in Figure 8, it also highlights some insights for other health system actors.

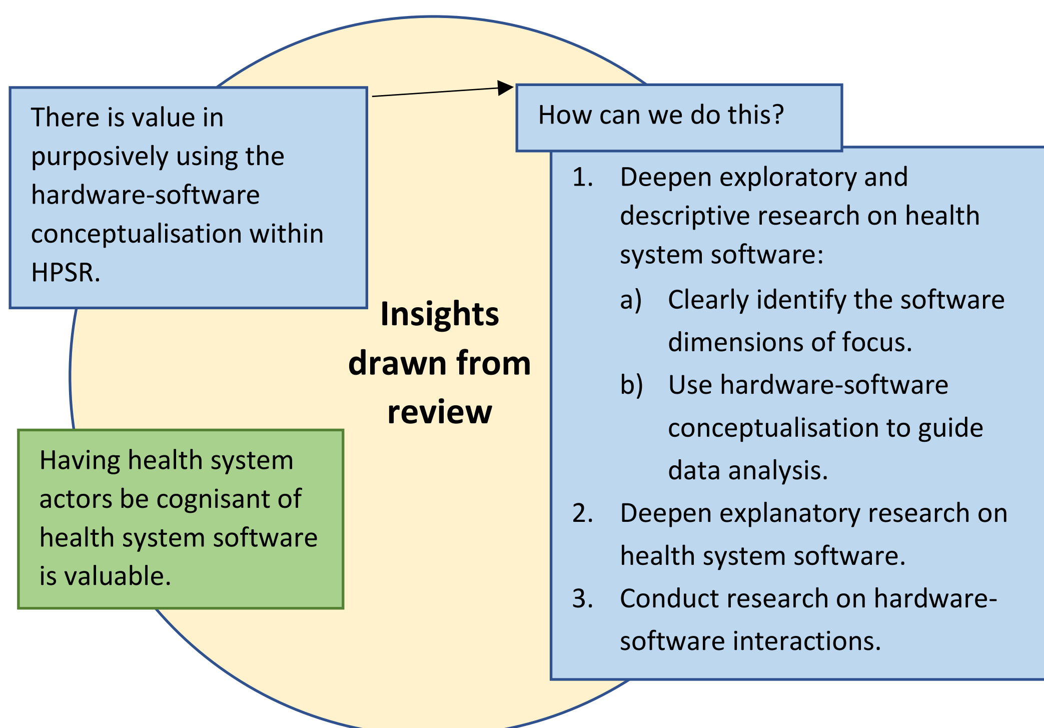

Figure 8. The insights drawn from this review (as summarised in this figure) can be grouped in two: insights for researchers (blue boxes) and insights for other health system actors (green box) (Source: Author)

The scoping review revealed an increase in use of the term 'health system software' over the last 12 years, suggesting that such research has picked up momentum. However, the review also reveals that few have used the concept actively to inform the research undertaken, implying, for the most part, a somewhat superficial application. This is evidenced by the high number of studies which were categorised in this review as 'using the concept to acknowledge its importance'.

The reviewed papers were mostly drawn from LMIC contexts, reflecting the general focus on LMICs within the field of HPSR, as emphasised by Sheikh et al. (2011) and Bennett et al. (2011) (who speak to the importance of HPSR within LMIC contexts). Nonetheless, Sheikh et al. (2011) did suggest that the hardware-software conceptualisation had value in high-income settings. Researchers in high-income settings should, therefore, not shy away from using the hardware-software conceptualisation.

Value of looking at hardware, software and their interactions

Established health policy and systems researchers have already proposed that viewing health systems as CAS is important, and that hardware-software interactions are part of their complexity (Elloker et al. 2012; Sheikh et al. 2011; Blaauw et al. 2003). These components have dynamic relationships and unpredictable influences on one another (Sheikh et al. 2011). Identifying and reviewing papers which have applied the hardware-software conceptualisation in considering how software, and its interactions with hardware, impact on wider experiences, offers further evidence of its value.

The wide range of experiences considered in these papers is summarised in Figure 5, Table 4 and Table 5. They suggest that the hardware-software conceptualisation has relevance across the, macro, meso and micro levels of the health system. They also highlight its value in understanding important health system experiences, some of which are recognised as important in their own right (for example, accountability, preparedness and policy implementation) and some of which have links to overall system performance (for example, CHW programme performance, quality of care). Some of these experiences are also captured by what Bertone et al. (2022) have recently called 'health system process goals' (for example, learning and resilience), to distinguish them from overall health system performance goals. This current review suggests, then, that the hardware-software conceptualisation could offer value in future health system evaluations considering these process goals – evaluations judged by these authors as important in generating new ideas about health systems strengthening.
However, as this review has shown, the existing research on health system software and hardware-software interactions remains limited. More research is needed to deepen understanding, and this research must be strengthened by more explicitly and purposively engaging with the hardware-software conceptualisation. This synthesis highlights three relevant approaches to do so.

1. *Deepen exploratory and descriptive research on health system software*

Given the still limited body of relevant research (Gilson 2013; Sheikh et al. 2011) more exploratory and descriptive work would be useful – offering further insights into forms of software and interactions with hardware, for example. Two steps to deepen such work could be to pre-identify which features of software to examine and to ensure full coding of all data collected using the overall conceptualisation in analysis.

a. Clearly identify the software dimensions of focus. Sheikh et al. (2011) and Elloker et al. (2012) both provide somewhat brief and surface-level descriptions of what software constitutes, as summarised earlier. The concepts they identify, such as ideas, interests, values, norms, power,

tangible and intangible software are broad, and somewhat open-ended categories that are not in themselves well defined.

In this review we have identified the various software elements that have been investigated empirically, providing examples of the forms of software examined in real-world experiences. We developed sub-categories of both tangible and intangible software from these experiences, as seen in Table 3. This table offers, then, some conceptual clarity about health system software based on previous empirical inquiry that can be used as a starting point for future research.

However, it is worth pointing out that some types of software have been neglected within past empirical inquiry explicitly framed as research on 'health system software'. Blaauw et al. (2003) describe research conducted in the beginning of the 2000s which investigated histories (Walker and Gilson 2004; Froestad 2002) and national political discourse (Schneider and Fassin 2002), calling these software. However, our review reveals that such software factors were not investigated in the literature selected, since 2011. This may point to limited understanding of what software constitutes, or limited inquiry, and may suggest that future research should seek to explore forms of software beyond that identified in Table 3, such as histories and political discourse.

b. Use hardware-software conceptualisation to guide data analysis. The review revealed that the conceptualisation was used in many of the included studies to code identified elements as either hard- or software as part of data analysis (outlined in Table 4). Das et al. (2022), Kagwanja et al. (2020), Mwamba et al. (2018), Topp et al. (2015) and Arakelyan et al. (2022) all discuss that the hardware-software conceptualisation was useful to characterise the various influences on the other health system experiences they examined.

Using frameworks during qualitative data analysis is important in enhancing rigour because it separates the interpretations of the researchers from the experiences of the participants (Ritchie et al. 2013). Therefore, the credibility of the findings is enhanced as interpretation and findings are clearly distinguished. Furthermore, using frameworks within analyses helps justify the decisions within qualitative research (Kegler et al. 2019). Rigour can be enhanced, then, by using the hardware-software conceptualisation as a framework during qualitative data analysis.

Finally, by categorising health system elements as either hard- or software, further conceptual clarity about the specific elements of both categories is gained (and this could, for example, add to Table 3). Researchers should, therefore, consider using the hardware-software conceptualisation as a coding framework to explore and describe influences on various aspects of health system experiences, similarly to the papers outlined in Table 4.

2. Deepen explanatory research about health system software

Stronger understanding of the influence of health system software in health systems would be developed by conducting more explanatory research, that explicitly sets out to explain how and why software impacts on other system experiences (Gilson 2013; Sheikh et al. 2011). Within such work a more purposive, or deductive inquiry approach would be useful in tracing complex interactions.

For example, the second phase of the review identify two literature reviews, one of which generated a specific framework, that were then purposively used in subsequent empirical research. Palagyi et

al. (2019) identified what hardware and software elements influence health system preparedness for emerging infectious diseases from a literature synthesis. This was then used by Moussallem et al. (2022) to guide their empirical inquiry in Lebanon. Similarly, Kok et al. (2017) developed a model of the interacting influences over CHW performance from literature synthesis and this was used by Zawolo et al. (2022) to inform their research.

Reviews could then be a step towards using the software concept to inform future research. They are useful in synthesising the evidence on a particular topic (Arksey and O'Malley 2005) and allow for rich interpretations of phenomena as they aim to synthesise all the relevant evidence (Flemming and Noyes 2021). Reviews could reveal which factors are worth looking at in relation to specific health system experiences, so that researchers can purposively investigate these factors.

However, three of the papers which used the hardware-software conceptualisation more deductively (Reddy et al. 2022; Wanyama et al. 2022; Schneider et al. 2014) did not make reference to being based on any prior work. This is problematic, as it may undermine the claims these authors make. We therefore encourage future researchers to make clear on which prior work they base their own research.

3. Conduct research about the interactions among hardware-software

The second phase of the review revealed that only three papers explicitly investigated the interactions amongst the identified hard- and software elements (Arakelyan et al. 2022; Das et al. 2022; Topp et al. 2015).

Blaauw et al. (2003), one of the first papers to introduce the concepts of hard- and software, theorised varying perspectives of health systems. One of these is the mechanistic perspective which views health systems as made up of clearly defined and separate components. Ironically, the lack of investigation into the interactions of the hard- and software elements is assuming a rather mechanistic view of these elements, seeing as they are presented as isolated and independent from each other. Adam and de Savigny (2012) also argue that focusing on isolated components limits our ability to conceptualise a health system as a CAS. Rather, they suggest that understanding the interacting components is critical in understanding the operations of a health system.

Elloker et al. (2012) and Sheikh et al. (2011) also specifically highlight that the interactions amongst hard- and software elements is an important feature of the conceptualisation. Although some papers included in this review did explicitly examine interactions within policy implementation (Arakelyan et al. 2022) and an accountability experience (Topp et al. 2015), some only presented a surface level assessment (for example, Kagwanja et al. (2020) and Mwamba et al. (2018)) and most did not examine interactions at all.

Arakelyan et al. (2022) provide an unusual and strong example of how to depict and examine these interactions. Visualising them diagrammatically (see Figure 7), they demonstrate how hard- and software interacted and influenced one another within the implementation of TB-IPC programmes. For example, staff workload (software) impacted on the patient file retrieval system (hardware), and this, in turn, impacted on the patient waiting time. This would ultimately influence patient flow and congregation within the TB-IPC programme (Arakelyan et al. 2022).

This presentation (Figure 7) acts as a useful example of the research approach Adam and de Savigny (2012) called for; "dynamic and holistic approaches that appreciate the multifacted and interconnected relationships among health system components" (p. iv). Future HPSR should seek both to understand and represent these relationships, as Arakelyan et al. (2022) have done. This would add to the knowledge of how to think of health systems as CAS and, as Adam and de Savigny (2012) argue, would aid in institutionalising this way of thinking.

Value of concept for purposes other than research

Adam and de Savigny (2012) discuss how the characteristics of CAS include the "views, interests and power of its different actors" (p. iv). Therefore, as components of complex health systems, actors are themselves interacting with other components. Health system actors are also conscious beings, and in this lies another opportunity for applying the concept of health system software outside research. Having health system actors be cognisant of the underlying software driving their behaviours, would increase awareness of software's influence within the health system.

One paper which demonstrates this value is Ramani et al. (2022), who discuss how to rewire intangible software within health facilities in India. They offer ideas for managers about strategies that could be used in addressing the underlying factors driving their staff's behaviours and actions, and, therefore, rewiring this software in a favourable way. Being aware of the concept of software allows managers to better understand that health systems are CAS and to navigate their dynamics.

Walker and Gilson (2004), a study not included in this review, provide an example of when it would have been useful to understand software within a particular context. They studied nurses' perceptions of the implementation of a free care policy in South Africa. One finding of this study, was that nurses felt overlooked in the development of the policy process, leaving them feeling isolated. These feelings of isolation (software) were found to be barriers to the implementation of the policy. Hypothetically, if managers and policy-makers had incorporated the nurses into the development of the policy process and made them feel more included, more positive perceptions and attitudes towards the policy may have resulted and led to more successful policy implementation.

Another study included in this review also found that health facility managers showed interest towards the software concept within a course on CAS (Nzinga et al. 2021). The course increased managers' recognition that health system software is important, improved their self-awareness and the overall communication practices. A recent article published in Bhekisisa Centre for Health Journalism in South Africa further supports the idea that understanding software has value to health practitioners:

> . . .medicine can be a powerful tool to restore people's dignity – but only when doctors understand the ways in which power systems such as racism, colonialism, imperialism and white supremacy continue to determine who is seen as fully human. . . (Mofokeng 2022).

Mofokeng is suggesting that health practitioners need to understand the underlying power systems which influence their own behaviours. These power systems are intangible software features that influence the social roles people have in a society and how they interact with each other.

Nzinga et al. (2021) also discuss the importance of seeing health systems software as an area of teaching in relation to health managers and practitioners, suggesting such teaching could change the way they work and so directly impact on the software of the health system.

Study Limitations

A search strategy was created with the help of an expert UCT FHS librarian. Although this contributed to the robustness of the paper searches, it is possible that that not all relevant papers were identified. This could have been due to the tight focus on the term 'health system software' multiple or differing terms being used for this concept. This means that studies which make reference to the health system software concept, without using the varying forms of the term 'health system software' which we indicate in the search strategy, were not included in this review. This tight focus was appropriate seeing as the aim was to review how the specific term 'software' has been used.

This review is also limited by only including English publications. Only one reviewer undertook the data extraction and analysis for this review, although the supervisor of this researcher aided in ensuring the rigour by reviewing the extracted data and analyses. Nonetheless, the bias that it perhaps introduced must be acknowledged.

Conclusion

The field of HPSR acknowledges that understanding health system software can aid understanding of how health systems work in reality. However, this review has revealed that, since 2011, when first called for, limited research has directly considered the software concept, and very few papers have used the concept purposively to support empirical research. Various insights were drawn from the review. First, the hardware-software conceptualisation offers value as a framework within HPSR. Furthermore, future research can build on existing work that has actively used the software concept. Clarity and practical guidance on how to investigate interactions between hard- and software elements is, however, needed as there is perhaps uncertainty on how to conduct such research. Lastly, health system actors other than researchers could gain from being aware of health systems software. We therefore encourage future research to make use of this concept, and so strengthen HPSR by considering health systems as complex adaptive systems.

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Part C: Appendices

Appendix A: Search strategy record of excluded subjects

Table 1. Excluded subject areas during scoping review literature search

Scopus	Web of Science
• Computer science • Engineering • Mathematics • Physics and astronomy • Materials science • Earth and planetary science • Energy • Biochemistry • Genetics and Molecular Biology • Chemical engineering • Environmental science • Chemistry • Economics • Econometrics and Finance	• Software Engineering • Distributed and Real Time Computing • Telecommunications • Astronomy and Astrophysics • Design and Manufacturing • Brain Imaging • Nuclear Fusion • Medical Physics • Robotics • Automation and Control Systems • Knowledge Engineering and Representation • Education and Educational Research • Safety and Maintenance • Law • Management • Mineral and Metal Processing • Geochemistry, Geophysics and Geology • Music • Nucleic Acids Chemistry • Nitroxides, Antioxidants and Free Radicals • Crop Science • Dairy and Animal Sciences • Computer Vision and Graphics • Security Systems • Artificial Intelligence and Machine Learning • Meteorological and Atmospheric Sciences • Space Sciences • Instrumentation • Physics Education • Geometrical Optics • Ceramics • Metallurgical Engineering • Geotechnical Engineering • Energy and Fuels • Combustion • Testing and Maintenance • Electrical – Sensors and Monitoring • Manufacturing • Environmental Sciences • Ocean Dynamics

Appendix B: Data extraction form for Phase 1

Table 2. Data extraction forms for Phase 1 scoping review (Source: Author)

	Paper name		
1	Year		
2	Type of paper *For example; empirical research, commentary, editorial, review.*		
3	Country/setting investigated (if relevant)		
4	Was the concept used within study design or identified in data analysis? (if relevant)		
	Elaboration on use. *For example; was it used as a framework informing design?*		
	Pre-determined themes; how the concept was used	Interpretation	Evidence for interpretation
5	Classify as; 5. Acknowledgement of concept importance 6. Conceptualisation of software element/s 7. Concept used to explore a health system experience 8. Other		
6	According to classification in Row 7, if classified as;		
	2. 'Conceptualize importance of software element', then; ➔ What software element? (examples; trust, norms, power, processes of decision making) ➔ Tangible or intangible software?		
	3. 'Concept used to explore another health system experience, then; ➔ Which health system experience? *(for example; preparedness, resilience, implementation, performance).* ➔ How was software concept used in relation to this experience?		
	4. 'Other', then; ➔ Explain use of the concept		
7	Any other remarks or notes.		

Appendix C: Data extraction form for Phase 2

Table 3. Data extraction form for Phase 2 of review (Source: Author)

1	2	3	4	5		6
Authors	Year	Description of use within study design	Overall conclusion of the influence of software on the health system experience	Interactions between hardware and software looked at		Health system experience investigated (e.g. resilience, preparedness, performance)
				Yes/No?	How?	

Appendix D: Data extraction record

Link to Extracted Data for Phase 1:

https://docs.google.com/spreadsheets/d/1icz86hgEMpj0xU4wwcfM2yhhEnvYCuM0/edit?usp=share_link&ouid=117041985422251980308&rtpof=true&sd=true

Table 4. Data extraction record for Phase 2

1	2	3	4	5		6
Authors	**Year**	**Description of use within study design**	**Overall conclusion of the influence of software on health system experience**	**Interactions between hardware and software looked at?**		**Health system experience investigated (e.g. resilience, preparedness, performance)**
				Yes/No?	**How?**	
Kok et al.	2017	Development of framework which incorporates and suggests the hardware and software which influences on CHW performance.	"The above examples show that it is important to investigate how CHW programmes can be shaped to increase common understanding, improve relationships and balance power between different actors in the health system. Questions about "how" and "why" interventions work or do not work are closely related to the software elements" (p.5)	Yes	Highlighted in framework	Community Health Workers
Zawolo et al.	2022	The study used the hardware-software conceptualisation to frame examining hard and software factors which shape CHW motivation and support. They used Kok's et al. (2017) framework for influences on CHWs.	"this study shows how system and intervention hardware, and software dimensions provide leveraging opportunities to address gaps and increase CHW motivation and competencies towards better health care delivery and stronger and resilient health systems" (p.14) "software dimensions show challenges regarding community engagement and dialogue in CHW programming" (p.2)	No	n/a	Community Health Workers

Moussallem et al	2022	Concept used to decide what hardware and software elements to look at in relation to preparedness. They used the review by Palagyi et al. to determine what hard- and software elements to investigate in relation to preparedness.	"'hardware' capacities of the system were found to be responsive yet deeply influenced by the challenging national context" (p.1) "… the system 'software', there were attempts for a participatory governance mechanism, but the actual decision-making process was challenging with limited cooperation and strategic vision, resulting in decreased trust and increased confusion among communities. Moreover, the power imbalance between health actors and other stakeholders affected decision-making dynamics and the uptake of scientific evidence in policy-making" (p.1)	No	n/a	Preparedness
Topp et al.	2019	Hardware and software model used to frame the phenomena under investigation – it was used to frame looking at willingness of patients, providers and health planners/managers to participate and how this would impact on health service feasibility.	"policy directives, health service delivery systems, adequate resourcing, and population dynamics" (p.189) play a critical role in the feasibility and likely sustainability of UTT in correction facilities in Zambia and South Africa. Here, they didn't state the overall impact that software had.	Yes somewhat	"respondents described HIV-related stigma as an ongoing barrier to UTT uptake. Accounts referenced recent and past trauma that interacted with feelings of fear and isolation, leaving many individuals unwilling to start treatment" Here, they are outlining the elements that interacted to cause unwillingness to start treatment. Although, they are not explicitly outlining hardware-software interactions.	Implementation of UTT services
Wanyama et al.	2022	This protocol, uses the concept of software to frame the concepts that will be looked at and explored. They are seeking to explore what	n/a (only a protocol)	n/a	n/a	Quality of care

		(software) factors influence on quality of care in neonate hospitals.				
Kagwanja et al.	2020	Use to label stressors as either hardware or software.	"the conceptual framework use [hardware-software of health systems] for analysis was useful to demonstrate different types of strategies and the role of organizational capacities in nurturing (for building) everyday resilience" (p.532)	Yes	When describing stressors, the authors would allude to these interactions. E.g. "These HR management issues (tangible software) coupled with resource constraints (hardware) created dissatisfaction among HCWs leading to frequent HCW strikes"	Everyday resilience
Reddy et al.	2022	This study uses the hardware-software model to explore and frame what concepts they are looking at. In this review, they look at workplace culture, division of labour, supervision and monitoring, working conditions	"ultimately, changes in 'software' elements of organisational management must be matched by serious attempts to address the challenges posed by resource shortages, and with wider improvements in training, renumeration and formal professional recognition that are also powerful levers to tackle medical hierarchies" (p.21)	No	n/a	Provider behaviour and experience of maternity care/respectful maternity care
Mwamba et al.	2018	Used to arrange identified themes of what influences on decisions to disengage from HIV services.	"health system 'hardware' (resourcing) and 'software' (clinic operating practices – including work norms and patterns and HCW attitudes) often interacted and amalgamated to influence patients' decisions to engage or disengage in care" (p.8)	Partially	The said that they investigated the interactions, however, these weren't explicit.	Problem of 'disengagement from care' for ART services.
Das et al.	2022	Used to code influences and contributors to performing out.	"using a CAS framing, we demonstrate how these individual behaviours emerge from the dynamic interaction between underlying system elements of chronically deficient hardware, audit-style performance accountability approaches (tangible software), and an organisational culture that validates 'performing out' (intangible software)" (p.9)	Yes	e.g. "the mechanisms through which ELAs are managed, monitored, and reported evoke formal and informal power, especially in terms of the job insecurity or the precarity created through contractual arrangements,	Problem of 'performing out'.

					and serve as disguised forms of dominant power" "the dynamic interaction between chronically deficient hardware, audit-style performance accountability processes (intangible software), and a culture that validates 'performing out' have proven to be path dependent and emergent patterns of the system as a whole"	
Topp et al.	2016	Used to deductively code influences on trusting relationships as either hardware (drug supplies, financing, human resources) or software (leadership, workplace norms and patient expectations)	"investment in HIV-specific infrastructure, health information systems and supplies (hardware) as well as quality assurance and supportive supervision (software) promoted workplace trust and patient-provider trust in the ART clinics via positive feedback loops" (p.8)	No	n/a	Trusting relationships
Topp et al.	2015	Used to deductively code influences as either hardware (governance, financing, human resources) or software (leadership, workplace norms and patient expectations)	"the findings confirm the relevance of the Sheikh et al.'s (2011) hardware-software model and demonstrates how the original framework may be adapted to achieve greater analytical and explanatory power by examining first, the way hardware-software interactions act positively or negatively on particular mechanisms of accountability, and though these, health system performance" (p.498)	Yes	Described in results sections. For example: "structural human resource shortages (a hardware factor) thus contributed to a high burden of work and pressure to completel tasks quickly, which compounded in some cases by lack of capacity, contributed to data-entry errors, shortcuts or	Mechanisms of accountability

					shirking of these duties altogether” (p.10) “significant hardware factor was the chronic human resource shortage experienced across all four sites… health-care workers… described the time pressure they experienced…” (p.10)	
Arakelyan et al.	2022	Used to frame/code the influences on TB-IPC measures.	“’hardware’ and ‘software’ constraints interact to impact negatively on the capacity of primary care staff to implement TB-IPC measures” (pp.1-2)	Yes	Created a concept map which showed the various interactions between identified hardware and software influences. Useful because “indicate what dynamics must be considered when studying the implementation of TB-IPC, or indeed IPC practice more generally” (p.17)	Uptake of a policy (IPC measure)
Myburgh et al	2021	Used to categorise articles in the review as either infrastructural or relational, referring to hardware and software respectively. This was done to locate challenges or opportunities for expanding ART access.	“our review results and consultative process both identified the need for developing and implementing policies that expressly address the software in the system and that include systems of accountability. But, we can only invest in what we understand” (p.934)	No	n/a	Accessibility
Schneider et al	2014	Used to inform the interviews and checklists of what to look for within the evaluation. Informed looking at “actor knowledge and ownership of the policy, and changing roles and relationship” (p.4)	“the case study highlights how a collective vision [software] can facilitate commitment to and engagement with new policy in complex organisational environments” (p.9)	No	n/a	Implementation of primary health care reform

Palagyi et al.	2019	Used to code what was influences on emerging-infectious diseases preparedness.	"highlights the critical role of system 'software' (i.e. governance and trust) in enabling LMIC health systems to achieve and maintain EID preparedness" (p.1847)	No	Only acknowledged that interactions are important and that health system frameworks do not reflect or account for these interactions (p.1862).	EID preparedness
Nzinga et al.	2021	Used within the learning site to teach health workers the conceptualisation of hardware-software; this was done to build "critical thinking skills" (p.1035).	"All eight participants were highliy enthusiastic about the course, reporting that the concepts and tools shared were useful for their everday work. The concepts most often mentioned influded understanding health systems as complex systems, considering the software of the system…" (p.1029)	n/a	n/a	n/a
Mayhew et al.	2020	Used by coding the influences on integration between sexual and reproductive health and HIV services.	"Two groups of software factors emerge as essential enablers of effective integration of SRH and HIV services that often interact with systems hardware: (1) leadership, management, and governance processes and (2) provider motivation, agency, and relationships" (p.711)	No		Integration of different service deliveries
Zwama et al.	2021	Used by coding the influences on implementation of TB-IPC programmes in health facilities.	"… predominantly focussing on health system hardware. However, we need to adopt a whole system approach to (1) further investigate system cross-cutting influences and interactions that have bearing on the implementation of TB-IPC, with particular attention to health system software" (p.10)	No	Although, acknowledged that interactions are important but did not investigate interactions itself. Although, it couldn't really, because it was a review.	Implementation of TB-IPC.

Appendix E: Guidelines for authors

Health Policy and Planning Journal: Submission Guidelines[1]

Instructions for Authors

Health Policy and Planning will be published online-only from May 2020. All print editions will be discontinued.

Health Policy and Planning improves the design, implementation and evaluation of health policies in low- and middle-income countries through providing a forum for publishing high quality research and original ideas, for an audience of policy and public health researchers and practitioners. HPP is published 10 times a year.

Health Policy and Planning has received transformative journal (TJ) status by cOAlition S. HPP is committed to transitioning to a fully open access journal by gradually increasing its open access content in line with growth targets set by cOAlition S.

For authors funded by groups who have now implemented the principles of Plan S, such as UK Research and Innovation (UKRI) and Wellcome, this means that you can publish open access in HPP, receive funding for your Article Publishing Charges (APCs), and meet the requirements laid down by Plan S.

For more information about complying with funder policies please visit: https://academic.oup.com/journals/pages/open_access/funder_policies

For more information about transformative journal status please visit: https://www.coalition-s.org/transformative-journals-faq/

HPP has a double-anonymised peer-review policy. This means the identity of the authors is anonymous to the reviewers and vice-versa. All types of papers are peer reviewed and all article abstracts from each issue are translated into French, Spanish and Chinese.

Before you submit please make sure you have followed all the relevant instructions. A checklist for authors is available on the HPP webpage.

We're pleased to offer these video resources guiding authors and reviewers on the best practices for reviewing and submitting to *Health Policy and Planning*.

Please submit your paper to the most appropriate section. Read our Section Summaries.

Please note that submission of a paper implies that it reports unpublished work and that it is not under consideration for publication elsewhere. Plagiarism, including duplicate publication of the author’s own work, in whole or in part without proper citation is not tolerated by HPP. Submitted manuscripts are screened with iThenticate software, as part of the CrossCheck initiative to detect and prevent plagiarism.
Guidance

[1] Some parts of the author guidelines for Health Policy and Planning journal have been omitted – where considered irrelevant.

Appendices

Improving chances of publication

Manuscript format and style for all articles

Prior publication guidelines

Types of papers

Submission process

Guidance

Improving chances of publication

As well as the high overall quality required for publication in an international journal, authors should take into consideration:

Addressing HPP's readership: national and international policy makers, practitioners, academics and general readers with a particular interest in health policy issues and debates.

Manuscripts that fail to set out the international debates to which the paper contributes, and to draw out policy lessons and conclusions, are more likely to be rejected, returned to the authors for redrafting prior to being reviewed, or undergo a slower acceptance process.

Economists should note that papers accepted for publication in HPP will consider the broad policy implications of an economic analysis rather than focusing primarily on the methodological or theoretical aspects of the study.

Public health specialists writing about a specific health problem or service should discuss the relevance of the analysis for the broader health system. Those submitting health policy analyses should draw on relevant bodies of theory in their analysis, or justify why they have not, rather than only presenting a narrative based on empirical data.

Primarily focus on one or more low- or middle-income countries.

The editors cannot enter into correspondence about papers considered unsuitable for publication and their decision is final. Neither the editors nor the publishers accept responsibility for the views of authors expressed in their contributions. The editors reserve the right to make amendments to the papers submitted although, whenever possible, they will seek the authors' consent to any significant changes made. The manuscript will not be returned to authors following submission unless specifically requested.

Should you require any assistance in submitting your article or have any queries, please do not hesitate to contact the editorial office at hpp.editorialoffice@oup.com.

Should your manuscript require any English language editing, we recommend contacting AuthorAid, a free network which provides free mentoring and English-language editing for researchers in low- and middle-income countries.

Manuscript format and style for all articles

Only articles in English are considered for publication.

The journal follows Oxford SCIMED style. Please refer to these requirements when preparing your manuscript. More information on preparing your manuscript is available. Oxford English spelling

style should be used consistently throughout your manuscript. (-ize/-ization), except in quotations and in references.

Prepare your manuscript, including tables, using a word processing program and save it as a *.doc, .rtf* or *.ps* file. Use a minimum font size of 11, double-spaced and paginated throughout including references and tables, with margins of at least 2.5 cm. The text should be left justified and not hyphenated.

Authorship: Please note there should be a LMIC (lower-middle-income) named author from the region of the paper included in the paper. If all named authors are from HICs' (high-income countries) please clarify the reason for this on the Title Page. In addition, a contributorship statement is required - please note as follows on the Title Page:

Please clarify how each author has contributed to the paper. You need to create a list assigning a person's name against the following roles or tasks:

Conception or design of the work

Data collection

Data analysis and interpretation

Drafting the article

Critical revision of the article

Final approval of the version to be submitted - all named authors should approve the paper prior to submission.

Reflexivity Statement:

At *Health Policy and Planning*, we believe in reducing inequities in global health research. We invite you to reflect on the inclusivity within the authors' group for this paper. You may want to consider inclusivity and balance in dimensions such as gender, seniority, regional location, etc when writing this statement.

The Title Page should be uploaded as a separate file type "Title Page" and contain the following information:

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Corresponding authors name,address,country,e-mail address, ORCID details

Each authors affiliation and qualification (BSc, MA, PhD...)

Keywords and an abbreviated running title

2-4 Key messages, detailing the main points made in the paper

Reflexivity Statement

A word count of the full article:Word Limits do not include Abstract, References, Figure/Table legends.

Ethical Approval

if no ethical approval was required for the research, please note the reason:

Appendices

Example A: Ethical approval for this type of study is not required by our institute.

Example B: Ethical approval for this research was waived by the authors institute/s IRB.

Ethical Approval Received-Please note the institute/s which approved the research with reference number.

Original Articles-word limit 6000
Review Articles- word limit 10000
Commentaries: Word limit 1200
How to do...or not to do - word limit 3000
Methodological Musings-word limit 3000
Innovation and practice reports: word limit 2000

Funding/Acknowledgements/Conflicts of interest/Ethical approval should be noted on the title page.

In the acknowledgements, all contributors who do not meet the criteria for authorship should be listed. Sources of funding for research must be explicitly stated, including grant numbers if appropriate. Other financial and material support, specifying the nature of the support, should be acknowledged as well.

Figures should be designed using a well-known software package for standard personal computers. If a figure has been published earlier, acknowledge the original source and submit written permission from the copyright holder to reproduce the material.

Please be aware that the requirements for online submission and for reproduction in the journal are different: (i) for online submission and peer review, please upload your figures separately as low-resolution images (.jpg, .tif, .gif or. eps); (ii) for reproduction in the journal, you will be required after acceptance to supply high-resolution .tif files. Minimum resolutions are 300 d.p.i. for colour or tone images, and 600 d.p.i. for line drawings. We advise that you create your high-resolution images first as these can be easily converted into low-resolution images for online submission.

Figures will not be relettered by the publisher. The journal reserves the right to reduce the size of illustrative material. Any photomicrographs, electron micrographs or radiographs must be of high quality. Wherever possible, photographs should fit within the print area or within a column width. Photomicrographs should provide details of staining technique and a scale bar. Patients shown in photographs should have their identity concealed or should have given their written consent to publication. When creating figures, please make sure any embedded text is large enough to read. Many figures contain miniscule characters such as numbers on a chart or graph. If these characters are not easily readable, they will most likely be illegible in the final version.

Certain image formats such as .jpg and .gif do not have high resolutions, so you may elect to save your figures and insert them as .tif instead.

For useful information on preparing your figures for publication, go to the Digital Art Support page.

All measures should be reported in SI units, followed (where necessary) by the traditional units in parentheses. There are two exceptions: blood pressure should be expressed in mmHg and haemoglobin in g/dl. For general guidance on the International System of Units, and some useful conversion factors, see 'The SI for the Health Professions' (WHO 1977).

Manuscript file must include text body. Title Page, Figures and Tables should be uploaded separately.

Prior Publication Policy

Appendices

[Based on a statement developed by a group of editors of journals that publish articles on health, health services, and health policy. Journals currently using this statement include: Health Affairs, Health Services Research, Inquiry, Journal of Health Politics, Policy and Law, Journal of Health Services Research & Policy, Medical Care, and the Milbank Quarterly.]

Background

The policy of the journals subscribing to this statement is to consider for publication only original work that has not previously been published. Questions about what constitutes previous publication are arising with increasing frequency because of the growth of electronic publishing and the increasing number of reports and papers being produced by organizations and agencies. This statement provides guidance on this issue.

There are legitimate reasons why research may be disseminated before submission to a journal. Active communication among researchers about preliminary findings or the circulation of draft reports for discussion and critique contributes to the eventual quality of published work. In addition, organizations that support or carry our research have an understandable interest in disseminating their work. From the perspective of journals, these reasons for dissemination must be balanced against two considerations. The first is the value of the peer review process. The rules against prior publication are intended to add some assurance of the credibility of published research.

Papers are often improved during the peer review process, with findings, conclusions, and recommendations sometimes changed in response to reviewers' comments. The public and policymakers might be confused or misled if there were multiple versions of a paper in the public domain. Second, from a more parochial viewpoint, journal space is limited, and much time and expense are involved in the evaluation, publication, and distribution of journal articles. Journals must make difficult choices about what to include; there is less value in publishing papers that have already been disseminated to their target audiences.

We discuss here several types of dissemination and provide guidelines with respect to the prior publication question. This discussion is essentially an elaboration of two rules, the first emphasizing previous dissemination of the material, the second stressing disclosure.

Rule One: If the material in a paper has already been disseminated to a journal's audience, particularly in a format that appears to be a final product, then it is unlikely that a second version will be worth publishing in the journal.

Rule Two: It is the responsibility of authors to let editors know at the time of submission whether a paper's contents have been previously disseminated in any manner so that the editors can determine whether to proceed with the review process.

Previous Presentations at Meetings

Presentation of a paper at conferences or seminars usually does not jeopardize the possibility of publication.

. . .

Appendices

Manuscript Preparation

Page 1: *Title Page* – as above.

Page 2: *Abstract.* The abstract should be prepared in one paragraph, no headings are required. It should describe the purpose, materials and methods, results, and conclusion in a single paragraph no longer than 300 words without line feeds.

Page 3: *Introduction.* The Introduction should state the purpose of the investigation and give a short review of the pertinent literature, and be followed by:

Materials and methods. The Materials and methods section should follow the Introduction and should provide enough information to permit repetition of the experimental work. For particular chemicals or equipment, the name and location of the supplier should be given in parentheses.

Results. The Results section should describe the outcome of the study. Data should be presented as concisely as possible, if appropriate in the form of tables or figures, although very large tables should be avoided.

Discussion. The Discussion should be an interpretation of the results and their significance with reference to work by other authors.

Abbreviations. Non-standard abbreviations should be defined at the first occurrence and introduced only where multiple use is made. Authors should not use abbreviations in headings.

All *measures* should be reported in SI units, followed (where necessary) by the traditional units in parentheses. There are two exceptions: blood pressure should be expressed in mmHg and haemoglobin in g/dl. For general guidance on the International System of Units, and some useful conversion factors, see 'The SI for the Health Professions' (WHO 1977).

References. References must follow the Harvard system and must be cited as follows:

Baker and Watts (1993) found...

In an earlier study (Baker and Watts 1993), it...

Where works by more than two authors are cited, only the first author is named followed by 'et al.' and the year. The reference list must be typed double-spaced in alphabetical order and include the full title of both paper (or chapter) and journal (or book), thus:

Baker S, Watts P. 1993. Paper/chapter title in normal script. Journal/book title in italics *Volume number in bold* : page numbers.

Baker S, Watts P. 1993. Chapter title in normal script. In: Smith B (ed). *Book title in italics*. 2nd edn. Place of publication: Publisher's name, page numbers.

Tables All tables should be on separate pages and accompanied by a title - and footnotes where necessary. The tables should be numbered consecutively using Arabic numerals. Units in which results are expressed should be given in parentheses at the top of each column and not repeated in each line of the table. Ditto signs are not used. Avoid overcrowding the tables and the excessive use of words. The format of tables should be in keeping with that normally used by the journal; in

particular, vertical lines, coloured text and shading should not be used. Please be certain that the data given in tables are correct. Tables should be provided as Word or Excel files.

Availability of Data and Materials

Where ethically feasible, *Health Policy and Planning* strongly encourages authors to make all data and software code on which the conclusions of the paper rely available to readers. Authors are required to include a Data Availability Statement in their article. This policy applies to all papers submitted to the journal on or after June 2020.

We suggest that data be presented in the main manuscript or additional supporting files, or deposited in a public repository whenever possible. For information on general repositories for all data types, and a list of recommended repositories by subject area, please see Choosing where to archive your data.

Data Availability Statement

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. . .

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