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**Improving Digital Health Competencies for Health Service Managers
in Australia**

Submitted by

Mark Stephen Brommeyer

In fulfilment of the requirements for the degree of

Doctor of Philosophy

College of Public Health, Medical and Veterinary Sciences

James Cook University

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Statement of the use of Generative AI

Grammarly[®] and Paperpal for Word[®] were used for syntactical and grammatical guidance.

No other forms of Generative AI technology were used in the preparation of any part of this thesis.

Peer reviewed publications included in this thesis

1. Brommeyer, M., Whittaker, M., Mackay, M., Ng, F. & Liang, Z. (2023). Building health service management workforce capacity in the era of health informatics and digital health—a scoping review. *International Journal of Medical Informatics*, 104909. <https://doi.org/10.1016/j.ijmedinf.2022.104909>
2. Brommeyer, M., Mackay, M., Liang, Z., Schaper, L. & Balan, P. (2021). A proposed approach to investigate whether postgraduate health care management education in Australian universities facilitates the development of informatics competencies. *Studies in Health Technology and Informatics*, 284, 93-97. <https://doi.org/10.3233/SHTI210677>
3. Brommeyer, M., Whittaker, M., Mackay, M. & Liang, Z. (2023). Developing Health Management Competency for Digital Health Transformation: Protocol for a Qualitative Study. *JMIR Research Protocols*, 12, e51884. <https://doi.org/10.2196/51884>
4. Brommeyer, M., & Liang, Z. (2022). A Systematic Approach in Developing Management Workforce Readiness for Digital Health Transformation in Healthcare. *International Journal of Environmental Research and Public Health*, 19(21), 13843. <https://doi.org/10.3390/ijerph192113843>
5. Brommeyer, M., Whittaker, M. & Liang, Z. (2024). Organizational Factors Driving the Realization of Digital Health Transformation Benefits from Health Service Managers: A Qualitative Study. *Journal of Healthcare Leadership*, pp.455-472. <https://doi.org/10.2147/JHL.S487589>
6. Brommeyer, M., Whittaker, M., Mackay, M. & Liang, Z. (2025). Digital Competencies for Health Service Managers and Health Service Implications for Australia. *Health Information Management Journal*, pp.1-13. <https://doi.org/10.1177/18333583251396573>

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3. Brommeyer, M. and Liang, Z. (2024). *Digital Competencies for Health Service Managers: Educating for Transformation*. Health. Innovation. Community: It Starts With Us. Australasian Digital Health Conference 2024.
4. Brommeyer, M. and Liang, Z. (2023). *Health Service Managers – Digital Health Workforce Capability Factors and Implications*. SHAPE International Symposium 2023.
5. Brommeyer, M. Whittaker, M. and Liang, Z. (2023). *Health Service Managers' Digital Competencies: A Conceptual Framework*. MedInfo 2023: 19th World Congress on Medical and Health Informatics.
6. Brommeyer, M. and Liang, Z. (2022). *Digital Health Competencies for Health Service Managers*. SHAPE International Symposium 2022.
7. Brommeyer, M. and Liang, Z. (2021). *Digital health, health informatics and health service management – similarities and differences*. SHAPE International Symposium 2021.
8. Brommeyer, M. and Mackay, M. (2019). *Improving health informatics competencies for health service managers*. The Society for Health Administration Programs in Education Symposium, Melbourne, Australia.

List of abbreviations

ACHSM	Australasian College of Health Service Management
ADHA	Australian Digital Health Agency
AHICF	Australasian Health Informatics Competency Framework
AI	Artificial Intelligence
AIDH	Australasian Institute of Digital Health
AIHW	Australian Institute of Health and Welfare
CDO	Chief Digital Officer
CEO	Chief Executive Officer
CHIA	Certified Health Informatician Australia
CIO	Chief Information Officer
COREC	Consolidated criteria for reporting qualitative research
COVID-19	Coronavirus disease 2019
EHR	Electronic Health Record
EMR	Electronic Medical Record
EPR	Electronic Patient Record
FGD	Focus Group Discussion
HACC	Home and Community Care
HIMAA	Health Information Management Association of Australia
HIMSS	Health Information and Management Systems Society
HISA	Health Informatics Society of Australia
HSM	Health Service Manager
ICT	Information and Communications Technology
IMIA	International Medical Informatics Association
IT	Information Technology
OECD	Organisation for Economic Co-operation and Development
SME	Subject Matter Expert
WEF	World Economic Forum
WHO	World Health Organization

Glossary

Accountability	The obligation to take responsibility for actions and decisions and to justify them to stakeholders (McGrath and Whitty, 2018)
Capability	The ability to use transferable skills in both new and familiar situations (Rimpiläinen, 2024)
Capacity	The ability of managers or organisations to effectively perform required functions, supported by appropriate resources, skills and systems (Moen and Antypas, 2022)
Competency	“The observable ability of a person, integrating knowledge, skills and attitudes in their performance of tasks” (Mills et al., 2020)
Credentialling	The assessment and validation of a manager’s competencies, including emerging digital health capabilities, to ensure they meet established professional and organisational standards required for safe, effective, and accountable practice (Brommeyer et al., 2025)
Digital health	The “field of knowledge and practice associated with the development and use of digital technologies to improve health” (World Health Organization, 2021)
Digital health literacy	The “ability to find and use health information with the goal of addressing or solving a health problem using technology” (Arias López et al., 2023)
Digital literacy	Foundational to the ability to access, understand, and use information and technologies (Reid et al., 2023)
Healthcare management workforce	The collective group of individuals responsible for the planning, coordination, leadership, and administration of healthcare services, systems, and organisations, ensuring the effective, efficient, and equitable delivery of care (Valiotis et al., 2025)
Health literacy	The ability of individuals to access, understand, evaluate, and use health information and services to make informed decisions about their health and healthcare (World Health Organization, 2025c)
Health services manager	Are “professional managers charged with the responsibility of leading and managing individual health care services, large healthcare organisations and the overall health system” (Australasian College of Health Service Management, 2016)
Professional development	The ongoing process through which individuals enhance their knowledge, skills, competencies, and professional capabilities to

	maintain and improve performance within their field of practice (Al-Omary et al., 2024)
Responsibility	The obligation or duty to ensure that particular tasks are performed to achieve specific results (McGrath and Whitty, 2018)
Roles	“A category that characterises certain groups of activities . . . that serve a common purpose . . . (and) determines scope of practice” (Mills et al., 2020)

Abstract

Healthcare systems across the world are experiencing turbulent and transformative times of change. Societies have been confronting ageing populations, escalating costs of chronic disease, pandemics, and increasing community expectations that are all placing ever increasing pressures on healthcare services. In addressing this challenge, new and novel service models have been adopted to ensure that high-quality care delivery can meet the increasing need and improve the efficacy, value, and safety of the health services provided. These innovative and transformative approaches have included embracing the use of digital health solutions, which were not plausible a generation ago. A healthcare workforce with the necessary skills to facilitate such transformation needs new thinking, new ways of working, as well as being properly resourced and managed accordingly, which can support the objectives of incorporation of digital health in efficacy, value, safety and effectiveness.

A number of competency frameworks have been established to guide management competency development for health service managers, though the evidence is inconclusive as to whether these frameworks satisfactorily captured the competency requirements for managing in the dynamic context of a digitally transforming healthcare environment. This accentuates the need to identify the competencies required for health service managers to effectively work with and manage in this digital health milieu. Therefore, confirming the changing competency requirements for health service managers is substantiated.

Demonstration of management competency is impacted by the organisation; therefore, it is imperative for the organisation to provide an enabling environment in which managers can apply digital health competence to their role. This research was conducted in the Australian healthcare setting to contextualise and describe national frameworks, system and organisational enablers, and factors that sustain health service managers in the Australian digital context. This PhD study sought answers to the following three research questions:

1. To what extent can the existing health service management and digital health competency frameworks guide development of competence for health service managers in understanding and managing in the digital health space?
2. What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context?
3. What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace?

This research was conducted in two phases. *Phase one* consisted of two steps. Step 1 was to understand the health service management competencies that have been used to guide curricula and the teaching focus of formal and informal health management training. Competency mapping of the existing frameworks guiding health service management accreditation, professional development, and postgraduate studies was completed in 2021. Step 2 was to identify international evidence on competencies health service managers needed to effectively demonstrate digital health competence in the workplace, along with the system and organisation capacity factors that were critical to building the management workforce capacity in the digital health environment. A scoping review was undertaken in 2022; the findings confirmed the importance of the research and guided the development of Phase 2. *Phase two* employed focus group discussions to collect primary data that were conducted between February and March 2023. The findings demonstrated the competencies that health service managers need to attain to effectively work with and manage in the digital health context, as well as identifying the key factors that enable and inhibit attainment of these competencies.

This study has uniquely identified the lived experiences of health service managers working in public organisations in Australia that are introducing and increasing use of digital health. Their insights have identified changes in competencies required, to both strengthen and enhance the requirements for health service managers to undertake this work effectively in supporting the organisation's vision, mission and strategic goals. In addition, the study builds the evidence base by providing detailed insights into workforce development and performance needs, informing credentialing and professional development requirements, as well as illuminating the postgraduate and continuing professional development requirements for health service management education and training programs, in the Australian context.

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Chapter One – Introduction

“Accelerating the digital transformation of our health care systems and the adoption of digital health technologies can further transform health systems, improving their effectiveness” (Organisation for Economic Co-operation and Development, 2023, p.4).

— OECD Secretary-General, Mathias Cormann

1.1 Background

Globally, healthcare systems are experiencing an epoch of dynamic and disruptive change. Societies are facing an ageing population, an escalating cost of chronic disease, pandemics, and increasing community expectations. These are all placing escalating demands on healthcare services (Sharma et al., 2025, Khan et al., 2024, Angerer et al., 2022). In addressing this challenge, new and novel service models have been embraced to ensure the continuity of high-quality care delivery to meet this burgeoning need and to improve the efficacy, value, and safety of the health services provided (Mishra and Jain, 2025, World Health Organization, 2025a, Zhang et al., 2025). These innovative and transformative approaches have included the uptake and use of digital health solutions, which were not possible a generation ago. A health workforce with the essential skills to support such transformation needs new thinking, new ways of working, as well as being properly supported and managed to do so, and help achieve the objectives of incorporation of digital health in efficacy, value, safety and effectiveness (Chansanguan et al., 2025).

1.1.1 *Digital health transformation has been experienced*

Digital health services have been shown to be critical in developing timely, tailored and targeted healthcare that is accessible, affordable, appropriate and sustainable (Craig et al., 2025, Brommeyer et al., 2023b, World Health Organization, 2023b). By the very nature of digital health, its defining characteristics evolve over time, and digital health is increasingly being seen as the integration of digital technologies to provide and support healthcare and service delivery. “Digital health refers to systems, tools and services based on information and communications technology that can be used to treat patients and collect and share a patient’s health information” (Australian Institute of Health and Welfare, 2024). In Australia, digital health now includes mobile and wearable technologies and applications, electronic health records, virtual care, electronic decision support systems, artificial intelligence, robotics, and secure national infrastructure to access trusted digital data. “Digital health can increase the quality and efficiency of information sharing between healthcare consumers and providers across the health system” (Australian Institute of Health and Welfare, 2024).

Success in digital healthcare transformation requires digital health solutions that have been designed, developed and delivered effectively, efficiently, ethically and evidence-based under good organisational governance and strategy (Stoumpos et al., 2023, Hovenga, 2022, World Health Organization, 2022, Socha-Dietrich, 2021).

The COVID-19 pandemic saw an increase in the speed of uptake of a range of digital health solutions globally, which compelled healthcare practitioners, managers and organisations to adapt to new ways of working. International responses included digital-first strategies, remote monitoring, and virtual care approaches, which were rapidly instigated to ensure the continuity of healthcare services without physical interactions (Peek et al., 2020). Government responses included employing the requisite policies and funding requirements for innovative digital health solutions to be deployed across jurisdictions, including Australia (Sturgiss et al., 2022).

1.1.2 Skilled workforce requirements

In answering the call for the rapid deployment of digital health technologies, a competent healthcare management workforce with the capability and confidence to implement and integrate digital health technologies into health service delivery is essential (Gnanadhas et al., 2025, Brommeyer et al., 2023b, Laukka et al., 2022). This includes improving the “digital health readiness of healthcare leaders in operational management to implement digital health tools” (Steenkamp et al., 2025, p.1).

In the Australian context, the Australian Digital Health Agency created the National Digital Health Workforce and Education Roadmap and highlighted that “there has been significant interest in emerging literature that examines the future of work and the impact digital technologies will have on the health workforce, or indeed are having. However, there has not been as much concentration on the planning, programs and strategies required to improve the digital health literacy of the health workforce” (Australian Digital Health Agency, 2020, p.29). This suggests that in the Australian context, focusing on the digital health workforce to develop management competency and capability with contemporary and contextual training that is relevant and responsive to the current healthcare environment is crucial.

1.1.3 Competency, capability and demonstration

Adapting to new ways of planning and managing increasingly complex digital tools in an ever-changing environment requires contemporary capabilities and contextual competencies. This will help harness the power of these new technologies and better support both strategic and operational decision making (Alves et al., 2024, Fanelli et al., 2023, Strudwick et al., 2019). The growing evidence emphasising the importance of investing in

developing a competent health service management workforce includes the importance of academic credentialing and professional association certifications (Brommeyer et al., 2023b, Yen and Anderson, 2023, Brommeyer and Liang, 2022, Liang et al., 2020).

Digital competence in healthcare can be seen as encompassing “digital knowledge and skills of digital technology to provide patient-centric care of good quality, digital interaction skills with patients and an interprofessional team, knowledge of ethical perspectives of digitalisation, and motivation and attitude to adopt and gain experience of digital technologies in a professional context” (Jarva et al., 2023, p.1).

A variety of management competency frameworks have been instituted to guide management competency development for health service managers (Brommeyer et al., 2024a, Kakemam and Liang, 2023). The evidence is inconclusive as to whether these frameworks satisfactorily encapsulated the competency requirements for managing in the fast-paced context of a digitally transforming healthcare landscape (Ahrendt et al., 2025, Longhini et al., 2022). This accentuates the need to identify the competencies required for health service managers to effectively manage and lead in this digital health environment (Yen and Anderson, 2023). Therefore, confirming the changing competency requirements for health service managers is warranted.

Management competency demonstration is influenced by the organisation; hence, it is crucial for the organisation to provide an enabling environment in which managers can apply digital health competence to their role (Longhini et al., 2024, Brommeyer et al., 2023b). This research is being conducted in the Australian healthcare setting to contextualise and apprise national frameworks, system and organisational enablers, and factors that buttress health service managers in the Australian digital context.

1.1.4 Knowledge gap and practice gap

This doctoral research investigates both a knowledge gap and a practice gap. The knowledge gap pertains to the extent to which existing health service management competency frameworks sufficiently encompass the competencies necessary for managing within digitally transforming healthcare environments. Although existing frameworks offer guidance on general management competencies, there is a paucity of empirical evidence identifying the specific digital competencies required for health service managers and how these competencies are conceptualised within contemporary healthcare systems.

In addition to the knowledge gap, there exists a significant practice gap between the competencies defined in existing frameworks and the realities of management practice within digitally enabled healthcare settings. Health service managers are increasingly required to

engage with digital systems, data governance and technology enabled decision-making; however, organisational structures, workforce development strategies, and formal training have not consistently evolved to support the development and demonstration of these competencies in practice.

1.2 Research Questions

This research study contributes to confirming the competencies that health service managers need to attain to effectively work with and manage in the digital health context, as well as identifying the key factors that enable and inhibit demonstration of these competencies, by seeking answers to the following three research questions:

1. To what extent can the existing health service management and digital health competency frameworks guide development of competence for health service managers in understanding and managing in the digital health space?
2. What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context?
3. What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace?

1.3 Research Aim

This research program aimed to provide an overarching framework for improving digital health competencies for health service managers. This research generates new evidence regarding the enhanced and new competencies required for health service managers working in the digital health context, as well as detailed insights into workforce development and performance needs. In addition, the study builds the evidence base by informing credentialing and professional development requirements, as well as illuminating the postgraduate and continuing professional development requirements for health service management education and training programs, in the Australian context. The research was conducted in two phases to achieve these outcomes.

1.3.1 Phase 1: Preparation

The preparation phase consisted of two steps. Step 1 was to understand the health service management competencies that have been used to guide curricula and the teaching focus of formal and informal health management training. Competency mapping of the existing frameworks guiding health service management accreditation, professional development, and postgraduate studies was completed in 2021 (Brommeyer et al., 2021b).

Step 2 was to identify international evidence on competencies health service managers needed to effectively demonstrate digital health competence in the workplace,

along with the system and organisation capacity factors that were critical to building the management workforce capacity in the digital health environment. A scoping review was undertaken in 2022 (Brommeyer et al., 2023b), which addressed Research Question 1: To what extent can the existing health service management and digital health competency frameworks guide development of competence for health service managers in understanding and managing in the digital health space?

The findings confirmed the importance of the research and guided the development of Phase 2 in designing the focus group discussions, which addressed Research Question 2 and Research Question 3 and achieved the overall research aim.

1.3.2 Phase 2: Focus group discussions

This phase employed focus group discussions as a data collection method designed to address Research Question 2: What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context? and Research Question 3: What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace?

Six focus group discussions were conducted between February and March 2023. The findings demonstrated the competencies that health service managers need to attain to effectively work with and manage in the digital health context, as well as identifying the key factors that enable and inhibit attainment of these competencies.

1.4 Research Methodology

The research methodology was guided by the empirically validated management competency identification and development process conducted in the Australian health system (Liang et al., 2018b), employing the following three steps: (1) health management and digital health competency mapping; (2) a scoping review of the literature and policy analysis; and (3) focus group discussions with health service managers.

1.5 Positionality Statement

Research occurs in context, then researchers position themselves within that context and apply various perspectives and worldviews, which are shaped by a variety of factors that “influence the researchers’ assumptions, methods of accessing and interacting with participants, the questions they pose, and how they interpret the findings” (Goundar, 2025, p.1). Clarifying the researcher’s positionality provides credibility and clarity to the study, as the researcher is more aware of their ‘insider and outsider hat’ that they wear (Goundar, 2025).

As the principal researcher in this study, the PhD candidate has a background including having trained as a registered nurse at the original Royal Adelaide Hospital, with the apprenticeship style training fostering a reductionist approach to decision making and care provision. Working then as a nurse educator, followed by project officer roles in establishing telehealth networks across domestic and international jurisdictions helped develop a more holistic approach that considered both the context and complexity of human behaviour (Yip, 2024), to understand the interconnectedness of behaviour through a more inductive lens. Thirty years of independent consulting in digital health and working across eleven countries provided a systems approach and organisational change management methods being applied to large scale digital health transformations. This was underpinned by the PhD candidate's various roles in applying, teaching and then modifying national competency development frameworks in both digital health and health service management. The culmination of which led to undertaking doctoral research to explore and improve digital competencies for health service managers in the Australian healthcare sector. In the PhD candidate's role as an academic teaching postgraduate healthcare managers digital health, this also provides a unique insight into the study's research questions.

A qualitative approach was undertaken, guided by an empirically validated methodology to inductively develop a greater understanding of the competencies required for health service managers to operate in the digitally transforming landscape, supported by deductive analysis of research findings against existing national and international industry based and empirically validated competency frameworks.

Lived experience in qualitative research plays an important role (Goundar, 2025) and the researcher's own experiences can be viewed from the duality of an 'insider' and 'outsider' lens, where 'insiders' can be seen as a part of the population they are researching and 'outsiders' seen to be outside of the subjects they are studying (Wilson et al., 2022). This study benefitted from the "insights brought through my identity as both insider and outsider to the research context" (Goundar, 2025, p.3). This was evidenced during the course of the research study when the review of the Australasian Health Informatics Competency Framework (Second Edition) was completed in 2022, as well as the current review of the AHICF (Third Edition) being undertaken by the Certified Health Informatician Australasia Examination Committee, of which the PhD candidate is a member, who directly contributed insights gleaned from evolving findings of this PhD research. In addition, the revised AHICF (Second Edition) contained eleven leadership and management competencies (Australasian Institute of Digital Health, 2022). Also in 2022, a review of the Master Health Service Management Competency Framework was completed by the Australasian College of Health Service Management Review National Steering Committee, of which the PhD candidate is

also a member, who was able to directly contribute six new digital management competencies within the revised framework (Australasian College of Health Service Management, 2022). These were invited expert inputs that the PhD candidate derived from Step 1 of this PhD study, competency mapping, and Step 2, the scoping review findings.

1.6 Thesis Structure and Chapter Organisation

This thesis is organised into seven chapters, including six peer-reviewed journal publications reformatted into chapters as per James Cook University requirements. The thesis structure and summary of the chapters are presented below.

Chapter 2 is a literature review conducted in 2022, which built on a rapid review undertaken in 2020 (Brommeyer et al., 2021a) that explored international literature on the competencies that health service managers needed to acquire to effectively work with and manage in the digital health context, as well as describing the key factors that enable and inhibit health service managers in demonstrating digital health competence in the workplace. This scoping review of the literature was published in the *International Journal of Medical Informatics* in January 2023 (Brommeyer et al., 2023b). Chapter 2 also addresses Research Question 1: To what extent can the existing health service management and digital health competency frameworks guide development of competence for health service managers in understanding and managing in the digital health space? Competency mapping was undertaken to investigate whether postgraduate healthcare management education in Australian universities facilitates the development of informatics competencies. This was published in *Studies in Health Technology and Informatics* in December 2021 (Brommeyer et al., 2021b). Acknowledging the growing impact of Artificial Intelligence (AI) on the healthcare system, it was also timely to examine the extant literature to explore these technological advancements and their potential implications for health service managers. This rapid review of the corpus explored the dynamically evolving nature of AI in digital health and the health service management workforce, from which four themes emerged: (1) resource management, (2) workforce development, (3) data and Information management, and (4) clinical governance, which are then discussed.

Chapter 3 describes the qualitative methodology adopted, guided by the empirically validated management competency identification and development process, employing three steps: (1) health management and digital health competency mapping; (2) scoping review of the literature and policy analysis; and (3) focus group discussions with health service managers. This was published as a research protocol in the *Journal of Medical Internet Research: Research Protocols* in November 2023 (Brommeyer et al., 2023a).

Chapter 4 presents the findings of a three-step approach to understanding the current obstacles to developing a health management workforce that can enable and maximise the benefits of digital health transformation. It also explores ways to surmount such obstacles in support of health service management and digital workforce transformation. This was published in the *International Journal of Environmental Research and Public Health* in October 2022 (Brommeyer and Liang, 2022).

Chapter 5 addresses Research Question 3: What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace? This chapter details the findings of the focus group discussions and was published in the *Journal of Healthcare Leadership* in September 2024 (Brommeyer et al., 2024b).

Chapter 6 addresses Research Question 2: What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context? It details further findings from the focus group discussions, analysing the development of health service manager competencies in a digitally transforming context, and has been published in the *Health Information Management Journal* in December 2025 (Brommeyer et al., 2025).

Chapter 7 is the thesis' final chapter. It summarises the main study findings synthesised from each empirical chapter further advancing understanding of how the framework for developing health service management workforce capacity should be applied in the digital healthcare environment. The chapter concludes with the potential implications of this study for future practice, policy, and research in the Australian healthcare context.

1.6.1 Thesis structure map

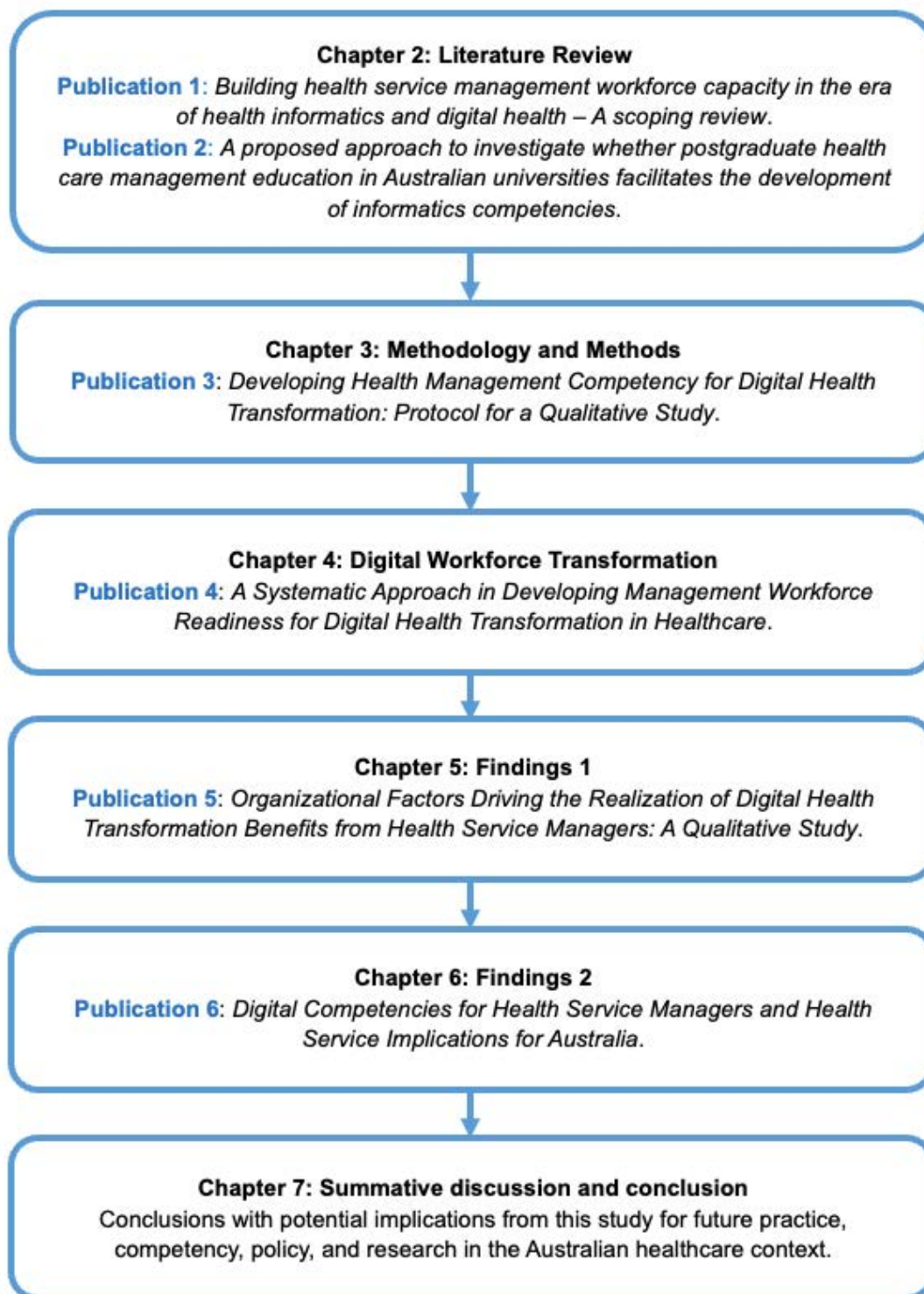


Figure 1: Thesis structure map

Chapter Two – Literature Review

2.1 Chapter Introduction

The purpose of this chapter is to examine current knowledge regarding the competencies health service managers need to acquire to effectively work with and manage in the digital health context, as well as describe the key factors that enable and inhibit health service managers in demonstrating digital health competence in the workplace. This chapter also addresses Research Question 1: To what extent can the existing health service management and digital health competency frameworks guide development of competence for health service managers in understanding and managing in the digital health space? Competency mapping was undertaken to investigate whether postgraduate healthcare management education in Australian universities facilitates the development of informatics competencies, noting that digital health has now become the umbrella term covering health informatics. Digital health is becoming increasingly relevant in the contemporary environment and is the more commonly used lexicon in the industry. The competency frameworks now being developed internationally are increasingly focussing on digital health rather than health informatics alone.

Figure 2 situates this chapter in the map of the broader thesis structure:

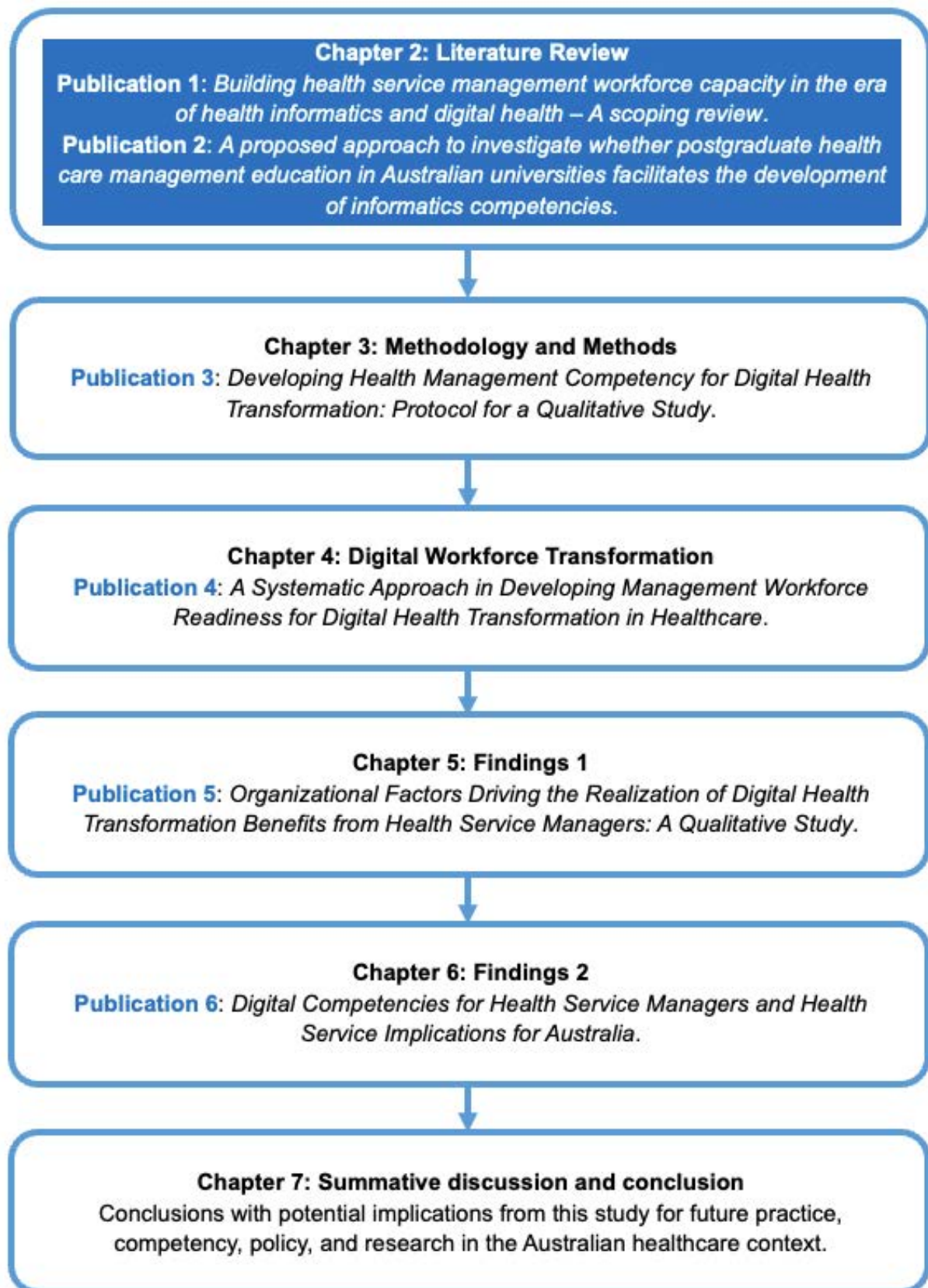


Figure 2: Thesis structure map Chapter 2

This chapter comprises two peer-reviewed publications. They are inserted as published. The citations are:

1. Brommeyer, M., Whittaker, M., Mackay, M., Ng, F. & Liang, Z. (2023). Building health service management workforce capacity in the era of health informatics and digital health—a scoping review. *International Journal of Medical Informatics*, 104909. <https://doi.org/doi.org/10.1016/j.ijmedinf.2022.104909>
 - This is to confirm that the PhD candidate contributed 50% of the development of the manuscript.
2. Brommeyer, M., Mackay, M., Liang, Z., Schaper, L. & Balan, P. (2021). A proposed approach to investigate whether postgraduate health care management education in Australian universities facilitates the development of informatics competencies. *Studies in Health Technology and Informatics*, 284, 93-97. <https://doi.org/10.3233/SHTI210677>
 - This is to confirm that the PhD candidate contributed 40% of the development of the manuscript.

2.2 Publication 1: (Brommeyer et al., 2023b)

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Building health service management workforce capacity in the era of health informatics and digital health – A scoping review

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ABSTRACT

Introduction: Health informatics and digital health, two rapidly growing disciplines, are becoming increasingly important to the sustainability of health service provision, highlighted especially through the COVID-19 pandemic. To maximise the benefits of the adoption and growth of health informatics and digital health, health service managers play a critical role in leading and managing the implementation and transformation of the system, both strategically and operationally, whilst still needing to manage 'business as usual'.

Objectives: The objectives of the paper are to present and discuss the findings from a scoping review identifying: 1) competencies required for health service managers leading the implementation and transformation of informatics and digital technology in the health sector; and 2) factors that are critical to building the management workforce capacity in the era of health informatics and digital health.

Methods: A scoping review of the literature was conducted in 2020 focussing on identifying empirical articles published in the English language since the year 2000 using a number of keywords such as 'health informatics', 'digital health', 'electronic health', 'competencies', 'capability', 'proficiency', 'qualification', 'certification', 'health manager', 'health executive' and 'health administrator'. The literature search was guided by a PRISMA approach searching within eight databases: Scopus, ProQuest, Web of Science, ACM Digital Library, CINAHL, PubMed, Google Scholar and ProQuest Dissertations.

Results: After duplicates were removed, 941 publications were included for title screening as the result of an initial review. Title screening selected 185 articles to be included for abstract screening by two reviewers confirming 19 papers relevant to the focus of the current paper which were included in data extraction and content analysis. The analysis identified the additional competency of 'information and data management' be included as a core competency for health service managers. The analysis also confirmed additional elements for the following four core management competencies that are important to health service managers working in the digital health context, including: 1) leadership; 2) operational and resource management; 3) personal, interpersonal and professional qualities, and 4) understanding the industry and environment. Factors that are critical to developing the system and organization capacity in the use of health informatics and digital health technology, and leading and managing the adoption in the healthcare organizations were identified in three categories: 1) policy/system; 2) organizational structure and processes; and 3) people factors.

Conclusions: This paper has taken an important step in confirming the competency requirements for health services managers that are relevant to leading and managing in the health informatics and digital health space, consequently indicating the directions for developing a competent workforce in meeting the existing and emerging healthcare delivery challenges, both now and in the future.

1. Background

Health informatics and digital health, two rapidly growing

disciplines, are becoming more important to the sustainability of health service provision in the last two decades [1]. The COVID-19 pandemic has seen an unprecedented swift adoption of digital health technologies

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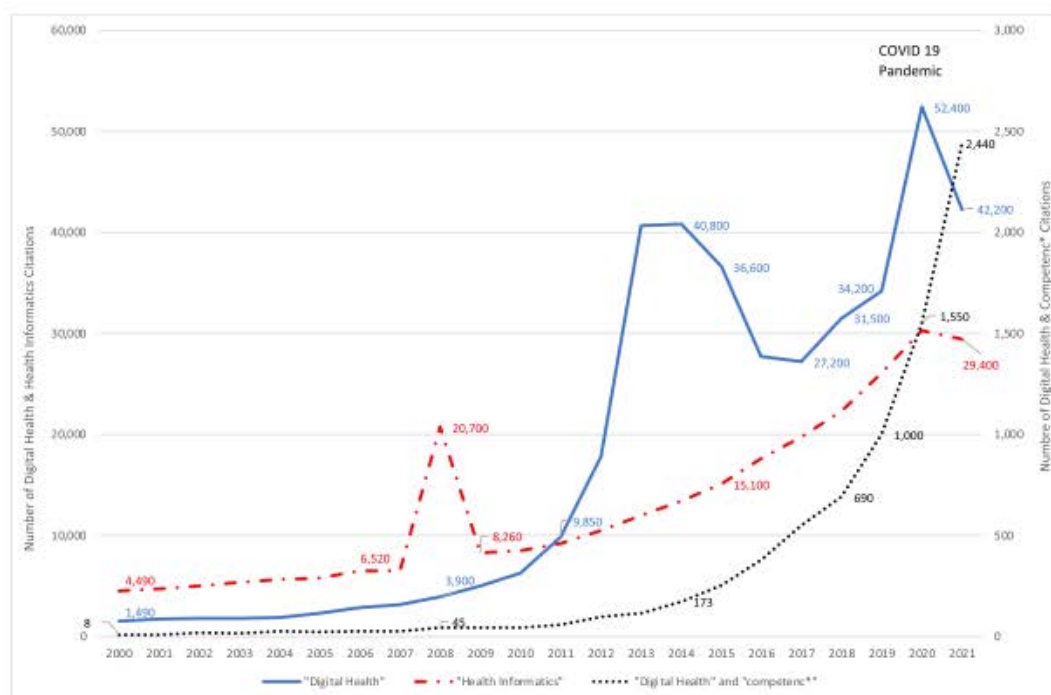


Fig. 1. Trend in publications relating to digital health, health informatics and digital health competencies based on Google Scholar citations. While health informatics was initially the dominant field (based on citations), digital health surpassed this in 2011. The pandemic saw a resurgence of interest in digital health but did not appear to affect health informatics. The interest in digital health competencies represents a small subset of digital health publications and has sustained exponential growth between 2000 and 2021.

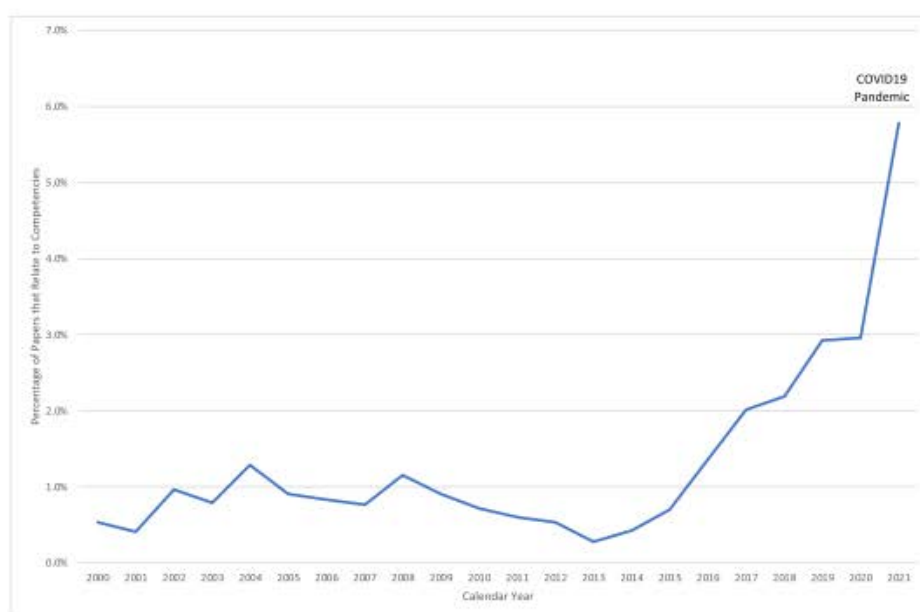


Fig. 2. Trend in the proportion of digital health publications relating to digital health competencies based on Google Scholar citations.

as health professionals and health systems needed to rapidly adopt methods of maintaining service delivery during periods of social distancing and lockdowns [2]. A significant focus on the implementation

of digital health was witnessed during the pandemic, related to the use of communication technologies such as audio and video conferencing. Digital health, however, has the potential to offer a far wider range of

service delivery change than what has been adopted to date [1,2]. The rest of the decade is likely to see a focus on the delivery of value for other aspects of patient care such as chronic disease.

The term digital health is becoming progressively predominant in the literature and health care generally [3]. The analysis of the citations listed in Google Scholar indicates that there has been a constant growth in the number of health informatics publications between 2000 and 2021, from approximately 4,490 citations in 2000 to 29,400 in 2021 (see Fig. 1). There was no apparent increase in publications associated with the pandemic.

The growth in digital health, however, has surpassed that of health informatics. Analysis of the google citation indicates that the growing interest in digital health has not been constant over the last two decades (Fig. 1). Between the years 2000 and 2012 there was exponential interest in digital health based on citations listed in Google Scholar and no effect of the Global Financial Crisis can be seen. The period of 2014–2018 marked a lower level of interest in digital, with strong growth occurring when the pandemic occurred.

The increase in interest in digital health competency-related publications can be gauged from the proportion of citations that relate to digital health competencies (see Fig. 2). Until 2013, interest in competencies represented approximately one per cent of all digital health publications. Since 2014 there has been continued growth in the interest in digital health competencies with a doubling of the growth of the proportion of citations relating to competencies occurring since the pandemic. This can be seen in the context of the urgency to operationally respond to the pandemic and “the implementation of digital health technologies to support continuity of high-quality primary care provision” [4].

However, the implementation is not without challenges. Many existing challenges to the adoption of digital health solutions, including workforce related challenges have been identified [5], and the inevitable transformation of health workers’ roles requiring a digitally competent health workforce to be developed [6]. As digital health competencies evolve, further advancement of health informatics and health service management competencies is required. To maximise the benefits of the adoption and growth of health informatics and digital health, one particularly pertinent question is whether health service managers have the capacity to lead and manage the implementation and transformation at the system level, both strategically and operationally, whilst still needing to manage ‘business as usual’.

Health service managers must face the challenge of exponential growth in digital health literacy as well as how to plan and manage the digital tools and technologies in a changing landscape [7,8]. They need capabilities and relevant competencies to apply these new technologies to assist in informing both strategic and operational decision-making [9,10,11]. A flurry of new positions such as Chief Digital Officer (CDO), Chief Clinical Information Officer (CCIO) and Chief Health Information Officer (CHIO) have emerged to reflect the changing landscape and skills required by healthcare executives [12]. There is increasing evidence regarding the importance of investing in developing a competent health service management workforce, through professional institution certifications and academic credentialing [13]. Additionally, various management competency frameworks instantiated to guide developing the competence of health service managers have been published and utilised [14,15]. However, whether these frameworks can guide the development of health service managers’ understanding, effective scale-up and management, of health informatics and digital health, remains unanswered.

In 2016, the Australian Digital Health Agency stated that “A workforce confidently using digital health technologies to deliver health and care will be required to address the technology adoption challenge ... and embrace the changes and opportunities created by digital health innovation” [16]. However, there is a significant gap in the readiness of the Australian health and health management workforce to engage with digital health and health informatics. The Australasian Institute of

Digital Health submission to the 2022–23 Australian Federal Budget [17] stated that “Currently, the health sector lacks a critical mass of personnel with technical expertise in computing and data harvesting, storage, and analysis”. Evidence cited included data from a pre-pandemic survey where 42 % of health professionals reported interest in digital health and only 15 % self-identified as having any expertise [18]. It is therefore timely to examine the changing competency requirements for health services managers that enable them to lead and manage in the changing ecosystem of digital health, and the specific competencies needed to develop a capable health informatics and digital health workforce.

The objectives of this paper are to present and discuss the findings from a scoping review identifying: 1) competencies required for health service managers in leading the implementation and transformation of informatics and digital technology in the health sector; and 2) factors that are critical to building the management workforce capacity in the era of health informatics and digital health, that need to be developed.

2. Methods

2.1. Design

A scoping review of the literature was conducted in 2022 to develop the above two understandings and builds on a rapid review undertaken in 2020 [14]. The review was guided by the five-step framework defined by Arksey and O'Malley [19] including the following steps: (1) defining a research question, (2) identifying relevant studies, (3) selecting and confirming empirical studies, (4) data extraction, and (5) collating, summarising and reporting results.

2.2. Data source and search strategies

The review searched the following databases: Scopus, ProQuest, Web of Science, ACM Digital Library, CINAHL, PubMed, Google Scholar and ProQuest Dissertations. The scoping review used the following keywords: ‘health informatics’, ‘digital health’, ‘electronic health’, ‘competencies’, ‘capability’, ‘proficiency’, ‘qualification’, ‘certification’, ‘health manager’, ‘health executive’ and ‘health administrator’. A PRISMA approach [20] was used for eligibility screening. The review searched for empirical articles published in the English language since the year 2000 that provided information addressing the two objectives as detailed above.

2.3. Data extraction

Data were extracted from eligible papers including the following types: author(s), year of publication, country of origin, the aim of the study, target population and methods for data collection, and key findings related to the objectives stated above. Content analysis performed on the extracted data aimed to develop an understanding of the contents and identify the essential themes relevant to the search focus.

3. Results

An initial search conducted in 2020 generated 1,212 publications, and after duplicates were removed, 941 publications were included for title screening, leading to 185 articles included for abstract screening by two reviewers. An updated search was then conducted in 2022 which generated 467 publications, and after duplicates were removed, 403 publications were included for title screening, leading to 114 articles included for abstract screening. As a result, an additional 4 articles went through full-text review with the initial 185 articles identified. Full-text review further confirmed that 81 papers are closely relevant to Digital Health Competencies and workforce development in the digital health context.

Based on the actual focus of the studies, the 81 papers were placed

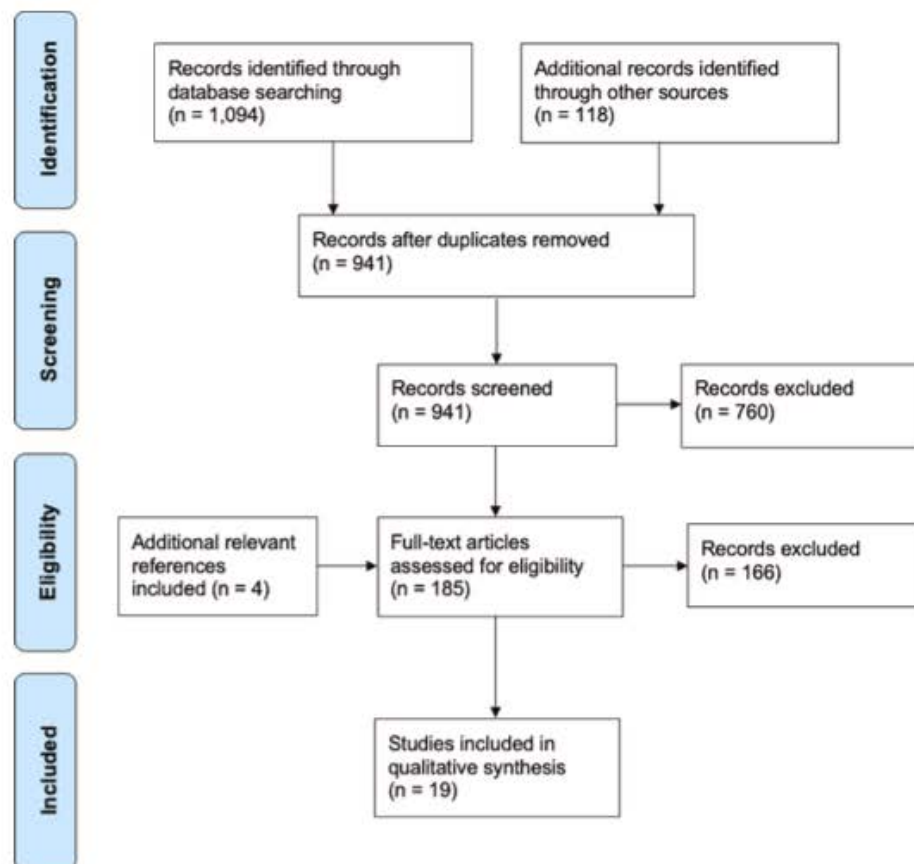


Fig. 3. Scoping Review Flow Chart.

into six categories:

- 1) Publishing results of scoping review or systematic review (n = 15);
- 2) Focussing on how competencies are assessed (n = 10);
- 3) Focussing on competency requirements or competency frameworks for health service management, health information managers or digital health managers (19);
- 4) Focusing on management workforce development, training programs, and formal training curriculum design (n = 18);
- 5) Focusing on competencies required for managers working in the health informatics or digital health context (n = 9), and
- 6) Discussing policy and organizational adoption and implementation, focussing on factors influencing the implementation of health informatics and digital health initiatives (n = 10).

Nineteen articles in categories 5 and 6 are relevant to the focus of this paper which underwent qualitative content analysis. The overall search findings are detailed in Fig. 3 below, guided by the framework outlined by Arksey and O'Malley [19].

3.1. Study characteristics

Eighteen out of the 19 papers were published after 2010. Five of the studies were conducted in multiple countries (Europe, Southern Asia, Northern America and the Western Pacific), 3 in Australia, 8 in the USA, 1 in and UK and 1 in Ireland. Eighteen of these studies focused on multiple target groups including health professionals, clinicians or

nursing staff (n = 5), health managers/leaders and nursing directors (n = 6), researchers/academics/data scientists (n = 6), health information practitioners and managers (n = 5), digital health professionals (n = 1), allied health professionals (n = 1), and patients and consumers (n = 1). Multi-methods were adopted by 10 of the studies. Twelve of the studies used sole or multiple qualitative methods. Three studies used quantitative methods only. Surveys (n = 6), interviews (n = 5) and focus groups (n = 4) were the commonly used methods. Details refer to Appendix A.

3.2. Changing competency requirements for health service managers

The review confirms there has been consistent agreement on the important role of health service managers in the adoption and implementation of health informatics and digital health technology [10,12,13]. Although there are not many studies committed to exploring the changing competency requirements for health service managers working in the dynamic healthcare landscape as a result of digital health adoption, there are agreements on the changing competency requirements in the identified studies.

The analysis of the identified studies confirmed that five broad competencies are important to health service managers working in the digital health context, as detailed in Table 1.

3.3. Factors critical to building system and organization capacity

The review confirmed a number of factors that are critical to

Table 1
Competencies and core elements for health service managers working in the digital health context.

Competencies	Additional knowledge/skills/attitudes
Leadership [21–23]	• Critical and analytical thinking • Systems thinking • Demonstrated strong interests in technology • Commitment to innovation and change
Operational and resource management [8,24,25]	• Financial management • Resource allocation to enable innovation • Organizational assessment • Ability to drive performance/results • Ability to facilitate/enable development of workforce preparation strategy and educational program for digital health readiness.
Personal, interpersonal and professional qualities [8,23–25]	• Cultural competence • Emotional intelligence • Ability in managing nurse/physician relationship management • Ability in leading diverse teams • Flexibility/adaptation/improvisation • Ability in accessing and using data to support decision making.
Understanding the industry and environment [24–26]	• Ability to actively and accurately represent service needs in design and deployment as well as procurement and customization • Political savvy • Expertise in regulatory affairs • Understanding the legal system for information management.
Information and data management [8,22,24–28]	• Understanding of data governance, access and translation • The ability to develop the right system for data management • Systematic awareness of informatics and technologies • Fundamental understanding of core informatics concepts and their utility to patient care and professional collaboration • Understanding how digital health information ecosystems either support or disrupt clinical workflows and the implications of any such changes • Understanding of privacy and release-of-information activities • The ability to analyse, evaluate and maintain the information system.

developing the system and organizational capacity in the use of health informatics and digital health technology, and leading and managing the adoption in healthcare organizations (refer to Table 2). These factors can be put into three categories: 1) policy/system; 2) organizational structure and processes; and 3) people factors.

3.4. Factors critical to the development of management workforce capacity

Amongst all the factors, some are critical to ensuring health services managers' readiness in leading and managing in the digital health era. They are:

- System-level investment in overall workforce development [29,32,36–39];
- A culture of trust and investing in innovation [32,34,37];
- Identifying and developing training that is relevant to specific health professional groups (including managers), roles, levels of seniority, and settings [32,34,37];
- Supportive team climate to reduce fear and uncertainty [32,34,37];
- Opportunities to the design of monitoring and evaluating framework that measure the impact of the technology [38,39]; and

Table 2
Factors that are critical to the success of digital health adoption.

Categories	Factors
Policy/system [29–34]	• The policy process should assure a comprehensive health policy dialogue leading to well defined goals • Assure strong trust by all into eHealth infrastructures and applications • Support and invest in socio-economic and regulatory impact assessments • Support and invest in infrastructural development in both system and organization level • Ensuring data privacy and integrity • Clear governing rules and regulation • Adapt existing tools to the context of educating health professionals about the challenges of the information age • Technological training (informal and formal) to health workforce • Create a shared repository online of measure instruments.
Organizational structure and processes [29,30,32–39]	• Information systems harmonise with existing workflows • Effective and timely technical and expert support • Timely communication amongst across the organization and users • Minimising the risk of the adoption of digital health technology • Optimised use of existing resources • Empower users to taking up innovation and embrace change • Clear focus on health professional and stakeholder needs and benefits • A robust mechanism and framework to identify, prioritise and support the introduction of system wide clinical analytic initiatives • Streamlined data process framework • Develop a consistent platform for technology triangulation: business, clinical, workforce, financial
People factors [29,30,32–34,37,38]	• Stronger emphasis on leadership and accountability. • Leaders' interest in technology has been shown to be a critical predictor of successful digital transitions among organizations • Leadership attitudes and the organizational culture are critical to technology success • Healthcare leaders may have affinity for technology in their personal lives • Upskill workforce such as IT knowledge and retaining expertise • Develop managers' confidence in monitoring and measurement systems • Develop service level and system managers who can utilise data from clinical analytics alongside administrative and other data to guide policy development and improve performance.

- Leaders and senior management of the organizations showing interest in and positive attitudes toward technology and innovation [23].

4. Discussion

Comparing what has been identified in the scoping review and the detailed requirements of management competency frameworks for health service managers, such as the ACHSM [40] framework that has been utilised to certify members of the Australasian College of Health Service Managers, the MCAP framework developed and validated in the Australian health system [13] broadly used to assess management workforce competencies in a number of Asia Pacific countries, and the

international competency framework developed as a recent of a scoping review [15], the analysis supports the proposition that new competencies or new competency components are required to develop the health management workforce in leading and managing innovation in the digital health context [21–24,29,32,34,36–39]. The analysis also highlighted the need for training current and emerging health service managers focussing on their digital health literacy and digital transformation knowledge in health services to enable innovative service provision in the digital health context.

4.1. Competencies required for health service managers working in the digital health context

As discussed earlier, the existence of core competencies for health service managers has been well recognised. However, in the continually evolving healthcare context, detailed requirements for each of the core competencies need to be periodically revised. The scoping review has confirmed that the new competency of ‘information and data management’ is to be included [8,22,24–28], and that additional elements are to be incorporated into the four recognised core competencies for health service managers [13,15,40]: 1) leadership; 2) operational and resource management; 3) personal, interpersonal and professional qualities; and 4) understanding the industry and environment [8,21–26].

The constant financial constraint and growing healthcare needs call for healthcare innovation. From a leadership perspective, a strong interest in technology and a demonstrated commitment to innovation and change are important for providing health services in the future [21,23] which, “demands new forms of innovation competence” [22]. From an operational and resource management perspective, the commitment to allocating and managing specific resources to enable innovation has been linked to maintaining a competitive organization [22]. Further, a demonstrated ability to facilitate and enable the development of strategies and educational programs for digital health readiness has been found to enhance overall health workforce competency development [24].

The personal, interpersonal and professional qualities required of a health service manager are diverse and dynamic [41]. In the digital health context, managers are required to have the ability to work effectively with the newly emerging digital workforce, enabling integration with the existing teams, together with a thorough grasp of their professional development needs [24,42]. This may not have been developed via the formal and informal training that they have received nor included in their management position description. The demand for managers’ abilities to access and use data to support decision-making has become greater to “assist in navigating a rapidly changing healthcare delivery system” [8]. Key requirements for successful management in the digital health environment include a sound understanding of the industry and environment [43], and an understanding of the legal system for information management [25].

Dammann [44] argues that “Data, information, and knowledge are central concepts in health informatics and data science”, which provides context for this study’s findings that, central to digital health management are the concepts of firstly, understanding data governance, access and translation [27]. Next, the ability to develop the right system for data management [25], as well as having a systematic awareness of informatics and technologies across the organization [26]. A fundamental understanding of core informatics concepts and their utility to patient care and professional collaboration, includes how digital health information ecosystems promote the provision of quality care [24]. An understanding of privacy and release-of-information requirements to ensure patient’s or consumer’s confidence in the security of their personal health information, are hallmarks of safe, clinical decision-making [25] and key attributes required of successful health service managers [8]. Finally, this scoping review found that a manager’s ability to analyse, evaluate and maintain the information systems employed, are key contributors to effective and efficient healthcare organizations [26].

4.2. Factors critical to building system and organization capacity

The importance of building system and organization capacity is a known strategic success factor for healthcare enterprises [41]. This study identified key factors that are critical to building digital health specific system and organization capacity, in the following three categories: 1) policy/system attributes; 2) organizational structure and processes; and 3) people factors.

Adapting policy and system attributes includes a focus on digital policy processes that assure a comprehensive health policy dialogue leading to well defined goals [34]. Governing rules, regulations and organisational policies are required to protect data privacy and integrity [41], especially in the digital health enterprise [33,38]. Strong trust in the organizational technical infrastructure and applications is important to provide a sound foundation for operating in the digital health environment [34]. It was also well recognised that support and investment in both socio-economic and regulatory impact assessments provided surety in digital investment decisions [34], and that support and investment in infrastructure development at both a system and organization level are equally important [34]. Adapting existing tools to educate health professionals about the challenges of the information age and providing capability development in context is important for the health workforce [30,33]. Burton-Jones, et al. [45] also argue that evaluating digital health transformations is important for both the significant investment involved and the associated potential consequences, and that creating a shared online repository of measurement instruments is a recommended activity to support building digital health specific, system and organisational capacity [39].

Contextual and effective healthcare organizational structures and processes are foundational for the delivery of quality care outcomes [41]. In the digital age, factors that facilitate system and organizational capacity, identified in this study, include information systems harmonising with existing workflows [30], along with effective and timely technical and expert support, to facilitate efficient communication across the organization and amongst users [29]. Importantly, the need to minimise the risks associated with the adoption of digital health technology has emerged [29]. Factors to build system capacity include:

- 1) optimising the use of existing digital resources [30], while developing a consistent platform for technology integration of business, clinical, workforce and financial systems [38];
- 2) empowering users to take up innovation and embrace change [30], with a clear focus on health professional and stakeholder needs and benefits [34], supported by a stronger emphasis on leadership and accountability [37]; and
- 3) having system enablers for the development of organisational digital capacity including, a robust mechanism and framework to identify, prioritise and support the introduction of system-wide clinical analytic initiatives and streamlining the data process framework [38,44].

Effective leaders and managers in organizations are key to producing quality services and required outcomes [43]. Their interest in and affinity for technology in their personal lives has been shown to be a crucial predictor of successful digital transformations among organizations, so is the demonstrative leadership, attitudes and the supportive organizational culture, i.e., employees seeing their leaders’ ‘walking the technology talk’ [23]. Furthermore, the evolving healthcare system requires a health workforce with information technology (IT) knowledge and expertise [32] as well as managers’ confidence in monitoring and measurement systems [39]. Hence, commitment to developing service level and system managers who can use clinical analytics data with administrative and other data to guide policy development and improve performance is required [38].

4.3. Factors critical to developing management workforce capacity

The development of health management workforce capacity requires a holistic approach with efforts from and collaborations between government, professional and tertiary institutions, and healthcare organisations [46]. In Section 3.4 of this paper, six enabling factors identified as being critical to ensuring health services managers' readiness in leading and managing in the digital health era were detailed.

From a system perspective, investment in overall workforce development has been argued as essential to enhancing contextual management capability, with a focus on digital health planning, implementation, and training that is relevant to specific health professional groups, including managers [22,29,32,34,36–39]. Such investment and efforts can come in various forms. Government policy, strategic intent and financial support in overall workforce upskilling set the momentum for improvement. Resetting the current training and development direction for health managers at the organisational level, and the review of higher degree teaching curricula to incorporate newly emerged competency requirements, are equally important to producing an upskilled and relevant health management workforce.

Rapid changes abound in the health sector and the subsequent change fatigue amongst health professionals is well documented [47]. Adopting well tested change management principles, including the development of an organisational culture for developing trust in innovation investment [32,34,37], and creating a team climate to reduce fear and uncertainty [32,34,37], was also pronounced in this review. This will be further enabled by leaders and managers demonstrating an interest in and a positive attitude toward technology and innovation [23]. One of the success factors for leading and managing change is ensuring that the relevance and positive outcomes resulting from the changes are evaluated and broadly communicated to those who are affected by the changes [48]. Therefore, it is important for managers to develop competence in designing monitoring and evaluating frameworks that measure the impact of digital technology and reliably and sensitively assess digital health service outcomes [38,39].

4.4. Policy, practice and research implications

Although substantial investment has been made in adopting digital health technology and innovation in health service provision and healthcare delivery, at both system and organisational levels, as well as an increasing interest in researching digital health innovation and its implementation, empirical studies in health workforce readiness, in particular, management workforce is limited. Although this scoping review has only identified a handful of articles focused on understanding the evolving competency requirements for health service managers working in the digital health context [8,21–26], the review has confirmed various important elements to complement the existing health service management competency frameworks used to guide the design of informal and formal training and development curricula [13,15,40].

However, the development of health management workforce capacity requires not only workforce training and education, but also system and organisational level commitment in developing policy, structure and processes to enable success in designing, planning and implementing the adoption of innovation [29–43], as well as financial resources to support workforce development and ongoing monitoring and improvement. Equally important, a positive organisational culture supportive of change is required together with demonstrated strong interest and support from senior management. Management competencies are context-sensitive and will continue to evolve over time. Hence, ongoing commitment from both professional and tertiary institutions to understanding the changing competency requirements and competency development needs of the health management workforce in leading and managing healthcare innovation is necessary.

5. Conclusions

To ensure the sustainability of the healthcare system in such challenging times, the adoption of innovative ways to meet the increasing demand for healthcare services is required and, in particular, a workforce that has the competence to lead and manage change in a digital health context. The implementation of digital competence and managing the transformation of healthcare may not be successful without guiding policy, supportive organizational structure, and strong leadership. Therefore, the investment in readying the health workforce, in particular the management workforce that can lead and manage the changing healthcare landscape, is critical.

The development of relevant competencies for the health service management profession needs joint efforts across government, educational and professional institutions, as well as healthcare organizations. This paper has taken an important step in confirming the competency requirements for health services managers that are relevant to leading and managing in the health informatics and digital health space, consequently indicating the directions for developing a competent workforce in meeting the existing and emerging healthcare delivery challenges, both now and in the future.

6. Summary Table

1) What is already known on the topic

- Health informatics and digital health, two rapidly growing disciplines, are becoming increasingly important to the sustainability of health service provision, highlighted especially through the COVID-19 pandemic.
- There has been consistent agreement on the important role of health service managers in the adoption and implementation of health informatics and digital health technology.
- There have been discussions on new skill requirements for health service managers to lead and manage in enabling the adoption of digital health innovation, but yet to be confirmed via a rigorous process.

2) What this study added to our knowledge

- Confirmation of additional competencies to be incorporated in the existing health management competency framework, which are relevant to leading and managing in the health informatics and digital health space.
- Identification of the additional competency of 'information and data management' be included as core competency for health service managers.
- Confirmation of key factors that are critical to developing the system and organization capacity in the use of health informatics and digital health technology, which can be placed in three categories: 1) policy/system; 2) organizational structure and processes; and 3) people factors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors' contributions

MB and ZL conceptualised the review and undertook title and abstract screening and full-text review. Data analysis, interpretation and quality appraisal was undertaken by MM, MW and FN. A first draft of the manuscript was prepared by MB. ZL revised it critically for important intellectual content, that all authors then conceptually commented on. MB and ZL finalised the manuscript, and all authors approved the final version of the manuscript.

Appendix A

See Table A1.

Table A1

Data extraction of 19 relevant studies.

No	Year	Country	Authors	Title	Study Target	Methods
1	2019	South Asia	Beane et al. 2019	Addressing the information deficit in global health: Lessons from a digital acute care platform in Sri Lanka	Clinicians, administrators, researchers and healthcare informaticians	Qualitative enquiry founded in technology adoption frameworks.
2	2019	USA	Vest et al. 2019	Adoption of Health Information Technology Among US Nursing Facilities	Nursing homes (aged care facilities)	Cross-sectional survey: 5,063 e-mail invitations. Response rate for the survey questionnaire was 17 % (n = 586 respondents representing 544 nursing facilities). Document analysis.
3	2011	34 Countries in the European Union (EU)	Stroetmann et al. 2011	Developing national eHealth infrastructures - results and lessons from Europe	E-health strategies of 27 Member States of the European Union	
4	2020	Australia (NSW)	Sutherland et al. 2020	Envisioning the future of clinical analytics: a modified Delphi process in New South Wales, Australia	Practising clinicians, patients and consumers, managers, policymakers, data scientists and academics	Six-stage process included face-to-face workshops, traditional Delphi voting via email, and innovative, real-time iteration between text re-formulation and voting until consensus was reached. Evaluating Educational Interventions – rapid review and expert analysis.
5	2017	Canada, Israel and Australia	Shachak et al. 2017	Evaluating educational interventions for health professions in the digital age	Health Professions in the Digital Age	Web-based survey elicited over 250 usable responses.
6	2015	USA	Afnan & Ranganathan 2015	Factors associated with EHR user satisfaction in small clinic settings	Ambulatory staff and physicians clinics	Methodological framework comprised of: 1) literature reviews of relevant issues; 2) an interactive workshop involving a multidisciplinary group of digital leads from Queensland hospitals; 3) a draft document based on literature and workshop proceedings; and 4) a review and feedback from senior clinical leads.
7	2019	Australia (Queensland)	Scott et al. 2019	Going digital: A checklist in preparing for hospital-wide electronic medical record implementation and digital transformation	Health professionals at hospitals undergoing hospital-wide EMR implementation and digital transformation	Experience from the frontline National Health Service (NHS) clinical informatics and epidemiological research to present the operational realities of health data quality and the implications for data science. Survey: n = 400 providers/staff responded (response rate approximately 25 %).
8	2018	United Kingdom	Scott et al. 2018	Learning health systems need to bridge the 'two cultures' of clinical informatics and data science	Policy makers and research funders of clinical informatics and data science	
9	2014	USA	Shea et al. 2014	Stage 1 of the meaningful use incentive program for electronic health records: a study of readiness for change in ambulatory practice settings in one integrated delivery system	Ambulatory staff at 47 practices	
10	2018	Ireland	Craig & Kodate 2014	Understanding the state of health information in Ireland: A qualitative study using a socio-technical approach	Health information policy makers and practitioners in Ireland	Qualitative study using a socio-technical approach - documentary analysis (including key policy and strategy documents, and original research articles from Australia, Canada, Ireland, the UK) and semi-structured interviews with 12 policy and practitioner health information experts in Ireland. Qualitative Descriptive Case Study.
11	2008	USA	Amendola 2008	An examination of the leadership competency requirements of nurse leaders in healthcare information technology	Nurse leaders	
12	2020	Australia	Butler-Henderson et al. 2020	A meta-synthesis of competency standards suggest allied health are not preparing for a digital health future	Allied Health Professionals	A nine-stage, sequential meta-synthesis of professional standards.
13	2019	USA	Ghafari 2019	Healthcare Leadership Styles, Competencies and Affinity for Technology in the Digital Era	Healthcare leaders	Quantitative, empirical, cross-sectional research design.
14	2018	Norway and Sweden	Gjellebaek et al. 2018	Competence Development and the Implementation of Technology in Healthcare Services	Managers and professionals in municipal healthcare services	Qualitative approach and group interviews.

(continued on next page)

Table A1 (continued)

No	Year	Country	Authors	Title	Study Target	Methods
15	2017	USA	Kennedy & Moen 2017	Nurse leadership and informatics competencies: shaping transformation of professional practice.	Nursing leaders	Literature review: expert analysis.
16	2016	USA	Sheridan et al. 2016	Health Information Management Leaders and the Practice of Leadership through the Lens of Bowen Theory	HIM director	Descriptive, mixed-methodology study used both quantitative and qualitative research methods that included surveys, interviews, focus groups, and real-time observation.
17	2016	USA	Valenta et al. 2016	Core informatics competencies for clinical and translational scientists: what do our customers and collaborators need to know?	Clinical and translational scientists	Iterative competency revision through key informant consensus with CTSA Education and Informatics Key Function Committees, Biomedical Informatics Training Workgroup, and Education Workgroup of the Association for Clinical and Translational Science and Clinical Research Informatics Workgroup of AMIA.
18	2008	USA	Westra & Delaney 2008	Informatics Competencies for Nursing and Healthcare Leaders	Nursing leaders, informaticians, and researchers were selected from the American Medical Informatics Association Nursing Informatics Working Group, the Minnesota Organization of Nursing Leaders, and the University of Minnesota School of Nursing	Literature review, Delphi (3 rounds for consensus) using a survey with content validity index (CVI) analysis.
19	2015	Southeast Asia, the Western Pacific, Europe, and the Americas	Whittaker et al. 2015	Preparing for the data revolution: identifying minimum health information competencies among the health workforce	Health Information System (HIS) competencies required among general health workers, to develop a framework on minimum HIS competencies needed in LMICs	Literature review, modified Delphi approach, survey, peer-review.

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2.3 Publication 2: (Brommeyer et al., 2021b)

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A Proposed Approach to Investigate Whether Postgraduate Health Care Management Education in Australian Universities Facilitates the Development of Informatics Competencies

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Abstract. Competencies have emerged as being important in healthcare. AIDH has health informatics competencies and ACHSM has health service management competencies but as health care is rapidly changing, it is important that the required competencies continue to evolve. The aim is to investigate whether postgraduate health care management education in Australian universities facilitates the development of informatics competencies. The proposed approach followed the NWCPHP 'Steps Used to Effectively Map Preexisting Courses to Competency Sets' to map the health informatics competency statements against the ACHSM accredited and RACMA recognised, postgraduate health care management programs offered domestically in Australia. The initial results show that only 10% of the AHICF competencies were fully addressed, 12% of the AHICF competencies were mostly addressed, 28% were partially addressed, and 50% of the AHICF competencies were not addressed at all. The proposed course competency mapping approach demonstrates that there is a need to revisit the informatics competencies taught in postgraduate health care management programs in Australia.

Keywords. Workforce, competency, nursing informatics

1. Introduction

The Fourth Industrial Revolution is upon us and we know that it "is broad and is characterized by a fusion of technologies across physical, digital and biological domains"[1]. In healthcare, this is having profound, transformational effects in the diagnosis, delivery and management of care due to the rapid speed of advances in genomic mapping, synthetic biology, nanotechnology engineering, big data, artificial intelligence and robotic automation.

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Global forecasts emphasise that these new technologies and innovations have important workforce implications and will have far reaching implications for how we educate and train health care managers, so we must consider “how education will need to evolve for those entering the workforce as well as how to retrain the existing workforce to align with evolving technologies and labour trends” [1]. This needs to be reflected in the competencies health service managers require.

Competencies for Health Service Managers have been established by professional bodies (for example, the Australasian College of Health Service Management) [2] and researched by academics, including Laing, et al [3]. The range of competencies required by health service managers continues to evolve as the industry changes. This requires regular review of the competencies required to be demonstrated in the management of healthcare.

The Australasian Institute of Digital Health (AIDH) recognised the need for those working in health informatics to meet certain competencies [4]. To this end, a competency framework and a certification process was developed by its predecessor, the Health Informatics Society of Australia (HISA), to enable health informaticians to have their competencies recognised – the Australasian Health Informatics Competency Framework (AHICF). A competency is defined as the specification of knowledge and skill, and the application of that knowledge and skill, to the standard of performance expected in the workplace [5]. In the United Kingdom’s National Health Service, it has been forecast that all areas of health service delivery will be affected by the adoption of digital technology and this will necessitate the upskilling of the workforce [6]. Given the rapid rate of progress in healthcare and informatics, there is a need to revisit the informatics competencies taught in postgraduate health care management programs.

The aim is to propose an approach to investigate whether postgraduate health care management education in Australian universities facilitates the development of informatics competencies. Part of the general aim will be achieved by gaining an understanding of what current educational programs are being provided in Australia. To this end, a starting point is the mapping of existing programs and this paper proposes an approach for this component of the overall research aim.

2. Methods

AHICF’s fifty (50) health informatics competency statements have been mapped to the Australasian College of Health Service Management (ACHSM) accredited and the Royal Australasian College of Medical Administrators (RACMA)[7] recognised postgraduate health management programs offered domestically in Australia, by subject or course topic using content that is publicly available and able to be accessed or provided by the universities. The mapping process followed the ‘Steps Used to Effectively Map Preexisting Courses to Competency Sets’ approach, developed by the University of Washington School of Public Health’s Northwest Center for Public Health Practice (NWCPHP), as this has demonstrated a high level of confidence in the accuracy of the process for mapping competencies to its courses [8].

The mapping process was undertaken to identify, collect, map and then validate the competencies, according to the NWCPHP’s six step approach:

1. Choose competency set(s) – the ACHSM Master Health Service Management Competency Framework and the Australian Health Informatics Competency Framework (AHICF).
2. Determine courses to be mapped – 21 post-graduate programs that were either accredited by ACHSM or recognised by RACMA.
3. Determine who does the mapping – an internationally experienced health informatics academic completed the initial mapping, with oversight provided by a health service management competency specialist, who is also a management competency researcher. The mapping was then independently validated by an expert health informatics competency specialist educator and a former head of a university business school.
4. Establish criteria for mapping – based on the Association of American Medical Colleges' Curriculum Management and Information Tool (CurrMIT) [9] a Competency Mapping Matrix spreadsheet was built to enter program names, subject or course topic learning objectives, and the fifty AHICF competencies. The programs were then reviewed by subject title, learning objectives and assessments for key words, competency indicators, and themes that matched with the competency framework. This was mapped on the spreadsheet as the degree to which the competency was seen as being addressed, using a four-point criteria scale: i) not addressed; ii) partially addressed; iii) mostly addressed; and iv) fully addressed.
5. Use reliability checking process – the Competency Mapping Matrix spreadsheet was piloted with one academic and one professional services university staff member to confirm the reliability and validity of the rating instrument. Interrater reliability of the competency mapping process and tool was used to establish the validity of the mapping itself.
6. Resolve outstanding disputes – any discrepancies were resolved by a subject matter expert, being an Australian Professor in Health Service Management.

3. Results

The RACMA recognised and ACHSM accredited listings of university master's level programs were accessed to provide the information about the health care management programs being offered domestically in Australia. Non-accredited or recognised programs were not considered.

It was found that there are 41 Australian university-based master's level health management programs, and that:

- 17 programs were ACHSM accredited
- 14 programs were RACMA accredited
- 10 programs were accredited by **both** ASCHM and RACMA
- 21 were accredited by **either** ASCHM *or* RACMA (based on available online listings on ACHSM and RACMA websites)

The 50 AHICF health informatics competencies are across six competency domains: 1) Health Sciences (9 competencies); 2) Information Science (5 competencies); 3) Information Technology (3 competencies); 4) Leadership and Management (10 competencies); 5) Social and Behavioural Sciences (5 competencies); and 6) Core Health

Informatics (18 competencies). The ACHSM 85 health service manager competencies are across five competency domains: 1) Leadership (12 competencies); 2) Health and Healthcare Environment (16 competencies); 3) Business Skills (32 competencies); 4) Communications and Relationship Management (12 competencies); and 5) Professional and Social Responsibility (13 competencies).

What the results show, is that of the 21 master's level programs mapped, only 10% of the AHICF competencies were fully addressed (all of the AHICF competency key words and the health informatics context was identified), 12% of the AHICF competencies were mostly addressed (two or more of the AHICF competency key words and the health informatics context was identified), 28% were partially addressed (two or more of the AHICF competency key words and no health informatics context was identified), and 50% of the AHICF competencies were not addressed at all (none of the AHICF competency key words and no health informatics context was identified).

4. Discussion

Internationally there is a growing body of literature around graduate health administration curricula and the need for health informatics competency development [10]. To ensure that we can best manage health care requirements, we need to harness the opportunities the Fourth Industrial Revolution provide us. In healthcare we need the required competencies in health informatics. Health care managers need to demonstrate contemporary and constantly evolving competency in the "knowledge and skill, and the application of that knowledge and skill, to the standard of performance expected in the workplace" [5].

Universities have responded to the need for those working in the health sector to become skilled in health informatics through the introduction of largely postgraduate level qualifications [11]. One of the pathways includes postgraduate health care management. The health care management pathway, however, while it provides limited specific health informatics education programs, does provide a well-rounded education (e.g., change management, financial management, etc.).

Given the changing nature of health informatics, it is important that the required competencies are able to be incorporated into existing and future Australian postgraduate health care management curricula. These informatics competencies will guide the workforce training and education developments into the future and will ensure that health care managers have the competencies required for the management of healthcare, for consumers, funders, governing and regulatory bodies assurance.

As Australia's largest health workforce, nurses and midwives have pivotal roles in the capture, creation, communication and use of clinical information. Accordingly, "the Digital Health Capability Framework for the Nursing and Midwifery Workforce has been created to define the knowledge, skills and attitudes required for professional practice in the digital health era" [12]. Importantly, the role of nursing management must also be underpinned by informatics competencies.

5. Conclusion

For health care practitioners interested in pursuing health care management studies, the majority of options in Australia are now at the postgraduate level. Given the rapid rate

of progress in health care and informatics, there is a need to revisit the informatics competencies taught in postgraduate health care management programs.

We believe that the proposed course competency mapping approach demonstrates that this is indeed the situation in health care management courses in Australia. This is part of a larger research project designed to investigate whether postgraduate health care management education in Australian universities facilitates the development of informatics competencies.

The findings of this study will potentially have far reaching implications for how we educate and train health care managers. This needs to be reflected in the informatics competencies all health care managers require.

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2.4 Artificial Intelligence and impacts on managing health services

Since commencing this research study in July 2019, society has seen the exponential growth of Artificial Intelligence (AI) across many industries, including healthcare.

Acknowledging the growing impact that AI is having on the healthcare system, it was timely to examine the extant literature to explore these technological advancements and potential implications for health service managers.

An additional desktop review was conducted in March 2025 specifically focusing on the role of AI in healthcare, services and on the workforce. This updated literature search was undertaken to: (1) review developments in the transformation of AI in healthcare, and (2) identify the impacts of AI on managing health services, on managing the workforce, and on managers, in the past five years using Scopus. The search was limited from 2020 to 2025, to ensure up-to-date literature reflecting the rapidly evolving nature of artificial intelligence in digital health and the health service management workforce. The keywords used for the 2025 search were: 'artificial AND intelligence', 'health', and 'manage'. The inclusion criteria included articles published in English from 2020 to 2025; publications that were peer-reviewed, empirical and from the grey literature.

318 records were identified through this database search, of which 67 publications were relevant to the topic, with 16 of the studies focussed on managing the workforce, 25 focussed on resource management, 12 focussed on information management, nine on data management, three on clinical governance, one focussed on management competency, and one focussed on ethical governance. Based on a full-text assessment for eligibility, 25 publications as referenced below were then placed into six categories from which the following four themes emerged: (1) resource management, (2) workforce development, (3) data and information management, and (4) clinical governance, which are then discussed within the following chapters, aligned with relevant findings and discussion.

This literature reveals common characteristics and challenges with the extant digital health for health service management corpus. The characteristics and challenges illuminated include:

1. Resource management: the use of AI for managing during a pandemic can assist across disease and resource prediction, diagnostic and decision support, patient scheduling and supply chain resilience (AlSerkal et al., 2025, Chen and Ding, 2025, Barbieri et al., 2024, Bartenschlager et al., 2024, Doo et al., 2024, Henderson et al., 2024, Liebowitz and Robertson, 2024, Kim and Lee, 2021, Syrowatka et al., 2021).
2. Workforce development: developing technology skills and knowledge in the digital age now also requires an understanding of the application of AI in health service

- management, with a particular emphasis on increasing competency in digital literacy, integrating with innovation and strategic directions, change management skills and ethical decision making (Dulaimy et al., 2024, Holland Brown and Bewick, 2023, Zakaria et al., 2023, Lattouf, 2022, Yoo and Lee, 2022, Aerts and Bogdan-Martin, 2021, Wiljer et al., 2021, Shinnars et al., 2020).
3. Data and information management: using AI to drive data analytics, clinical and business decision support, and patient management further enhances the digital capabilities of health service managers (Johnson et al., 2024, Barbieri et al., 2023, Jiao et al., 2023, Basit et al., 2021, Bragazzi et al., 2020).
 4. Clinical governance: AI's rapid growth in regulatory, policy, ethical, governance, safety and management guideline requirements, require a systemic focus on flexible guardrails and frameworks to guide appropriate and applicable use (Smith et al., 2024a).

This contemporary review was a cogent reminder of the rapidly changing digital health technology landscape, the competencies required to manage in the health service environment, and the ever pressing need to ensure health service managers and all healthcare providers have the competence and confidence to use digital technologies to support the management and delivery of safe, quality care. In conducting this desktop review, many of the precepts for practice in the digital health environment were consistent with the digital competencies required for health service managers. Though, with the escalating rise and rise of AI in healthcare, it is important to acknowledge that incorporation of AI into healthcare in this nascent field is rapidly developing. Future research for health service management must continually evolve and address the safe, efficacious, sustainable and affordable use of AI and its implications for delivering value to healthcare outcomes.

Although the focus group discussions did not explicitly ask about AI, and the definition of digital health used for the focus group was digital health is *“an umbrella term referring to a range of technologies that can be used to treat patients and collect and share a person's health information”* (Australian Government, 2022) *and is used by patients, practitioners, managers and healthcare organisations, amongst others*, respondents may have implicitly included AI in their response. However, the competencies identified in the literature on AI are generic for digital health per se and have been addressed in the thesis.

2.5 Chapter Summary

Chapter 2 examined current knowledge regarding the competencies health service managers need to effectively work with and manage in the digital health context. It describes the key factors that enable and inhibit health service managers in demonstrating digital

health competence in the workplace. This chapter also addressed Research Question 1: To what extent can the existing health service management and digital health competency frameworks guide development of competence for health service managers in understanding and managing in the digital health space? Competency mapping was undertaken to investigate whether postgraduate health care management education in Australian universities facilitates the development of informatics competencies.

The scoping review confirmed (Brommeyer et al., 2023b):

1. The additional competency of 'information and data management' must be included as a core competency for health service managers.
2. Enhanced elements for the following four core management competencies that are important to health service managers working in the digital health context, including: (1) leadership; (2) operational and resource management; (3) personal, interpersonal and professional qualities; and (4) understanding the industry and environment.
3. Factors that are critical to developing system and organisational capacity in the use of health informatics and digital health technology, and leading and managing the adoption in the healthcare organisations, were identified in three categories: (1) policy/system; (2) organisational structure and processes; and (3) people factors.

The course competency mapping confirmed that (Brommeyer et al., 2021b):

1. Mapping of the 85 Australasian College of Health Service Management (ACHSM) Master Health Service Management Competency Framework competencies to the 50 health informatics competency statements from the Australian Health Informatics Competency Framework (AHICF), found that nearly half of the AHICF framework's competencies were only partially or not addressed at all by the ACHSM framework.
2. Of the 21 Australian master's-level health service management programs mapped, only 10% of the AHICF competencies were fully addressed, 12% of the AHICF competencies were mostly addressed, 28% were partially addressed, and 50% of the AHICF competencies were not addressed at all.

Chapter Three – Methodology and Methods

3.1 Chapter Introduction

The purpose of this chapter is to explain the conceptual framework for the research, the methodological approach, study design, methods for data collection, and data analysis methods employed. This has been published in *JMIR Research Protocols* (Brommeyer et al., 2023a), as inserted below. Further, the ethical considerations, member checking, and limitations of this study are also presented.

Figure 3 situates this chapter in the map of the broader thesis structure:

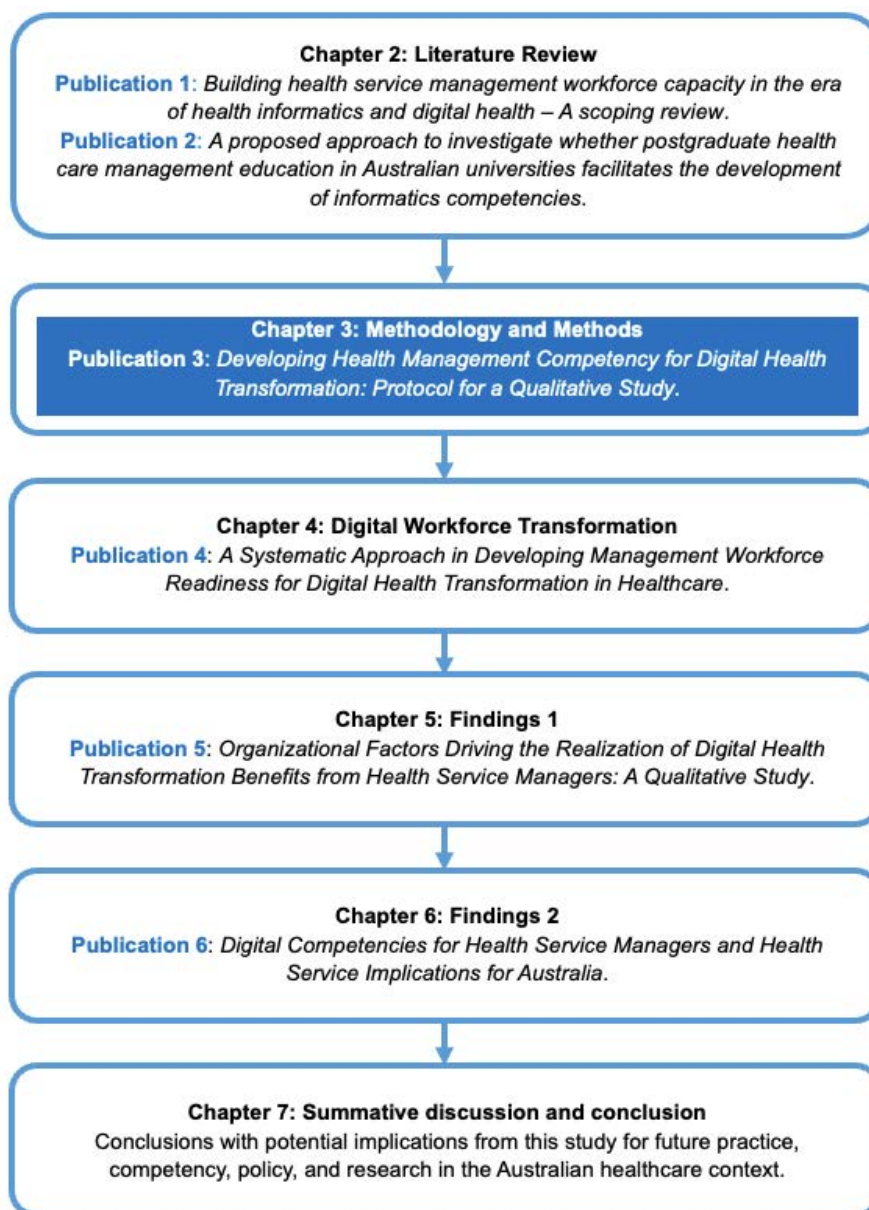


Figure 3: Thesis structure map Chapter 3

This chapter comprises one peer-reviewed publication. This is inserted as published. The citation is:

- Brommeyer, M., Whittaker, M., Mackay, M. & Liang, Z. (2023). Developing Health Management Competency for Digital Health Transformation: Protocol for a Qualitative Study. *JMIR Research Protocols*, 12, e51884. <https://doi.org/10.2196/51884>
- This is to confirm that the PhD candidate contributed 60% of the development of the manuscript.

3.2 Publication 3: (Brommeyer et al., 2023a)

Protocol

Developing Health Management Competency for Digital Health Transformation: Protocol for a Qualitative Study

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Abstract

Background: Globally, the health care system is experiencing a period of rapid and radical change. In response, innovative service models have been adopted for the delivery of high-quality care that require a health workforce with skills to support transformation and new ways of working.

Objective: The aim of this research protocol is to describe research that will contribute to developing the capability of health service managers in the digital health era and enabling digital transformation within the Australian health care environment. It also explains the process of preparing and finalizing the research design and methodologies by seeking answers to the following three research questions: (1) To what extent can the existing health service management and digital health competency frameworks guide the development of competence for health service managers in understanding and managing in the digital health space? (2) What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context? (3) What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace?

Methods: The study has adopted a qualitative approach, guided by the empirically validated management competency identification process, using four steps: (1) health management and digital health competency mapping, (2) scoping review of literature and policy analysis, (3) focus group discussions with health service managers, and (4) semistructured interviews with digital health leaders. The first 2 steps were to confirm the need for updating the current health service management curriculum to address changing competency requirements of health service managers in the digital health context.

Results: Two initial steps have been completed confirming the significance of the study and study design. Step 1, competency mapping, found that nearly half of the digital competencies were only partially or not addressed at all by the health management competency framework. The scoping review articulated the competencies health service managers need to effectively demonstrate digital health competence in the workplace. The findings effectively support the importance of the current research and also the appropriateness of the proposed steps 3 and 4 in answering the research questions and achieving the research aim.

Conclusions: This study will provide insights into the health service management workforce performance and development needs for digital health and inform credentialing and professional development requirements. This will guide health service managers in leading and managing the adoption and implementation of digital health as a contemporary tool for health care delivery. The study will develop an in-depth understanding of Australian health service managers' experiences and views. This research process could be applied in other contexts, noting that the results need contextualization to individual country jurisdictions and environments.

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KEYWORDS

health care management; health service manager; digital health; health informatics; competency; workforce development; innovation; research protocol; informatics; manager; managers; service; services; delivery; organization; organizational; workforce; management; management; qualification; qualifications; focus group; focus groups; interview; interviews; scoping; review methods; review methodology

Introduction**Definitions**

For the purpose of this protocol paper, the following definitions are being applied: (1) *health services managers* are the “professional managers charged with the responsibility of leading and managing individual health care services, large healthcare organisations and the overall health system” [1]; (2) *digital health* is “an umbrella term referring to a range of technologies that can be used to treat patients and collect and share a person’s health information” [2]; and (3) *digital health services* can be seen as the use of digital tools and processes to provide and support the delivery of health care in a digital society [3].

Background**Overview**

The health care system is experiencing a period of rapid and radical change. From a global perspective, the aging population, an escalating burden of chronic disease and pandemics, and increasing community expectations are all placing growing demands on health care services [4]. As a response, innovative service models have been adopted for the delivery of high-quality care to meet this burgeoning need and to improve the efficiency, value, and safety of health service provision [5]. Innovation has included the adoption and implementation of digital health solutions, which were not possible a generation ago. Hence, a health workforce with the requisite skills to support such transformation requires new thinking and new ways of working.

Digital Health Transformation Has Been Witnessed

Digital health services have been shown as crucial to developing just-in-time, tailored, and targeted health care that is accessible, affordable, appropriate, and sustainable [6]. Digital health has become “an umbrella term referring to a range of technologies that can be used to treat patients and collect and share a person’s health information” [2]. To ensure success in the digital transformation of health services, digital health solutions need to be designed, developed, and delivered in an effective, efficient, ethical, and evidence-based manner under good governance and management [7-10].

The COVID-19 pandemic saw an acceleration in the uptake of digital health solutions globally. This required health care practitioners and providers to adapt to new ways of working, with the ever-present social distancing and travel restriction requirements becoming commonplace. As an example of the accelerated uptake during the pandemic, digital-first strategies, remote monitoring, and digital care approaches were quickly implemented to enable continuity of health care service without physical interactions [11]. Across Europe, digital health systems

enabled critical support of public health policies [12,13] improving the monitoring, surveillance, information, and communication regarding COVID-19 requirements and its impact on health care, as well as the recording and monitoring of vaccination bookings [5]. In the United States, “technology innovations and policy prescriptions” [14] and “right-sizing of regulation” [14] were implemented to support the rapid adoption of innovative, digital health technologies. Furthermore, the web-based medical visit requirements under the HIPAA (Health Insurance Portability and Accountability Act) were also recalibrated [14]. Additionally, the Australian federal government’s responses to the pandemic included implementing the necessary policy and funding requirements for innovative digital health solutions to be deployed across the country [15].

Demands on a Skilled Workforce

In response to the fast adoption of digital health technologies, a competent health care workforce with capabilities and confidence in implementing and integrating digital health technologies into health service delivery is essential [6,16]. This includes the management and leadership of health care organizations in the digital health context. Some efforts in addressing the required workforce competencies have occurred. For example, the United Kingdom’s National Health Service [17] has responded by instantiating the Graduate Management Training Scheme for leadership development that includes a Health Informatics specialization, which leads to a postgraduate diploma in data analytics.

In Australia, the Australian Digital Health Agency [18] has developed the National Digital Health Workforce and Education Roadmap and recently noted that “there has been significant interest in emerging literature that examines the future of work and the impact digital technologies will have on the health workforce, or indeed are having. However, there has not been as much concentration on the planning, programs and strategies required to improve the digital health literacy of the health workforce.” Therefore, in the Australian context, it is imperative to focus on the digital health workforce, management competency, and capability development, with contemporary and contextual training that is relevant and responsive to the current health care environment.

Competency, Context, and Performance

How health service managers plan and manage the increasingly complex digital tools in an ever-changing environment, along with the resultant rise in digital health literacy, requires capabilities and contextual competencies to ensure these new technologies are best used to inform both strategic and operational decision-making [19-23]. This is supported by the growing evidence highlighting the importance of the investment required to develop a competent health service management workforce, including through academic credentialing and professional association certifications [24].

Although various management competency frameworks have been established to guide the development of management competence for health service managers [25,26], whether these frameworks have adequately captured the competency requirements for health service managers in managing the necessary, fast-paced change and digital transformation of health care is not evident. This highlights a need to articulate the competencies that are necessary for health service managers to acquire to effectively work with and manage in the digital health context. Therefore, confirming the changing competency requirements for health service managers in managing and leading digital health transformation in health care is warranted. This research is being undertaken in the Australian health care setting to contextualize and inform national frameworks, system enablers, and factors that support Australian health service managers in the digital context.

A review of the literature confirmed that the development of competence is context-sensitive [27,28], with performance improvement resulting from competency development. To improve a health service manager's capability in facilitating and implementing digital health transformation, it is desirable that health service managers develop relevant competencies. Providing an environment that enables managers to fulfill their responsibilities is equally important [29].

Preparatory Phase (Phase 1)

Overview

In exploring the theoretical concepts to inform the research design, the initial focus was on the health informatics competencies required for health service managers to perform effectively in today's health care environment, where the use of health informatics and digital tools is the norm [19-23]. Accordingly, preparatory work was undertaken to first explore competencies and what health informatics competencies already existed within the Australasian College of Health Service Management (ACHSM) Master Health Service Management Competency Framework competencies [1] and in the Australian Health Informatics Competency Framework (AHICF) [30], which apply to health service managers in Australia. It should be noted that in the 2022 revision of the AHICF, an international health informatics frameworks review was included that examined changes in the competency frameworks from the United Kingdom, Canada, Saudi Arabia, and the United States.

Second context, health service managers must be able to deliver these competencies in the context of health services management. Third competency (effective performance), health service managers need to be able to demonstrate competency, so what approach is recommended to measure the attainment of health informatics competencies for health service managers?

Digital competence and the demonstration of these competencies are context-sensitive [27,28]. Understanding the requisite knowledge and skills that are necessary to ensure the development of competency in the digital health environment is crucial, particularly in terms of rapid digital transformation. In addition, structural enabling and inhibiting factors to support a health service manager's demonstration of digital competence must be addressed to ensure the efficacy of this competency.

Underpinning this understanding is the importance as to how the development of competence can be supported at the organizational level as well as understanding the challenges health service managers face in demonstrating their competence in the digital context. This understanding must be informed by the system level and organizational factors that can support and enable the development and demonstration of competence in this dynamic, digital environment. Consequently, this preparatory work and the initial findings informed the significance of the research study and the final study design.

Research Focus, Research Questions, and Intended Benefits

The original focus of the research was "improving health informatics competencies for health service managers in Australia." The research project was designed in 2019. Since the COVID-19 pandemic, significant developments in digital health have been witnessed. Following the in-depth literature review, ongoing research work, and prevailing industry activities with the Australasian Institute of Digital Health (AIDH), this highlighted that digital health had now become the umbrella term covering health informatics. Digital health is becoming increasingly relevant in the contemporary environment and is the more commonly used lexicon in the industry. The competency frameworks now being developed internationally are increasingly focusing on digital health rather than health informatics alone [31].

The Australian Digital Health Agency [18] has also identified that "digital health is increasingly recognised as an area for research, capability development and investment" [18]. Therefore, expanding the study from health informatics only, to all aspects of digital health, was more relevant to the current health care context and climate.

The research study will contribute to the development of the capability for health service managers in managing health services in the digital health era and enabling digital transformation in the health context by seeking answers to the following three research questions: (1) To what extent can the existing health service management and digital health competency frameworks guide the development of competence for health service managers in understanding and managing in the digital health space? (2) What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context? (3) What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace?

Methods

Phase 1

The following initial 2 steps were completed in order to confirm the significance of the study and study design and to develop a conceptual framework as a research guide to answer the 3 research questions.

Step 1: Competency Mapping

Cognizant of the existing and enduring efforts to support health management competency development in the digital health context, the purpose of this initial step was to comprehend existing structures and factors that can enable competency development and education in digital health management. This guided the primary investigation enumerating the extent to which postgraduate health care management education in Australian universities facilitates the development of informatics competencies. A health care management and informatics competency mapping process was undertaken using industry certification competency frameworks to identify, collect, map, and then distinguish the competencies evidenced in the postgraduate health care management programs. As the leading health informatics competency framework in Australia, the 50 health informatics competency statements from the AHICF were first mapped to the ACHSM Master Health Service Management Competency Framework competencies [1]. These were then mapped to the 21 ACHSM accredited, and the Royal Australasian College of Medical Administrators (RACMA) recognized, postgraduate health care management programs offered domestically in Australia. The ACHSM accredits, and RACMA approves the health care management degrees in Australia. These are voluntary processes that are seen as the recognized industry standard and acknowledgment for higher degrees for health service managers. The mapping process used the “Steps Used to Effectively Map Preexisting Courses to Competency Sets” approach created at the University of Washington School of Public Health’s Northwest Center for Public Health Practice, as it has been shown to have a prominent level of assurance in the accuracy of the competency mapping process for university courses [32,33].

Based on the Association of American Medical Colleges’ Curriculum Management and Information Tool (CurrMIT) [34], the Competency Mapping Matrix spreadsheet was constructed, which contained the program names, subject or course topic learning objectives, and the 50 AHICF competencies. Each of the 21 postgraduate health care management programs was then reviewed by subject title, learning objectives, and assessments for keywords, competency indicators, and themes that matched with the competency framework. The degree to which the competency was seen as being addressed was then mapped using a four-point criteria scale: (1) not addressed, (2) partially addressed, (3) mostly addressed, and (4) fully addressed. To confirm the reliability and validity of the rating instrument, piloting of the Competency Mapping Matrix spreadsheet was completed with 1 academic and 1 professional services Australian university staff member, both working within health care management postgraduate awards.

An experienced international health informatics academic completed the primary mapping, with a health service management competency specialist and management competency researcher providing oversight. Independent validation was then provided by an expert health informatics competency specialist educator and previous head of a university business school. Interrater reliability of the competency mapping process and tool was used to establish the validity of the mapping itself. Any discrepancies were resolved by a subject

matter expert (an Australian professor in health service management) [35].

Step 2: Scoping Review**Overview**

The second step was to conduct a scoping review of research literature to confirm the changing competency requirements for health service managers as a result of digital transformation in health care [6]. This published work explored the competencies health service managers need to acquire to effectively manage in the digital health context as well as describing the key factors that enable and inhibit health service managers in demonstrating digital health competence in the workplace. This scoping review of the literature was conducted in 2022 and built on a rapid review undertaken in 2020 [25]. The review was guided by Arksey and O’Malley’s five-step framework [36], using the following steps: (1) defining a research question, (2) identifying relevant studies, (3) selecting and confirming empirical studies, (4) data extraction, and (5) collating, summarizing, and reporting results.

Data Sources and Search Strategies

The following databases were searched: PubMed, Scopus, ProQuest, Web of Science, CINAHL, ACM Digital Library, Google Scholar, and ProQuest Dissertations. The following keywords were used: “digital health,” “electronic health,” “health informatics,” “competencies,” “capability,” “proficiency,” “certification,” “qualification,” “health manager,” “health executive,” and “health administrator.” A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach [37] was used for eligibility screening. The review searched for publications in the English language since the year 2000 that were peer-reviewed, empirical, and from the gray literature, including government white papers and professional institution position papers.

Data Extraction

Data were extracted from eligible publications and included authors, year of publication, country of origin, the aim of the study, target population, methods for data collection, and key findings related to the scoping review objectives. Content analysis was performed on the extracted data to assist in developing an understanding of the content and identifying the principal themes pertinent to the search focus.

The original search conducted in 2020 generated 1212 publications, and after duplicates were removed, 941 publications were included for title screening. This led to 185 papers being included for abstract screening by 2 reviewers. The revised search conducted in 2022 generated 467 publications, and after the removal of duplicates, 403 publications were included for title screening. This led to 114 papers that were included for abstract screening, which resulted in an additional 4 papers that went through full-text review with the initial 185 papers identified. Full-text review confirmed that 81 publications were particularly relevant to digital health competencies and workforce development in the digital health context. From which, 19 papers pertinent to the focus of the scoping review then underwent qualitative content analysis [6].

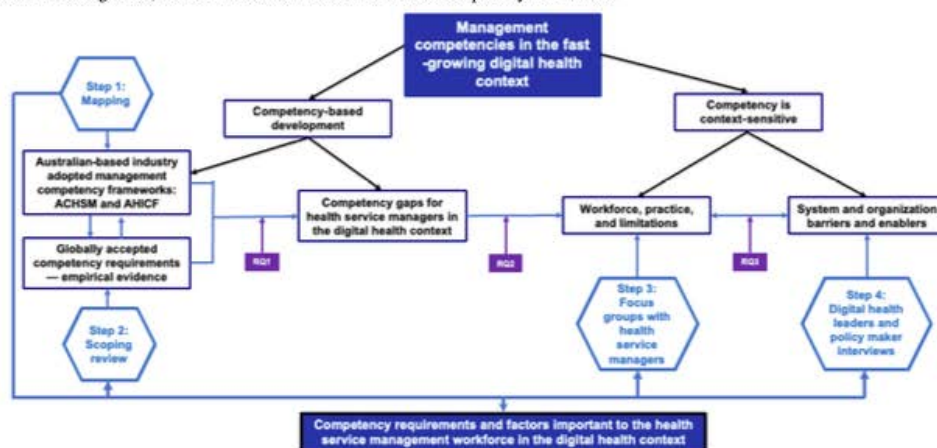
Phase 2

Overview

Based on the learnings from the competency mapping, the scoping review, and the knowledge gaps identified in the literature, the conceptual framework presented in Figure 1 has been developed to guide the overall design of the study. The framework follows the research process steps (the blue lines) and addresses the 3 research questions (the purple boxes). The study has adopted a qualitative approach, guided by the

empirically validated management competency identification process [27], using the following four steps: (1) health management and digital health competency mapping, (2) scoping review of literature and policy analysis, (3) focus group discussions (FGDs) with health service managers, and (4) semistructured interviews with digital health leaders. This approach is also substantiated by consistent evidence in the international literature supporting the use of these data collection methods in identifying and analyzing informatics and digital competencies in health care [38-41].

Figure 1. Conceptual framework—researching digital health competencies for health service managers. Blue lines show the research process. Purple boxes show the research questions (RQs). RQ1: To what extent can the existing health service management competency framework guide the development of competence for health service managers in understanding and managing in the digital health space? RQ2: What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context? RQ3: What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace? ACHSM: Australasian College of Health Service Management; AHICF: Australian Health Informatics Competency Framework.



As mentioned earlier, the first 2 steps have been completed as part of the preparation process, and the overall results from these 2 steps provided the foundation for and informed steps 3 and 4 of this research study. Data collection and analysis,

including triangulation of data, will be completed by December 2023. Table 1 details the target populations and the proposed number of participants for steps 3 and 4.

Table 1. Details of the qualitative research study focus group discussions and interviews.

Methods	Focus group discussions via videoconference	Semistructured interviews via videoconference
Focus	To explore the competencies that health service managers need to acquire to effectively work with and manage in the digital health context, along with factors that enable and inhibit the acquisition of these competencies.	To validate findings from the focus group discussions in relation to health service manager competencies, barriers, and enablers for managing in the digital health environment. Also exploring issues that influence digital health policy and practice.
Who are the participants?	Mid-level managers who are responsible for the day-to-day operations of Australian public hospitals. These positions may include department directors, unit managers, and ward managers representing level 3 and 4 management ^a from public hospital settings.	Digital health leaders and chief digital health or clinical information officers from national digital health organizations and public health departments who have executive responsibility for digital health.
Participants, n	48 (8 per group×6 focus groups)	15

^aManagement levels are defined by the organizational reporting hierarchy, with level 1 being the chief executive officer, level 2 reporting to the chief executive officer, level 3 reporting to level 2 management, and level 4 reporting to level 3 management.

Sampling

A purposive sampling technique will be used to identify participants for both the focus groups and interviews, as it

enables a deliberate selection of a participant due to their characteristics linked to the study variables. This sampling “involves identification and selection of individuals or groups of individuals that are proficient and well-informed with a

phenomenon of interest" [42]. Furthermore, snowball sampling will be used to assist in locating additional key informants who are information-rich and possess a certain characteristic of research relevance with the target population.

Recruitment

For the FGDs

Potential participants for the FGDs will be invited and recruited from the members of AIDH membership or ACHSM. Invitations of participation will be announced by AIDH and ACHSM in their newsletters and websites. The principal investigator's contact details will be included in the announcement. The announcement will encourage and invite potential participants to contact the principal investigator directly to express their interest to participate. Upon receipt of the expression of interest, the principal investigator will assess the eligibility and contact eligible participants directly via email to provide a formal invitation to participate in the FGD, which will contain a copy of the project information sheet and consent form. The principal investigator will also email those who expressed their interest in participating and who were not eligible and provide them with an explanation as to why they were not selected.

For the Semistructured Interviews

The semistructured interview participants will be invited and recruited from the members of the Digital Health Executive Network AIDH membership or ACHSM membership. Invitations of participation will be announced by AIDH and ACHSM in their newsletters and websites. The principal investigator's contact details will be included in the announcement. The announcement will encourage and invite potential participants to contact the principal investigator directly to express their interest to participate. Upon receipt of the expression of interest, the principal investigator will then assess the eligibility and contact eligible participants directly via email to provide a formal invitation to participate in the semistructured interview, which will contain a copy of the project information sheet and consent form. If there is no response within 5 working days, 1 further email will be sent before the completion of 1 follow-up phone contact. The principal investigator will also email those who expressed their interest in participating and who are not eligible and provide them with an explanation for not being selected.

Ethical Considerations

This research received ethics approval on October 20, 2022, by the James Cook University Human Research Ethics Committee (approval H8877; expiry December 27, 2024). For the focus group and interview participants who respond to the AIDH or ACHSM expression of interest to participate in the general announcement and meet the health service managers' inclusion criteria, an invitation email will be sent to potential participants by the PhD candidate with the participant information sheet and consent form attached to the email. Participants are asked to complete, sign, and return the consent form if they would like to attend the FGD or semistructured interview. The personal information collected will include participant name, position title, name of organization, and email address; however, no names will be retained, participants' identity will not be

disclosed, and all information is nonidentifiable. Each participant will be provided with a copy of their FGD or interview transcript, and they can request any specific information in the transcript to be excluded from the analysis. Results of the study will be presented collectively, and no individual information will be used. Participants will volunteer 90 minutes of their time to participate in the FGD or 45 minutes of their time to participate in the semistructured interview; there will be no payment to participate in the research study.

Conducting FGDs and Semistructured Interviews

In total, 6 FGDs will be conducted via videoconference (Microsoft Teams; Microsoft) by the principal investigator and 1 other member of the research team, who will play the role of observer or notetaker. The participants will be 40-50 midlevel managers who are responsible for the day-to-day operations of Australian public hospitals. These positions include department directors, unit managers, program managers, and ward managers, representing level 3 and 4 management from public hospital settings. Management levels are defined by the organizational reporting hierarchy, with level 1 being the chief executive officer, level 2 reporting to the chief executive officer, level 3 reporting to level 2 management, and level 4 reporting to level 3 management. The number of participants is consistent with the qualitative methodology being used to ensure data saturation [43-45]. The FGDs will be conducted for approximately 90 minutes each and digitally captured via the recording functionality of the Microsoft Teams videoconference call. The automatically transcribed text will then be reviewed and proofread for language and readability to provide a full transcript of the discussions.

In total, 15 semistructured interviews will be conducted by the principal investigator via videoconference (Microsoft Teams) with digital health leaders and chief digital health or clinical information officers from national digital health organizations and public health departments, who have executive responsibility for digital health, including authority over all aspects of a significant area of work and accountability for making decisions critical to the organization's success. The number of participants is consistent with the qualitative methodology being used to ensure data saturation [43-45]. Five open-ended questions will guide the interviews. The key informant interviews will be conducted for approximately 45 minutes each and digitally captured via the recording functionality of the Microsoft Teams videoconference call.

For both types of interviews, a person-specific transcription is provided to each participant to amend or delete any of their comments, particularly for validation of accuracy or to clarify a statement, should they wish to do so.

Data Analysis for the FGDs and Semistructured Interviews

All transcripts will be subsequently analyzed using NVivo software (QSR International) or Leximancer software (Leximancer) or other content analysis tools. For the focus group interviews, a thematic analysis will be conducted iteratively with data from the focus groups to develop concepts, categories, and themes. Competencies will then be analyzed and categorized

against existing national and international health service management and digital health competency frameworks. Enabling and inhibiting factors will also be analyzed using Braun et al [46] 6-phase reflexive thematic analysis approach to identify, organize, analyze, and advance insight into themes or categories of the factors emerging.

Importantly, reflexive thematic analysis enables the researcher to highlight meaning as contextual or situated while

simultaneously undertaking analysis of the text for meaning [47,48]. Further, the legitimacy and validity of the researcher's subjectivity are not just acknowledged, but it is also an intrinsic asset, as reflexive thematic analysis supports the active role of the researcher in the knowledge generation process [47]. Using the 6-phase reflexive thematic analysis approach as detailed in **Textbox 1** augments the acquisition of text patterns and key terms to reveal patterns that were previously unknown and furnish information with meaning [49].

Textbox 1. The reflexive thematic analysis 6-phase approach guiding data analysis [46].

Familiarization
Moving from data generation to analysis, that is, appreciating the data, by becoming immersed in and connecting with the data in different ways.
Generating codes
Moving to a more in-depth and systematic engagement with the data, that is, making sense of the data, by curating a list of terms, filtering out textual noise, and generating clear patterns to extract more valuable insights [49].
Constructing themes
Moving from codes into overarching themes that accurately and coherently represent the data, that is, creating a story about the data, through latent semantic analysis and singular value determination to uncover themes [49].
Revising themes
Moving to candidate themes and reviewing them to see how each theme relates to the others, that is, telling the overall story about the data.
Defining themes
Moving to clear definitions of each theme by elucidating the essence and scope of each theme, that is, what is meaningful about the data.
Producing the report
Moving to a final test of how well the themes work, both individually in relation to the data set and overall, that is, a logical story with sufficient evidence that the themes are relevant to the data.

The semistructured interview transcripts will then be analyzed using reflexive thematic analysis to triangulate the findings with the themes emerging from the FGDs. This will assist in validating the health service manager's competencies required to manage in the digital health context, as well as generating perspectives on both role development and enhancement needs for a health service manager's digital health competency, and aspirational and professional development requirements for health service managers to lead in the digital health space.

Both the FGDs and semistructured interviews will use the COREQ (Consolidated Criteria for Reporting Qualitative Research) checklist to "promote explicit and comprehensive reporting of qualitative studies (interviews and focus groups)" [50].

Results

Results from phase 1 of the study, which commenced in October 2019, were published in July 2021 [35] and October 2022 [6] and informed the significance of the research study and the final study design, which are presented here.

Competency Mapping Results

By completing the mapping of the 85 ACHSM Master Health Service Management Competency Framework competencies to the 50 health informatics competency statements from the AHICF, it was found that nearly half of this framework's competencies were only partially or not addressed at all by the

ACHSM framework. As the ACHSM framework guides accreditation of postgraduate health care management programs offered domestically in Australia and forms part of the RACMA fellowship program, this indicated that the existing formal graduate-level education may not be adequate in developing health service managers' competency in the digital health era [35]. This published work highlighted an important gap to address—developing skills for the health management workforce relies on industry competency framework requirements that guide the curriculum and training endeavors as well as for the university programs, professional organizations, and individual health care institutions.

Scoping Review Results

The scoping review confirmed the five key activities that influence the development of health management workforce competency and capacity, namely: (1) using competency assessment, (2) guided by competency models, (3) supporting formal professional development, (4) including short-term training activities, and (5) using work-based development. Additionally, the following seven key factors that facilitate development of the health management workforce in the digital health context were also identified and included: (1) acknowledgment and recognition of these new digital responsibilities, (2) the organization's capacity to adopt innovation in a supportive environment to embrace digital health, (3) system-level support and political will, (4) specialized digital technology expertise, (5) an investment in the health service management workforce, (6) being underpinned by

systematic integration in planning, and (7) being used for practice development [6]. How these key activities work in the health care context and how these factors should be addressed require further exploration.

Discussion

Anticipated Findings

Focus Group Discussions

The FGD participants will provide reflections and insights to explore the competencies that health service managers need to acquire to effectively work with and manage in the digital health context along with factors that enable and inhibit acquisition of these competencies. The FGDs will explore the relevance of the additional competencies identified in steps 1 and 2. Findings of the identified list of important competencies from the FGDs will then inform the finalization of the semistructured interview questions.

Semistructured Interviews

The focus of the semistructured interviews is to explore (1) validation of the findings from the FGDs in terms of core health service manager competencies, barriers, and enablers to manage in the digital health environment and (2) in-depth insights affecting digital health influences on digital health policy and practice.

Limitations

It is important to note some limitations associated with a research protocol. The study is qualitative in nature to develop an in-depth understanding of Australian health service manager's experiences and views. The methods described could be applied in other contexts; however, the results may not be generalized to other country contexts. Any recommendations provided in subsequent publications will note these limitations, and

suggested findings are contextualized to individual jurisdictions and environments.

Industry Impact

Review of the AHICF competencies was completed by the Certified Health Informatician Australasia Examination Committee in 2022, of which the principal investigator is a member, and version 2.0 of the AHICF [51] now contains 11 leadership and management competencies in domain D, up from the previous 5 management science competencies in domain 4 of version 1.0.

Further, a review of the ACHSM Master Health Service Management Competency Framework was completed by the National Steering Committee in 2022, of which the principal investigator was a member, and version 2.0 [52] now contains 6 digital management competencies in an action domain, whereas no specific digital competencies were articulated in version 1.0.

Conclusions

This study will provide real-time, in-depth insights into the health service management workforce performance and development needs for digital health and will uniquely inform credentialing and professional development requirements for health service management. Further, this will also illuminate the postgraduate programs and continuing professional development requirements for health service management education and training. Developing strategies based on these findings will assist in supporting the health service managers to lead and manage the adoption and implementation of digital health technology and initiatives in the health care sector, including insights into the health care system's digital workforce policy and capacity considerations. This will assist in optimizing the outcomes from adoption of digital health as a contemporary tool for health care delivery and furthering digital transformation outcomes for patients, practitioners, providers, and the public.

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Data Availability

The data sets generated during and analyzed during this study are not publicly available due to ongoing data collection from participants but may be made available from the corresponding author on reasonable request.

Authors' Contributions

MB, with the supervision of ZL, MM, and MW, conceived and designed the study. MB performed the competency mapping and literature search in collaboration with ZL, MM, and MW. The first draft of the paper was prepared by MB. ZL revised it critically for important intellectual content, upon which all authors then conceptually commented. MB, ZL, MM, and MW provided substantial contributions to the conception of the research protocol. MB and ZL finalized the paper, and all authors approved the final version of the paper.

Conflicts of Interest

None declared.

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Abbreviations

ACHSM: Australasian College of Health Service Management
AHICF: Australian Health Informatics Competency Framework
AIDH: Australasian Institute of Digital Health
COREQ: Consolidated Criteria for Reporting Qualitative Research
FGD: focus group discussion
HIPAA: Health Insurance Portability and Accountability Act
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RACMA: Royal Australasian College of Medical Administrators

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3.3 Ethics Approval

This research received ethics approval on October 20, 2022, by the James Cook University Human Research Ethics Committee (approval H8877).

3.4 Conceptual Framework

As the research progressed, there was sufficient depth and breadth of primary data captured in the focus group discussions that provided the basis to address all three research questions, as data saturation had been achieved by completing the first three steps, as detailed in the study's conceptual framework (Brommeyer et al., 2023a) presented above. Step four, key informant interviews, can therefore be seen as important in contextualising the study's findings for the next phase of research translation.

3.5 Focus Group Discussions Participant Characteristics

3.5.1 Target population

Participants included all eligible mid-level managers who are members of the Australasian Institute of Digital Health and the Australasian College of Health Service Management were invited to the study. These health service managers came from all Australian States and the Australian Capital Territory across various management positions in clinical, corporate, technical, research, quality and program management roles, representing level 3 and 4 management from public hospital settings. The management levels are defined by the organisational reporting hierarchy, as detailed in the Liang, et al. (2018) management competency study in the Australian health system (Liang et al., 2018a), with level 1 being the Chief Executive Officer (CEO), level 2 reporting to the CEO, level 3 reporting to level 2 management, and level 4 reporting to level 3 management. The number of participants is consistent with the qualitative methodology being used to ensure data saturation (Friedman et al., 2022, Hennink and Kaiser, 2021, Hennink, 2019), which was reached.

Participants were selected from Australian public hospital settings, as publicly funded organisations have typically made greater investment in digital tools, services and innovations, both prior to and as a result of the COVID-19 pandemic, which have increased the requirement for digital transformation (Borges do Nascimento et al., 2023a, Borges do Nascimento et al., 2023b, Garcia-Perez et al., 2023, Ghosh et al., 2023, Hajizadeh et al., 2023, Jarva et al., 2023, Kakemam and Liang, 2023, Ndayishimiye et al., 2023). The participants provided reflections and insights exploring the competencies that health service managers need to acquire to effectively work with and manage in the digital health context, along with factors that enable and inhibit acquisition of these competencies.

3.5.2 Inclusion criteria

Health service managers who were level 3 or 4 management level (and members of the Australasian Institute of Digital Health and the Australasian College of Health Service Management, as described in Section 3.5.1 Target population, above), employed by a public hospital in Australia were invited to participate in each of the six focus group discussions.

The following exclusion criteria were applied: (1) health service managers who were not employed at an Australian public hospitals; and (2) other healthcare management personnel who were outside of management levels 3 and 4.

3.6 Ethical Considerations

3.6.1 Sampling

A purposive sampling technique was employed to select participants who were eligible mid-level managers and members of the AIDH and the ACHSM for the focus group discussions, as this enables an intentional selection of a participant due to their attributes associated with the study variables. This sampling “involves identification and selection of individuals or groups of individuals that are proficient and well-informed with a phenomenon of interest” (Etikan et al., 2016, p.2). In addition, snowball sampling was used to locate further key informants who could contribute pertinent and contextual information, and possessed features of research relevance with the target population.

3.6.2 Recruitment

Prospective participants for the focus group discussions were recruited from members of the AIDH and ACHSM. Invitations to participate were announced by AIDH and ACHSM in their electronic newsletters and websites. The PhD candidate's contact details were contained in the announcement. The announcement invited prospective participants to e-mail the PhD candidate to communicate their interest to participate. Upon receipt of the expression of interest, the PhD candidate assessed the eligibility and communicated with eligible participants via e-mail, providing a formal invitation to participate in the focus group discussions. This invitation also contained a copy of the project information sheet and consent form. The PhD candidate also contacted those who expressed their interest in participating but were not eligible, including clarification as to why they were not eligible.

3.6.3 Informed Consent

All participants were sent an email invitation confirming participation and consent to participate in a Focus Group Discussion (FGD) via MS Teams – see Appendix B. Each participant responded to the email invitation with confirmation of participation and consent to participate in the research project. Prior to commencing the focus group, all participants were also advised of the option of withdrawing their consent at any stage.

3.6.4 Issues encountered

No ethical issues were encountered throughout the research study.

3.7 Data Analysis

All transcripts from the six FGDs were analysed using NVivo software (QSR International). Thematic analysis was then conducted iteratively to develop concepts, categories, and themes. Competencies were also analysed and compared with prevailing national and international health service management and digital health competency frameworks. Further, enabling and inhibiting factors were analysed using Braun and Clarke's (Braun et al., 2019) six-phase reflexive thematic analysis approach to identify, organise, analyse, and advance insight into themes or categories of the emerging elements. The FGDs were employed to achieve data saturation, which was achieved – and using reflexive thematic analysis, the themes emerged qualitatively and inductively. Themes were able to be grouped based on the competencies already identified; the new competencies that were then identified that didn't readily fit within existing competencies, and then discussed in terms of being an enhancement to existing competencies or a new or novel competency.

3.8 Member checking

Multiple approaches were employed to check participants' intended meaning, "where participants are asked to input on whether an analysis faithfully or fairly represents their experience" (Braun and Clarke, 2023, p.4). Once the initial transcripts had been cleaned up, all of the focus group discussion participants were emailed these transcripts and asked to revise or delete any of their comments if they wanted to do so, especially to validate accuracy or clarify a statement. The participants will also receive a copy of the final results. This "practice of checking back with study respondents to see if the research is in line with their views" (Busetto et al., 2020, p.7) can increase the quality of the research being conducted. Once this study has been concluded, a summary will be provided to both the ACHSM and AIDH, requesting to advise all the institution's members of the relevant research outcomes via their respective websites.

3.9 Limitations

There are some limitations associated with this research study that need to be acknowledged. The study is qualitative in nature to develop an in-depth understanding of the experiences and views of Australian health service managers who are responsible for the day-to-day operations of Australian public hospitals. The methods as described may be able to be applied in other contexts; however, the results may not be readily generalised to other countries' contexts, and any recommendations must be contextualised to specific jurisdictions and environments.

As this research was undertaken during and closely following the COVID-19 pandemic, future research might concentrate on the enduring effects of managing digital health in the changing dynamic of developing and proliferating technologies, how healthcare organisations and systems are growing and transforming to ensure efficient, effective, safe and sustainable service provision, as well as the type of health service managers competencies needed to purposefully navigate digital transformation. This would necessitate addressing the accelerated adoption of various business and clinical artificial intelligence tools, which will require human intelligence oversight to ensure appropriate governance, ethical decision-making, and implementation guidance to equitably manage the use of artificial intelligence in healthcare, in a safe and effective manner. Further, it would also be beneficial to extend this research into other components of the broader care system, including primary, community and aged care.

3.10 Chapter Summary

Chapter 3 detailed the qualitative methodology adopted, guided by the empirically validated management competency identification and development process, employing three steps: (1) health management and digital health competency mapping; (2) scoping review of the literature and policy analysis; and (3) focus group discussions with health service managers. Further, the study design, methods for data collection, ethical considerations, data analysis methods employed, and limitations of this study are presented.

Chapter Four – Developing Management Workforce Readiness for Digital Health Transformation

4.1 Chapter Introduction

The purpose of this chapter is to present the findings of a three-step approach to understanding the current obstacles to developing a health management workforce that can enable and maximise the benefits of digital health transformation, and discover ways of surmounting such obstacles in support of the health service management digital workforce transformation.

Figure 4 situates this chapter in the map of the broader thesis structure:

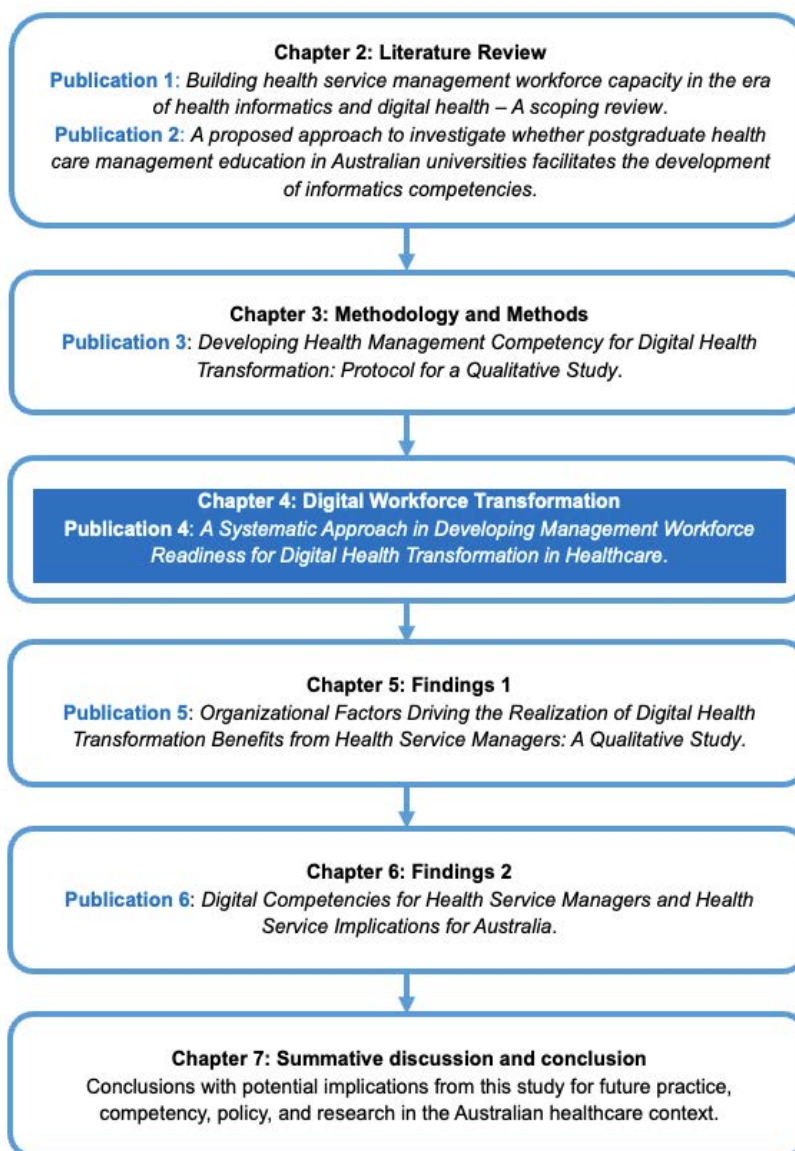


Figure 4: Thesis structure map Chapter 4

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Review

A Systematic Approach in Developing Management Workforce Readiness for Digital Health Transformation in Healthcare

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Abstract: Background: The COVID-19 pandemic has sped up digital health transformation across the health sectors to enable innovative health service delivery. Such transformation relies on competent managers with the capacity to lead and manage. However, the health system has not adopted a holistic approach in addressing the health management workforce development needs, with many hurdles to overcome. The objectives of this paper are to present the findings of a three-step approach in understanding the current hurdles in developing a health management workforce that can enable and maximize the benefits of digital health transformation, and to explore ways of overcoming such hurdles. Methods: A three-step, systematic approach was undertaken, including an Australian digital health policy documentary analysis, an Australian health service management postgraduate program analysis, and a scoping review of international literatures. Results: The main findings of the three-step approach confirmed the strategies required in developing a digitally enabled health management workforce and efforts in enabling managers in leading and managing in the digital health space. Conclusions: With the ever-changing landscape of digital health, leading and managing in times of system transformation requires a holistic approach to develop the necessary health management workforce capabilities and system-wide capacity. The proposed framework, for overall health management workforce development in the digital health era, suggests that national collaboration is necessary to articulate a more coordinated, consistent, and coherent set of policy guidelines and the system, policy, educational, and professional organizational enablers that drive a digital health focused approach across all the healthcare sectors, in a coordinated and contextual manner.

Keywords: health service managers; competency frameworks; capacity building; digital health; health informatics; health workforce; health management degrees

1. Introduction

In the rapidly changing, digitally-connected healthcare environment, health service managers need capabilities and relevant competencies to enable data-driven, strategic and operational decision-making [1–3], and the capacity to lead and manage digital health transformation. Health service managers must tackle the challenges of unprecedented growth in digital health literacy within this period of systemic transformation, and be proficient in planning and managing the digital tools and technologies across this shifting landscape [4,5].

1.1. COVID-19 and Digital Health Transformation in Healthcare

The COVID-19 pandemic has pressured the adoption of innovation in service delivery within healthcare systems and organizations globally, including the rapid adoption of digital health technologies, as healthcare practitioners and systems needed to adapt to new ways of working, with omnipresent social distancing and travel restriction requirements the norm. As witnessed in Europe and the United Kingdom, “many countries have adopted digital-first strategies, remote monitoring and telehealth platforms to enable healthcare

provision without physical interactions” [6] (p. 1). In addition, digital health systems have also played a critical role in support of public health policies [7,8] and improving communication and information in healthcare; COVID monitoring and surveillance; health services provision, and vaccination bookings, recording, and monitoring [9]. In the United States of America, elements that supported the rapid adoption of digital health solutions and innovation during the pandemic included “technology innovations and policy prescriptions” (p. 9), including “right-sizing of regulation” (p. 8), for example, recalibrating virtual medical visit requirements under the Health Insurance Portability and Accountability Act [10]. In Australia, the Federal government’s pandemic response included implementing the required policy and funding arrangements for digital health innovation to be used across the country [11].

Globally, in August 2020, the G20 Riyadh Declaration on Digital Health was formulated, which presented nine recommendations on digital health to address the challenges of the COVID-19 and future pandemics. This included a “consensus on high-priority issues identified within 5 themes: team, transparency and trust, technology, techquity (the strategic development and deployment of technology in health care and health to achieve health equity), and transformation” [12] (p. 1). The fast growing cross-sector, digital health transformations highlight the pressing need to develop a workforce equipped with the knowledge, skills, and capabilities in deploying and managing digital technologies vital to meet the current and future public health challenges, in a timely and systematic manner [12].

1.2. Evidence on Workforce Development Needs

Success in healthcare innovation and transformation necessitates a health workforce with the required understanding and new skill sets, which does not happen overnight and is a continuous improvement process. Using the introduction of electronic health records (EHR) as an example, after being broadly implemented in the healthcare system, in particular the hospital sector for more than a decade, mounting evidence indicates that EHRs have not been adequately utilized by clinicians to guide clinical decision-making [13]. Clinicians’ lack of understanding of the benefits of EHRs, their frequent encounter with difficulties in access, and the perceived lack of effectiveness and efficiency of EHR usage, were the three major reasons for the lack of EHR take-up [14,15].

Empirical evidence further identified that leaders’ lack of awareness of their role in mobilizing and supporting staff and collaborating between key stakeholders in implementation, and inadequate understanding of the benefits of EHR, were two of the barriers to EHR success [1,16,17]. Not having the understanding of how EHRs can benefit and guide practices, and not having the technical skills required to work in the EHR context and utilize the digital data to guide decision-making, were the two key areas requiring targeted training and development prior to and during the introduction and implementation process [13].

1.3. Policy Guiding Digital Health Workforce Development

Overall health workforce development should be fundamentally driven and supported by workforce policy with allocated funding and resources [18], and concomitant efforts at system, institution, organization, and individual levels. In Australia, the Australian Digital Health Agency (ADHA) provides national policy direction and targeted funding for digital health, including the development of the National digital health workforce and education roadmap [19]. The roadmap clearly specifies the need to acquire a variety of digital literacy and baseline capabilities across the healthcare workforce, and suggests that the digital knowledge and skills required, will differ based on the diverse digital health roles and service delivery requirements throughout the healthcare system. They have also identified eight digital profiles, recognizing some consistency of digital capabilities required across health workforce roles, contexts or environments.

Two of the profiles: ‘leadership and executive profile’, and ‘the business, administration, and clinical support digital profile’, are both of particular importance as capable leaders and managers of a digitally-enabled workforce are key factors in successfully adopting and managing digital health transformation.

Unlike other health professions, health service management is not regulated, resulting in no specific requirements for management qualifications. Management competency improvements are often not embedded in regular management performance appraisals. This results in inadequate incentives for continuous, informal management training and development, which are both costly and time-consuming. Hence, in order to develop overall management workforce competence, political will and policy direction are required. International studies [20–25] have also highlighted that policy and system-level factors are crucial for healthcare management workforce development, in ensuring digital health adoption success. These factors include ensuring that a comprehensive digital health policy clearly aligns with the organization’s strategic goals, that support and investment in socio-economic and regulatory impact assessments of digital technologies are provided, and the privacy and integrity of digital data are assured. Clear governance rules and regulations regarding the use of digital technologies, supported by contextually applied technology implementation and outcome measurement training, are also critical.

1.4. The Role of Universities, Professional Institutions, and Organizations in Workforce Development

In addition to policy direction and incentives, the provision of skill development for the health workforce relies on the combined efforts between university programs, professional institutions, and individual healthcare organizations. Using the health service management (HSM) workforce in Australia as an example, at the institutional level, its development relies on 21 university programs such as the Master of Health Administration (MHA) and Master of Health Service Management (MHSM) awards, and professional institutions: the Australasian College of Health Service Management (<https://www.achsm.org.au>; accessed on 1 September 2022) and Royal Australasian College of Medical Administrators (<https://racma.edu.au>; accessed on 1 September 2022). Other member-based professional institutions, such as the Australian College of Nursing (<https://www.acn.edu.au>; accessed on 1 September 2022), Australian College of Rural and Remote Medicine (<https://www.acrrm.org.au>; accessed on 1 September 2022), and Australasian Institute of Digital Health (<https://digitalhealth.org.au>; accessed on 1 September 2022), also provide management development opportunities to specific professions.

In Australia now, there are a slowly developing number of digital health postgraduate program offerings, but they are not specifically targeting health service managers, and the capacity in developing HSM is limited [26]. Digital health transformation requires competent managers with the capacity to lead and manage, with relevant competencies that enable data-driven, strategic, and operational decision-making [1–3]. Health service managers must tackle the challenges of unprecedented growth in digital health literacy, within this period of systemic transformation, and be proficient in planning and managing the digital tools and technologies across this shifting landscape [4,5]. The COVID-19 pandemic has accelerated digital health adoption in healthcare for safer and more efficient service delivery in a timely manner. Such fast transformation does not allow much room for ‘learning on the job’ for health service managers, therefore, a holistic approach incorporating different upskilling mechanisms in addressing the health management workforce development needs has to be reconsidered.

1.5. Aims and Objectives

Health management workforce development needs are context-sensitive, and heavily influenced by the existing political will and policy direction. Hence, in order to develop a management workforce with the capacity to lead and manage digital health transformation in Australia, the current efforts at system and institution levels need to be identified, and

learning from international experience and their applicability in the Australian context, are required. In addition, a systematic and universal guiding framework for overall management workforce development needs to be developed, clearly specifying how efforts at various levels interact.

The purposes of this paper are to examine the current approaches in, and hurdles to, developing the Australian HSM workforce in the context of digital health transformation, and to identify strategies that can develop a digitally enabled health management workforce in the digital health era. This will lead to the development of a guiding framework for short- and longer-term health management workforce development and transformation requirements.

2. Materials and Methods

A three-step, qualitative approach has been adopted which includes: (1) documentary analysis of the Australian digital health policy; (2) analysis of the Australian HSM postgraduate programs and mapping the programs against the digital health-related competencies, and (3) a scoping review of international literatures focusing on strategies to develop HSM workforce capacity in the digital health context. This was guided by the evidence-informed approach to the development of workforce competency frameworks in healthcare professions, as described by Batt et al. [27] (p. 914), who indicate that “While there is no guidance on what specific methods to use, when to use them, or how to use them, there is consensus that in order to increase the validity and utility of competency frameworks, a combination of approaches may be necessary, akin to a process of triangulation”. The study analyzed the Guide to Developing Competency Standards for Professions by Heywood et al. [28], describing the first of five stages, which included examining: (1) the existing information from government reports, (2) studies undertaken by the profession, and (3) curriculum documents. This provided the basis for guiding the adoption of the three-step approach used for this study: (1) an analysis of Australian health policy documents, (2) a scoping review of international literature, and (3) an analysis of Australia’s health services management postgraduate programs.

2.1. Digital Health Policy

Digital health and workforce policy drivers were analyzed from twelve national organizations that are pertinent to digital health and workforce development in Australia (listed in Appendix A). These policies were identified by national expert digital health working groups, led by the Australian Digital Health Agency, through undertaking environmental digital health policy, capability, and competency framework scans. As Cardno explains, “As a qualitative research method, documentary analysis is often chosen as a second or supplementary way of collecting data in order to add rigour to a study through a multi-method form of triangulation” [29] (p. 626).

The twelve identified digital health government, educational, and workforce registration credentialing policy frameworks, were analyzed for digital health capability statements and keywords, competency domains, and professional certification requirements. These were then validated using a competency and narrative analysis review by the two researchers with domain expertise, for congruence.

2.2. Postgraduate Healthcare Management Programs

This research builds on a previous study, where the Australian Health Informatics Competency Framework’s 50 health informatics competency statements were mapped to the 21 postgraduate health management programs offered domestically in Australia, that received accreditation from the Australasian College of Health Service Management (ACHSM) by course purposes and learning outcomes of core subjects [30]. This followed the ‘Steps Used to Effectively Map Preexisting Courses to Competency Sets’ approach, developed by the University of Washington School of Public Health’s Northwest Center for

Public Health Practice (NWC PHP), as this has demonstrated a high level of confidence in the accuracy of the process for mapping competencies to its courses [31].

Both authors then independently analyzed the current 17 master's degree programs (listed in Appendix B), adopting a modified 'Steps Used to Effectively Map Preexisting Courses to Competency Sets' approach, developed by the University of Washington School of Public Health's Northwest Center for Public Health Practice (NWC PHP) [31].

2.3. Scoping Review

A scoping review of the literatures was conducted between 2020 and 2022. The initial focus was to identify the current efforts in developing a digitally enabled HSM workforce. Considering the small number of papers identified, the search of literatures was later expanded to cover all efforts in developing the health management workforce with key capabilities for the demonstration of required management competencies. The review was guided by the five-step framework defined by Arksey and O'Malley [32] including the following steps: (1) defining a research question, (2) identifying relevant studies, (3) selecting and confirming empirical studies, (4) data extraction, and (5) collating, summarizing, and reporting results.

The review searched the following databases: Scopus, ProQuest, Web of Science, ACM Digital Library, CINAHL, PubMed, Google Scholar, and ProQuest Dissertations. The scoping review used the following keywords: 'health informatics', 'digital health', 'electronic health', 'competencies', 'capability', 'proficiency', 'qualification', 'certification', 'health manager', 'health executive', 'health administrator', 'training', 'education', and 'professional development', which were confirmed in consultation with an academic research librarian at James Cook University. A PRISMA approach [33] was used for eligibility screening. The review searched for empirical articles published in the English language since the year 2000, that provided information addressing the objectives as detailed above.

The key findings of the review were extracted from the eligible papers, which were subject to content analysis in order to identify the essential themes relevant to the search focus.

3. Results

3.1. Policy Analysis

The analysis of digital health and workforce policy drivers from the above mentioned twelve national organizations found that for the digital health capabilities required for a competent, nationally certified, and registered healthcare workforce, there are disparate, differentiated, and diverging requirements included in these national policy frameworks, which guide the development of digital health capabilities across the healthcare workforce. The core digital health capabilities, foundational to all the healthcare workforce, could focus on domains such as Digital Professionalism, Leadership and Advocacy, Data and Information Quality, and Information Enabled Care, and Technology [34]. The contextualized roles, e.g., HSM, require discipline-specific competencies to be demonstrated for increased proficiency across healthcare settings.

3.2. Postgraduate Healthcare Management Program Analysis

Ten out of the 17 postgraduate programs offered digital health subjects, either as a major specialization or as elective topics. These subjects commonly address the following competency areas, as included in the Australian Health Informatics Competency Framework:

- (1) digital literacy,
- (2) use of information technologies in the health context,
- (3) awareness of new and emerging technologies in healthcare,
- (4) technology-enabled and data-driven operational and strategic decision-making,
- (5) future and current applications for digital health including the role of government, trends in big data, virtual, and telehealth,
- (6) use of technology for sustainable healthcare,
- (7) digital innovation and data analytics, and

(8) digital transformation of healthcare delivery.

These programs cover a range of operational and technical, program, project and change management capabilities for implementing digital tools and technology. However, the specific competencies required for leading and managing the workforce through digital transformation need to be included. This may include system, organizational, and team management skills, aligning the digital tools and technologies in support of required business and clinical, evidence-informed decision-making.

In Australia, there is now a Master of Digital Health program: (<https://www.latrobe.edu.au/courses/master-of-digital-health>: accessed on 2 September 2022), along with eleven Graduate Certificates in Health Informatics and Digital Health offerings. The master's degree focuses on evidence-based practice in digital health, implementing and evaluating contemporary digital health solutions, digital health safety and patient outcomes, with a primary focus on digital health consultants, managers and researchers. Whereas, the graduate certificates have a varied and diverse range of subjects targeting digital health skills development for the clinical, operational, and technical workforce, at a discipline-specific and foundation level.

3.3. Scoping Review

An initial search conducted in 2020 and 2022 generated 1679 publications, and after duplicates were removed, 1344 plus 239 publications were included for title screening, leading to 406 articles included for abstract screening by two reviewers. In total, 169 papers were deemed relevant for full-text review, leading to the inclusion of 28 papers that discussed strategies for developing the HSM workforce, which were then included in the data extraction and qualitative content analysis. The overall outcome of the review process is detailed in Figure 1 below, guided by the framework outlined by Arksey and O'Malley [32].

Twenty-four out of the 28 papers were published after 2010 including four published between 2020 and 2022. These papers presented results of the studies conducted in multiple countries located in Europe, Southern Asia, Northern America, and the Western Pacific with about 30% of them conducted in the USA and 20% of them in Australia. All of these papers presented some evidence on ways of developing health service manager's competence and management capacity. Twelve papers presented results of the evaluation of various leadership and management training to different professional groups, including clinicians, nursing staff, and different types of management positions. These evaluation studies presented positive outcomes in improving managers' management competencies, and the analysis confirmed that training programs targeting specific competency areas could develop managers' competency and management capacity, and institute positive change [35–46]. Leadership and management training has been proven a key ingredient in health system strengthening [40]. In addition to the importance of training and development, five other strategies in developing the management workforce's competency and capacity have also been discussed and confirmed in the studies, which are detailed in Table 1.

In addition to developing health management workforce competency and capacity, efforts in enabling health managers to lead and manage in the digital health context have also been discussed and confirmed in the literature, and presented as seven key factors that enable health management workforce development, as detailed in Table 2.

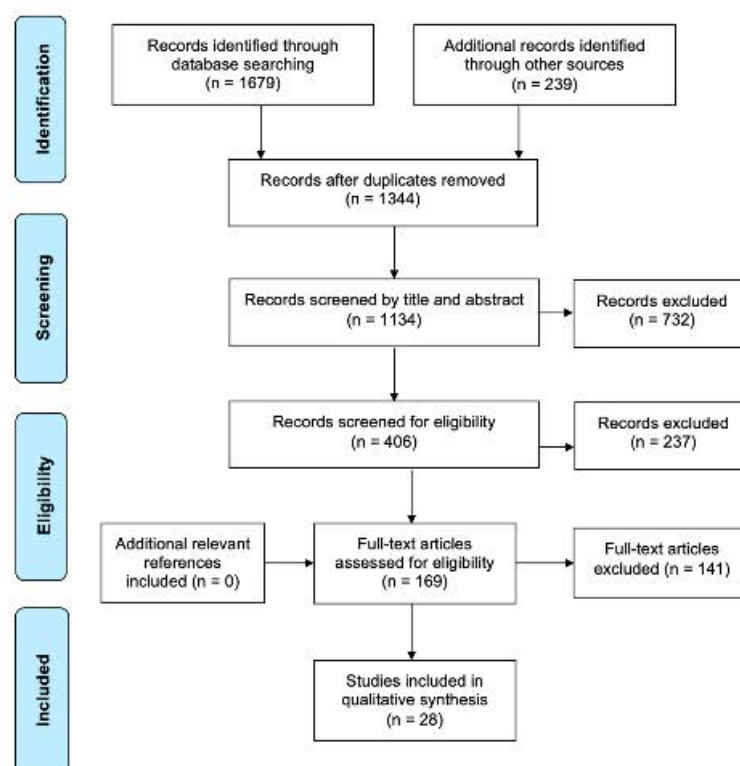


Figure 1. PRIMA flow diagram.

Table 1. Five key strategies for developing health management workforce competency and capacity.

Strategy	Details
Competency assessment [46–48]	Embedding competency assessment into management competency development processes.
Competency models [44,46]	Developing a competency model to guide in developing competent HSM.
Formal development [49–51]	Providing formal and comprehensive HSM development opportunities to managers with three considerations. *
Short-term training [36–40,52]	Providing short-term training programs targeting specific competency areas with seven considerations as management competency is context-sensitive. **
Work-based development [38,52–55]	Adopting a work-based learning and capacity-building approach in providing training and support within the organization.

* Analysis of the literature identified three key considerations for providing formal and comprehensive HSM development opportunities to managers: (1) Incorporating digital health competencies into the HSM teaching curriculum; (2) Integrating required digital health curriculum content with theory and practice to allow immediate translation; (3) Allowing knowledge to be articulated to the requirements at organizational, sectorial, and institutional levels. ** Short-term training programs targeting specific competency areas should have the following considerations: (1) Meeting the needs of different management levels within the organization; (2) Taking the size of the hospitals into consideration, as additional support may be required for small hospitals; (3) Leadership and management training and development needs to reflect local culture, hence work-based and action learning approaches should be adopted; (4) Recognizing management competency development is an iterative, dynamic, and complex process; (5) Keeping capacity-building approach in mind when developing training programs; (6) Recognizing complex leadership challenges can be a source of significant experiential learning for individuals and groups, hence, articulating and reflecting on experiential learning can elucidate the skill, knowledge, and judgments embedded in management practice; (7) A progressive and staged learning process contributes to skill consolidation.

Table 2. Seven key factors that enable health management workforce development.

Factors	Details
Acknowledgement and recognition [39,45]	• Acknowledging health service managers' new responsibilities and the efforts of HSM in acquiring new skills. • Provide formal recognition of the required competencies via certification or provision of credentialing.
Adopting innovation [45]	Organization's capacity in adopting innovation and support that assists HSM in adopting innovation.
Supportive environment [56]	A supportive environment in innovation and efforts in addressing system and individual level constraints, allowing managers to facilitate the adoption of health innovations and learn from the process.
System level support [40,57]	Provide high level support and political will in developing leadership and management across sectors and organizations.
Specialized expertise [58]	Support from experts with required digital health and health informatics expertise is provided with complementary information to explain difficult digital health concepts and understand digitized data for decision-making.
HSM workforce investment [51,59–61]	Investment in developing the health informatics and digital health workforce is critical. Managers cannot lead a workforce that are not yet ready.
Systematic integration [51]	Invest in systematic planning and development of professional practice in the health professions and integrate the professional development need in long-term ehealth and clinical informatics goals.

4. Discussion

A digitally enabled management workforce is crucial for health service organizational and care delivery success [13]. The three-step approach undertaken in this study has confirmed some recent efforts in meeting such workforce development needs. However, a systematic and universal guiding framework for overall management workforce development clearly specifying how efforts in system, institution, organization and individual levels interact, has yet to be identified. The findings of the three-step approach confirmed the pressing need to incorporate digital health-related competencies in the existing training curriculum for health services managers, further, it has highlighted the important role of short-term targeted training in developing a health management workforce that is digital health ready. The policy settings for the digital health management workforce also need to provide an increased focus on leading and managing digital transformation, and the competencies that can inform organizational capability, professional credentialing, post-graduate curricula, and industry certifications [26]. Factors that enable the development of the requisite health management workforce capabilities and system-wide capacity may include appropriate policy, supportive organizational systems and structure, aligned education and training offerings, and the capacity of the organization to support digital health adoption [40,45,56,57].

There has been an increasing movement to develop management competency frameworks, against which health service managers can apply for credentialing and certification. These frameworks are evolving, recognizing the fast-moving environment in which health-care is delivered. It was also evidenced that there has been a paucity of digital health competencies embedded within these HSM competency frameworks. This study also highlighted the requirement to both develop a competency model to guide the required digital health competencies for health service managers [47,53], as well as embed competency assessment into management competency development processes [46–48]. The need to include management and leadership competencies that focus on enabling system-wide transformation in the current digital context, was also evidenced [26].

This paper used a three-step approach, supported by empirical research, in guiding the creation of a conceptual framework (see Figure 2) for developing the health service management workforce capacity, in context. A contemporary approach to using new knowledge is

presented, in developing this conceptual framework. Information represented, as a result of the scoping review, provides an evidence-based process to confirm the relevance and importance of existing knowledge, to guide the policy and practice implications, frameworks, directions, and workforce recommendations.

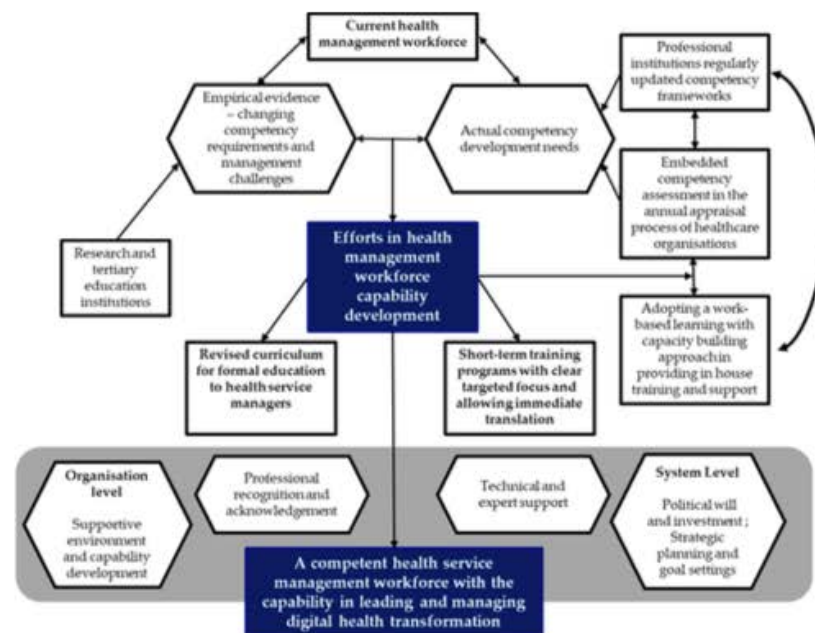


Figure 2. Framework for developing the HSM workforce in the digital health context.

4.1. Efforts in Developing a Digitized HSM Workforce

Efforts in developing a digitized HSM workforce are evident at multiple levels. Digital health and workforce policies have been developed [18]; professional institutions have been fast to recognize the additional skill development requirements by adding new competencies into the existing training frameworks. New postgraduate degrees focused on the systematic development of digital health professionals have also been developed and offered by a small number of Australian universities. However, whether the policies and revised frameworks have been translated into guiding the development of the HSM workforce that is digital health ready, remains unclear [26].

Although formal education is important in its ability to systematically develop one's overall professional competence, the immediate upskilling of the HSM workforce relies on short-term professional development programs that allow immediate translation into practice [36–40,52]. This is particularly true when evidence indicates that specific competencies relevant to leading and managing digital health transformation are required to be developed among health service managers [62]. Short-term training targeting identified gaps in competencies is more appealing and relevant to health service managers for several reasons: workload, time availability, and level of required commitment.

Literature has confirmed that management and management competency is context-sensitive and influenced by the different nature of management positions and management levels [47,48]. A number of papers discussing the evaluation results of training programs reinforced the importance of taking organizational culture into consideration when designing training programs [45,55], hence, a work-based and action-learning approach was suggested [38,52]. This is certainly much easier to be adopted through short-term train-

ing programs rather than formal education, which was subject to strict university rules and regulations.

The higher the management levels, the higher the proportion of managers who would have acquired postgraduate qualifications [47,48], hence, short-term programs, without fulfilling other degree requirements, may be more attractive to senior management levels. On the other hand, entry- and middle-level managers may take on postgraduate study to increase competitiveness in advancing their management careers, hence, ensuring that the existing postgraduate curriculum addressing the competency development needs of their targeted student cohorts, must become one of the annual quality assurance processes for all postgraduate programs. In the case of digital health readiness, incorporating competencies that are necessary for managers to lead and manage in the digital health era, within the existing educational framework, is a very important step to take [35]. Professional institutions, such as ACHSM in Australia, have the responsibility to support and ensure the accredited formal education programs for health service managers, and are responsive to the development needs of the changing workforce [63].

4.2. The Importance of Strategic Planning, Support, and Removing Obstacles

It is important to develop health service managers' digital health competencies, but this is only part of the answer to developing a workforce capable of leading and managing digital health transformation. Leading and managing digital health transformation is an emerging and essential requirement for health service managers, in addition to their existing core responsibilities. No training can immediately fully develop their competencies in strategically utilizing the ever-changing digital health tools and technologies, applying data governance [64], developing the right systems for data management [65], and having an organization-wide awareness of required digital tools and technologies [66]. Furthermore, a sound understanding of how digital health systems promote quality care [67], as well as personal health information privacy and security principles, are key attributes required of successful health service managers [5,65]. Technical expertise and organizational support are also necessary.

It is equally important to develop the health workforce's overall understanding of digital health and how it can be used in context. This can be achieved through integrating digital health capabilities in all workforce activities, including systematic planning and embedding of professional development needs in long-term individual and organizational digital health goals [51]. The focus on developing foundational levels of digital literacy across the health workforce, and the depth of the requisite knowledge, needs to be based on the different digital health roles and people within the system [19].

System-level guidance in what competencies should be covered by formal education and professional institutions is also required. Digital health skill development amongst health service managers should be a coordinated effort, rather than relying on individual programs or organizations to fill the gaps, based on the expertise that they have.

4.3. A Holistic Approach toward HSM Workforce Development to Enable Digital Health Transformation

As discussed above, short-term training targeting the improvement of specific competencies, is one key strategy for the development of a competent and capable health management workforce. However, current training for managers is mostly designed and offered on an ad hoc basis and is based on a 'what I believe is important' mentality, by those who offer the training. A systematic approach to integrating the specific competencies required for leading and managing the workforce through digital transformation needs to be included in formal education, continuing professional development, and professional association recognition and certifications. This should include developing the system, organizational, and team management skills, as well as aligning the digital tools and technologies to support the necessary business and clinical, evidence-informed decision-making [61].

Competency assessment can identify an individual's competency gaps and training needs via various processes such as self-assessment and 360-degree assessment [48,53]. Empirical evidence has also suggested that self-assessment is a very beneficial self-educational process leading to actual knowledge and skills improvement, and also an important motivating factor for self-learning [68,69]. Considering all key strategies and factors as discussed above, this paper proposes the following framework (Figure 2) to guide overall health management workforce development in the digital health era.

The framework suggests a national collaboration to articulate a more coordinated, consistent, and coherent set of policy guidelines that foster digital health and workforce development. Any national, digital health policy guidance and directions should be underpinned by relevant and contextualized global policies, for example, the World Health Organization guideline on digital interventions for health system strengthening [70].

Ongoing and collective efforts are required in developing a national, core set of digital health competencies for the healthcare management workforce that guide a more consistent curriculum and set of course offerings, which could then be accredited via a nationally endorsed, digital health capability framework, to better guide postgraduate workforce development and relevant professional development offerings. Recognizing that in Australia, as in many countries around the world, significant work has been undertaken, and is ongoing, to produce and ratify national digital health capability frameworks. These could also include reference to relevant and contextualized global frameworks, for example, the World Health Organization's guidance on digital education for building health workforce capacity [71].

In the rapidly changing healthcare environment, the professional development needs of the HSM workforce cannot be met without specific efforts in understanding the changing requirements. The scoping review only identified six papers most relevant to HSM development in the digital health context [50,51,57,59–61]; more research is needed to generate up-to-date evidence to guide developing a competent HSM workforce, and to address the challenges facing health service managers with the capacity to lead and manage in the digital health era.

5. Conclusions

Sustainable, quality, and safe healthcare services require a management workforce equipped with contemporary leadership and management capabilities. With the ever-changing landscape of digital health, health service managers are required to lead and manage in times of system transformation. Digital competencies are required for the HSM profession as well as the general healthcare workforce, which needs collaborative efforts across healthcare organizations, government, educational, and professional institutions.

This paper not only confirmed the urgent need to incorporate digital health-related competencies in the existing training curriculum for health service managers, but also highlighted the important role of short-term, targeted training in developing a health management workforce that is digital health ready, and the efforts that are required to enable managers to lead and manage in the digital health space. The proposed framework, for overall health management workforce development in the digital health era, suggests that national collaboration is necessary to articulate a more coordinated, consistent, and coherent set of policy guidelines that foster digital health and workforce development.

Management workforce capacity-building needs to adopt a holistic approach to developing the requisite HSM capabilities and system-wide capacity, which may include appropriate policy, supportive organizational systems and structure, and aligned education and training offerings. HSM workforce development is not a one-off effort. It requires system-level investment, support, and recognition, and collective efforts in removing the barriers and hurdles to the ongoing development of required digital health competencies and capabilities.

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Appendix A Twelve Analyzed Digital Health Policies

- (1) Australasian College of Health Service Management (2022). Master health service management competency framework, 2.0.
- (2) Australian College of Rural and Remote Medicine (2021). ACRRM Fellowship Training Program.
- (3) Australian Digital Health Agency (2020). National digital health workforce and education roadmap.
- (4) Australian Digital Health Agency (2020). Nursing and Midwifery Digital Health Capability Framework.
- (5) Australian Digital Health Agency (2021). Workforce Strategy 2021–2026.
- (6) Australasian Institute of Digital Health (2022). Australian Health Informatics Competency Framework.
- (7) Australasian Institute of Digital Health (2022). Australian Digital Health Executive Competencies: Second Edition.
- (8) Australian Medical Council (2021). Digital Health in Medicine Capability Framework.
- (9) Royal Australian College of General Practitioners (2021). RACGP educational framework.
- (10) Royal Australasian College of Medical Administrators (2011). Medical Leadership and Management Curriculum Framework.
- (11) Royal Australasian College of Physicians (2013). Physician and Paediatrician Training Program Professional Qualities Curriculum.
- (12) Victoria Health (2021). Digital Health Capability Framework for Allied Health Professionals.

Appendix B Postgraduate Healthcare Management Programs Analyzed

The 17 contemporary postgraduate health management programs offered domestically in Australia were analyzed, including publicly available information from:

- (1) Charles Sturt University—Master of Health Management and Leadership: <https://study.csu.edu.au/courses/medical-science/master-health-services-management> (accessed on 2 September 2022).
- (2) Curtin University—Master of Health Administration: <https://handbook.curtin.edu.au/courses/course-pg-master-of-health-administration--mc-hladmnhv1> (accessed on 2 September 2022).
- (3) Deakin University—Master of Business Administration (Healthcare Management): <https://www.deakin.edu.au/course/master-business-administration-healthcare-management> (accessed on 2 September 2022).
- (4) Deakin University—Master of Health and Human Services Management: <https://www.deakin.edu.au/course/master-health-and-human-services-management> (accessed on 2 September 2022).

- (5) Flinders University—Master of Health Administration: <https://www.flinders.edu.au/study/courses/postgraduate-health-administration> (accessed on 2 September 2022).
- (6) Flinders University—Master of Business Administration (Healthcare Management): <https://www.flinders.edu.au/study/courses/postgraduate-business-administration-health-management> (accessed on 2 September 2022).
- (7) Griffith University—Master of Health Services Management: <https://www.griffith.edu.au/study/degrees/master-of-health-services-management-5586> (accessed on 2 September 2022).
- (8) Latrobe University—Master of Health Administration: <https://www.latrobe.edu.au/courses/master-of-health-administration> (accessed on 2 September 2022).
- (9) Monash University—Master of Health Administration: <https://online.monash.edu/online-courses/health-courses/online-master-health-administration> (accessed on 2 September 2022).
- (10) Murdoch University—Master of Health Care Management: <https://www.murdoch.edu.au/course/Postgraduate/M1217> (accessed on 2 September 2022).
- (11) Queensland University of Technology—Master of Health Management: <https://online.qut.edu.au/online-courses/health/master-of-health-management/> (accessed on 2 September 2022).
- (12) University of Adelaide—Master of Business Administration Health Management: <https://online.adelaide.edu.au/campaign-lp-master-of-business-administration-health-management> (accessed on 2 September 2022).
- (13) University of New England—Master of Health Management: <https://handbook.une.edu.au/courses/2022> (accessed on 2 September 2022).
- (14) University of New South Wales—Master of Health Leadership and Management: <https://www.unsw.edu.au/study/postgraduate/master-of-health-leadership-and-management> (accessed on 2 September 2022).
- (15) University of Tasmania—Master of Health Service Management: <https://www.utas.edu.au/courses/bus/courses/c7o-master-of-health-service-management> (accessed on 2 September 2022).
- (16) University of Technology Sydney—Master of Health Services Management: <https://studyonline.uts.edu.au/online-courses/master-health-services-management> (accessed on 2 September 2022).
- (17) Western Sydney University—Master of Health Science (Health Service Management): <https://www.westernsydney.edu.au/future/study/courses/postgraduate/master-of-health-science-health-services-management> (accessed on 2 September 2022).

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4.3 Framework for developing the health service management workforce in the digital health context

The findings of the three-step approach to understanding the current obstacles to developing a health management workforce that can enable and maximise the benefits of digital health transformation highlighted and linked the evidence about the obstacles health service managers face in realising digital transformation benefits (Brommeyer and Liang, 2022). It also explored ways of surmounting such obstacles in support of health service management and digital workforce transformation. The strategies needed to develop a digitally-enabled health management workforce with the required capabilities and system-wide capacity drivers were confirmed. A proposed framework was provided to assist with overall health service management workforce development in the digital health context. Further, the findings indicated that national collaboration is needed to articulate a more coordinated, consistent, and coherent set of policy guidelines, as well as describing the system, policy, educational, and professional organisational enablers evidenced. This provided deeper knowledge of how the conceptual application of digital health competency requires demonstration of skills and knowledge in the practice setting, acknowledging that systemic enablers and barriers influence health service managers demonstration of competence.

The proposed framework for developing the health service management workforce in the digital health context (Brommeyer and Liang, 2022), detailed the seven key factors that enable health management workforce development, as well as the five key strategies for developing health management workforce competency and capacity. The framework has been confirmed and builds on empirical evidence (Brommeyer et al., 2024a, Brommeyer and Liang, 2024) and industry engagement to develop a new and enhanced understanding regarding the key factors and strategies that enable development of health management workforce competency and capacity in the digital context, which are presented in Table 1.

Table 1: Framework for developing the health service management workforce in the digital health context

Existing framework	Revised framework 2025
Seven key factors	Seven key enablers
1. Acknowledgement and recognition 1. Acknowledging health service managers' new responsibilities and the efforts of HSM in acquiring new skills.	1. Existing health service management and digital health competency education and training must continue to evolve, in maintaining currency of credentialing and professional development

2. Provide formal recognition of the required competencies via certification or provision of credentialing.	requirements for health service managers in this dynamic, digital health environment.
2. Adopting innovation Organization's capacity in adopting innovation and support that assists HSM in adopting innovation.	2. Health service management competencies necessary to lead and manage in the digital health context should reflect system, organisational and operational priorities.
3. Supportive environment A supportive environment in innovation and efforts in addressing system and individual level constraints, allowing managers to facilitate the adoption of health innovations and learn from the process.	3. Capacity building for health service management in the digital health context requires government, professional and tertiary institutions, and healthcare organisation's investment in infrastructure and the development of supportive environments for innovation.
4. System level support Provide high level support and political will in developing leadership and management across sectors and organizations.	4. Enabling factors and barriers to health service managers demonstrating competency in practice must be addressed at a policy, provider, professional and practitioner level.
5. Specialized expertise Support from experts with required digital health and health informatics expertise is provided with complementary information to explain difficult digital health concepts and understand digitized data for decision-making.	5. Education and training should reposition from traditional pedagogy by emphasising and reinforcing digital andragogy, stimulating critical thinking and enabling contextual application of the developed competencies in the management role.
6. HSM workforce investment Investment in developing the health informatics and digital health workforce is critical. Managers cannot lead a workforce that are not yet ready.	6. Formal and informal education and training for health service managers should focus on competency transferability, aligning corporate, clinical and digital governance.
7. Systematic integration Invest in systematic planning and development of professional practice in	7. Digital health workforce transformation requires multi-level, integrated, strategic, operational and tactical

the health professions and integrate the professional development need in long-term ehealth and clinical informatics goals.	support to assist in optimising the outcomes from adoption of digital health, as a contemporary tool for health care delivery.
<i>Five key strategies</i>	<i>Five-step andragogical approach</i>
1. Competency assessment Embedding competency assessment into management competency development processes.	1. Self-concept of the adult learner Enhancing the role of self-concept in enabling mastery in use of digital tools to lead and manage healthcare, including a focus on digitally-enabled, data-informed, evidence-based decision-making.
2. Competency models Developing a competency model to guide in developing competent HSM.	2. The role of experience Valuing the role of experience to contiguously link with the digital competencies required (ACHSM, AHICF) for increasing capability in a context and informing capacity and resourcing requirements in a disruptive and dynamic environment.
3. Formal development Providing formal and comprehensive HSM development opportunities to managers with three considerations: (1) incorporating digital health competencies into the HSM teaching curriculum; (2) integrating required digital health curriculum content with theory and practice to allow immediate translation; and (3) allowing knowledge to be articulated to the requirements at organizational, sectorial, and institutional levels.	3. The adult's readiness to learn The readiness to learn for postgraduate students working full-time in advancing digital capabilities essential for career development and progression.
4. Short-term training Providing short-term training programs targeting specific competency areas	4. The adult's orientation to learning Digital competencies that are essential for health service managers in a

with seven considerations as management competency is context-sensitive: (1) meeting the needs of different management levels within the organization; (2) taking the size of the hospitals into consideration, as additional support may be required for small hospitals; (3) leadership and management training and development needs to reflect local culture, hence work-based and action learning approaches should be adopted; (4) recognizing management competency development is an iterative, dynamic, and complex process; (5) Keeping capacity-building approach in mind when developing training programs; (6) recognizing complex leadership challenges can be a source of significant experiential learning for individuals and groups, hence, articulating and reflecting on experiential learning can elucidate the skill, knowledge, and judgments embedded in management practice; (7) a progressive and staged learning process contributes to skill consolidation.	transforming environment, including application of risk, resourcing, ethics, change and governance.
5. Work-based development • Adopting a work-based learning and capacity-building approach in providing training and support within the organization.	5. Adults' motivation to learn • Health service managers intrinsic motivation is to demonstrate capability in safely using and managing digital health systems for the benefit of patients, practitioners, providers and the public.

4.3.1 *Implications for healthcare systems*

Developing the health service management workforce to lead and manage in the ever-evolving digital health landscape requires a transformative approach to develop the necessary capabilities, supported by system-wide capacity drivers including national collaboration to communicate a more coordinated, coherent and consistent set of policy recommendations. In addition, the system, regulatory, educational, and professional institution enablers should drive a digital first approach across all the healthcare sectors, in a coordinated and contemporary fashion. Attention should be focussed on developing health service managers' competency in leading and managing digital transformation, guided by an evidence-informed framework within a supportive working environment that continues to adapt to the changing circumstances to deliver the digital health potential in assisting to achieve the health system gains of efficacy, value, safety and effectiveness.

Developing workforce capability can be realised in the ways health service managers are empowered to develop competencies for digitally-enabled healthcare through andragogical approaches to teaching and learning digital health management. This includes formal and informal education and training opportunities that focus on competency transferability, which requires educators and academics to have an in-depth understanding of the changing challenges facing health service managers in the digital healthcare context. The required education and training can be repositioned by emphasising and reinforcing a guiding role that facilitates learning, stimulates critical thinking, and enables demonstration of the developed competencies in healthcare management practice (Brommeyer and Liang, 2024).

4.4 Chapter Summary

Chapter 4 confirmed the strategies needed to develop a digitally-enabled health management workforce with the required capabilities and system-wide capacity drivers. A proposed framework is provided to assist with overall health management workforce development in the digital health context. Further, findings indicate that national collaboration is necessary to articulate a more coordinated, consistent, and coherent set of policy guidelines, as well as the system, policy, educational, and professional organisational enablers. This can facilitate a digital-first and focused approach across the healthcare sectors in a coordinated and contextual manner (Brommeyer and Liang, 2022).

Chapter Five – Findings 1

5.1 Chapter Introduction

The purpose of this chapter is to present findings addressing organisational factors driving the realisation of digital health transformation benefits from health service managers. This chapter addresses Research Question 3: What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace?

Figure 5 situates this chapter in the map of the broader thesis structure:

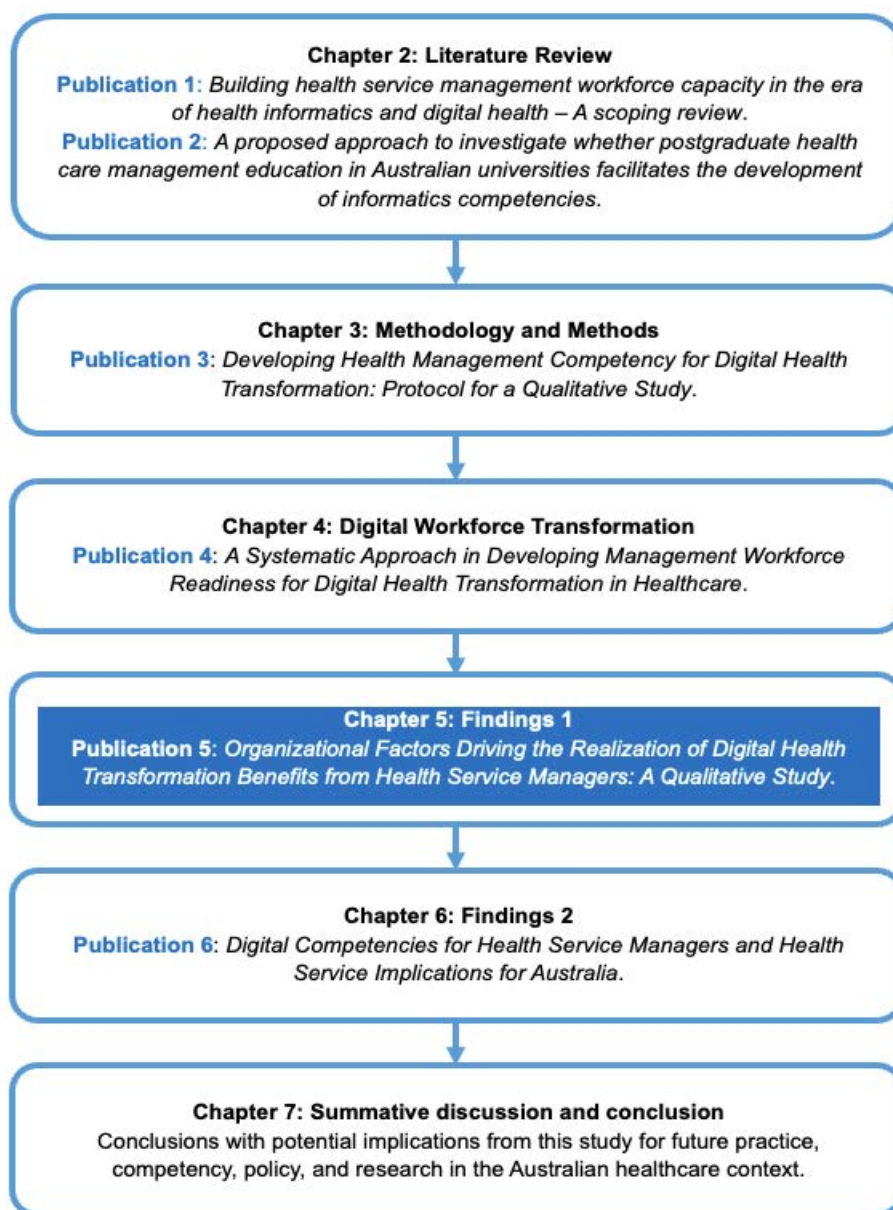


Figure 5: Thesis structure map Chapter 5

Findings from the focus group discussions highlighted organisational factors driving the realisation of digital health transformation benefits from health service managers. Health service managers need organisational and system-wide efforts to support managing in the digital health context. The key identified barriers experienced by health service managers include facing human and technical challenges with system adoption and the governance of data-driven decision-making in the digital context. In addition, enabling factors that support health service managers to effectively work with and manage in the digital environment are identified in key categories, namely (1) policy and system, (2) organisational structure and processes, and (3) people factors (Brommeyer et al., 2023b).

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- This is to confirm that the PhD candidate contributed 70% of the development of the manuscript.

5.2 Publication 5: (Brommeyer et al., 2024b)

Organizational Factors Driving the Realization of Digital Health Transformation Benefits from Health Service Managers: A Qualitative Study

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Introduction: Healthcare is experiencing a global period of profound transformation, and digital health shows the promise of dispensing innovative and contemporary service models. However, changes are required to improve the capabilities of health managers in driving successful digital transformation.

Objective: This paper aims to explore the organizational barriers that health service managers have encountered when realizing the benefits of a digitally transforming environment. This is part of a larger research study exploring digital competencies for health service managers, with the findings from focus group discussions providing a baseline from which to address the organizational improvements and changes in system capabilities required to assist in realizing the benefits of digital health transformation.

Methods: The study is qualitative in nature. It employs focus group discussions to gain an in-depth understanding of the experiences and views of health service managers and identify the benefits and barriers that managers have experienced in introducing digital health in their workplace.

Results: Barriers encountered in realizing digital health benefits in the workplace were evidenced across five major themes: (1) change resistance and usage, (2) trust and uniformity, (3) resourcing and procurement, (4) digital literacy, and (5) siloed systems.

Discussion: Findings from this study demonstrate that in driving the realization of digital health transformation benefits, health service managers need organizational and system-wide efforts to support managing in the digital health context. The key identified barriers experienced by health service managers include facing human and technical challenges with system adoption and the governance of data-driven decision-making in the digital context.

Conclusion: The importance of digital transformation in healthcare is evident and will increasingly become a necessity for organizational survival and success. This study adds important insights into the organizational barriers that health service managers have encountered when realizing the benefits resulting from digital transformation. Addressing these barriers requires macro-, meso- and micro-level system investments. These benefits are enhanced by enabling factors critical for digital health adoption that have been described in key categories involving health system related: (1) policy and system, (2) organizational structure and processes, and human resource management, and (3) people factors. The importance of ensuring the organizational factors driving the realization of benefits in a digitally transforming environment is also addressed and capitalized upon for health service managers.

Keywords: healthcare management, health service manager, digital transformation, digital health benefits, workforce development, digital health barriers

Introduction

Benefits That Digital Health Has Brought to Healthcare Organizations

Systemically, healthcare is experiencing a global period of profound change, fuelled by pandemics, an aging population, the escalating burden of chronic disease and accelerating workforce changes, which have all placed increasing demands on healthcare services.¹ Adopting innovative ways for service delivery is inevitable. Digital health is showing that it can,

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in many local and global settings, deliver on the promise of dispensing innovative and contemporary service models that can advance the value, efficiency, and safety of healthcare services.^{2,3}

Digital health can be seen as the “field of knowledge and practice associated with the development and use of digital technologies to improve health”,⁴ with digital transformation denoting large, complex institutional interventions or system-wide implementations involving major changes to how healthcare systems and organizations operate.⁵ Recent examples from the global pandemic highlight the utility and value of digital tools in providing and supporting healthcare, particularly in response to COVID-19, by enhancing information capture and communication, improving disease monitoring and surveillance, increasing access to care through the delivery of virtual health services, and the targeting, administering and recording of vaccinations.^{2,6,7}

In addition, digital health is crucial in cultivating accessible, appropriate and affordable healthcare delivery that is targeted, timely and tenable.⁸ Concomitantly, digital health’s benefits continue to be realized globally. With a recognition by the World Health Organization (WHO) that “digital health can radically change health outcomes if it is supported by sufficient investment in governance, institutional and workforce capacity”.⁴ Essential investment in these structural enablers supports the attainment of digital healthcare benefits according to the patient, practitioner and provider.

Difficulties Managers Have Encountered in Realizing the Benefits of Digital Health

Realizing the benefits of digital health requires macro-, meso- and micro-level system investments to ensure that benefits can be translated into value within healthcare contexts.^{9–11} These benefits are enhanced by enabling factors crucial to digital health adoption, which have been identified in key categories, including (1) policy and system, (2) organizational structure and processes, and (3) people factors.⁸ The focus of the factors tends towards policy alignment with organizational objectives, digital investment, infrastructure, data privacy, transparent governance and supporting regulations. The elements of workflow alignment, access to technology support, trust building and empowering users to embrace change and innovation are essential to consider. In addition, the digital attitude of leaders, supported by an organizational culture of embracing technology-driven innovation, has also been noted.^{6,8,10,12} The phenomenon of digital literacy has been presented variously in the literature, with the current discourse centring around the ability to efficiently search for and effectively critique information, acknowledging the intrinsic risk of bias in information sources.^{13–16} Indeed, some authors are now describing digital literacy as a new determinant of health,^{17–19} which, along with digital accessibility, availability and affordability, are factors that “impact sociodemographic disparities, health inequities, and challenges with care accessibility, affordability, and quality outcomes” contributing to citizens’ digital determinants of health.¹⁸ In the management literature, there is a lack of clarity regarding the digital literacy capabilities of health service managers, which needs to be addressed.

Obstacles to realizing the benefits being accorded from digital health are influenced by the barriers to adopting digital health technologies, including infrastructure and technical concerns, psychological issues, and workload-related trepidations.^{4,20} Appropriate training, understanding healthcare practitioners’ willingness to use and their perception of the usefulness of digital technologies, along with targeted incentives for different stakeholders, are all notable enablers to enhance the adoption of digital health services.²⁰ Furthermore, barriers to achieving digital health benefits are prevalent across healthcare delivery transformation environments and underscore the need for healthcare services to be designed, developed, and delivered in an ethical, efficient, effective and evidence-based manner.^{4,21–24}

Looking at the challenges faced when leading and managing digital health transformation, the evidence is consistent across a number of categories, including (1) information technology and integration, (2) user acceptance of digital health, (3) security of digital health, (4) structural capabilities to attain competitive advantage, (5) resourcing for innovation and value, (6) distributed leadership and decision-making, and (7) supporting the development of a learning culture.^{25–28} In addition, specific challenges and responsibilities of health service managers in the context of digital transformation are differentially described in the literature, including Dal Mas et al’s (2023) contention that “the healthcare sector is undergoing a renaissance due to the pandemic”,²⁸ which has “significant management implications as managers seek to increase technology resources’ efficiency to achieve patient-centred care”.²⁵ Further, managers need to grapple with the “transformational abilities of digital technologies (that) go further than merely automating processes and satisfying

information needs to enable fundamental changes in a company's business model",²⁹ which have profound impacts on the way that healthcare in the digital age is managed and maintained.

The challenges are also evident in the digital organizational literature, which describes the challenges in digital service innovation more broadly, noting that

the threat of digital disruption negatively impacts an organization's innovation activities...(and)...that strategic partnerships can be leveraged by organizations that face an imminent threat of digital disruption.²⁹

Furthermore, executive-level sponsorship and governance of the digital transformation is an essential element for successful digital service innovation.²⁹

The changes required to improve capabilities in managing digital health transformation are detailed in the literature and focus on capability and capacity development.^{25–28} However, the specific capabilities required for health service managers to drive digital transformation benefits are not clearly evidenced. Enabling factors and barriers to digital health transformation have been described in the literature, with some consensus. However, factors that enable and inhibit health service managers demonstrating their digital health competence remain elusive.

It is important to recognize that realizing benefits from digital health transformation relies on requisite health service managers' digital competencies that necessitate system, professional, organizational, leadership, and individual capabilities to deliver the benefits achieved in a digital society.^{30,31} There are a number of existing professional body and industry certification competency frameworks for both health service management and digital health, though an empirically validated set of digital competencies for health service managers has yet to be evidenced. In the Australian setting, the Australian Health Informatics Competency Framework (AHICF)³² and the Master Health Service Management Competency Framework³³ guide digital health and health service management certification programs, respectively. Both frameworks were revised in 2022, to which the primary author contributed. Of note is the comprehensive review process for the Australian Health Informatics Competency Framework that included

an international environmental scan to examine changes in the extant competency frameworks to which the AHICF was mapped. This included international frameworks from Canada, Saudi Arabia, the United States of America, and the United Kingdom.³⁴

Health service managers require system-wide support to address the organizational, professional, technical, and operational barriers in order to realize the benefits of implementing digital health.^{18,22,35} These required changes in a health system affect several of the World Health Organization's (2010)³⁶ defined building blocks of a health system, and the need for a holistic approach is required to ensure optimal benefit from the digital transformation. There are six inter-related building blocks: (1) leadership and governance, (2) financing, (3) access to essential medicines and health-related commodities, (4) health information systems, (5) health workforce, and (6) service delivery. Emphasizing that "leadership/governance and health information systems, provide the basis for the overall policy and regulation of all the other health system blocks".³⁶

With healthcare services being delivered in such a dynamic and often unpredictable environment, system enablers require a supportive and sustainable setting that fosters digital-first capabilities for health service managers.³⁷ However, there is a lack of evidence specific to health service managers, with the contemporary literature focussing on enabling and inhibiting factors for patients, as well as the clinical, administrative, and technical healthcare workforce.^{25,27,28,38} As detailed in the previously published conceptual framework for a larger study,³⁹ identification of the barriers and enablers health service managers face in developing capability to manage in the digital health environment should be identified and validated in the specific healthcare context, by in-depth analysis of findings from focus group discussions with health service managers.

The findings are part of a larger PhD research study, the aim of which is to identify the competencies that will contribute to the development of capability for health service managers in managing in the digital health era and enabling digital transformation within the Australian healthcare environment.⁴⁰ This paper presents some of the data and findings from the six focus group discussions that were conducted in February and March 2023, in addressing the following two research questions, namely: (1) What are the benefits that health service managers have experienced from implementing

digital health in their workplace? and; (2) What difficulties have health service managers experienced in realizing the benefits of introducing digital health in their healthcare organization?

This research, while conducted in the Australian public hospital setting, is situated within the global context of digital health transformation, which has far-reaching impacts for healthcare management including

streamlining administrative processes, improving communication, and enhancing overall patient care ... (while ensuring) ... ethical considerations, patient privacy, and regulation compliance.⁴¹

These considerations need to be at the forefront of health managers' decision-making. Recent literature also emphasizes the imperative for healthcare managers to improve their "resilience, flexibility, and innovation" for managing digital transformation in the post-pandemic era, including system-wide policy and funding imperatives for improving required digital health infrastructure and furthering global cooperation.⁴² This study contributes to the empirical evidence by illuminating the key strategies that can support and enable health service managers in driving the realization of digital health transformation benefits.

The aim of this paper is to explore the organizational barriers that health service managers have encountered when realizing the benefits in a digitally transforming environment. This provides a baseline from which to acknowledge and address the organizational improvements and changes in system capabilities required to assist in realizing the benefits of digital health transformation.

Materials and Methods

Guided by a published protocol in developing digital competencies of health service managers,⁴⁰ the study has adopted a qualitative approach, employing focus group discussions to gain an in-depth understanding of the experiences and views of health service managers and identifying the benefits and barriers that managers have experienced in introducing digital health in their workplace. Six focus groups were conducted virtually using MS Teams (Microsoft) by two researchers, for approximately 90 minutes each, and digitally captured via the recording functionality of the Microsoft Teams videoconference call. The principal investigator acted as facilitator, and one other member of the research team performed the roles of observer and notetaker.

The focus group discussions employed the consolidated criteria for reporting qualitative research (COREQ) to ensure the study met the recommended data reporting standards for qualitative studies;⁴³ see [Appendix 1](#). To check participants' intended meaning, a number of strategies were employed "where participants are asked to input on whether an analysis faithfully or fairly represents their experience".⁴⁴ All participants were emailed their "cleaned-up" transcripts and invited to amend or delete any of their comments, should they wish to do so, particularly for validation of accuracy or to clarify a statement, as well as receiving a copy of the final results.

Target Population

Study participants were drawn from a sample of mid-level health service managers across Australia who are responsible for the day-to-day operations in Australian public hospitals. The participants represented management levels 3 and 4 in the Australian public hospitals. The management levels are defined by the organizational reporting hierarchy, as detailed in the Liang et al (2018) management competency study in the Australian health system,⁴⁵ with level 1 being the Chief Executive Officer (CEO), level 2 reporting to the CEO, level 3 reporting to level 2 management, and level 4 reporting to level 3 management.

Sampling

A purposive sampling technique was used to facilitate a deliberate selection of participants for the focus groups due to the characteristics of the participants being linked to the study variables. Potential participants were invited and recruited from members of the Australasian College of Health Service Management (ACHSM) and the Australasian Institute of Digital Health (AIDH) membership, as pre-eminent, member-based organizations representing health service management and digital health, respectively, across Australasia, to enlist participants who are experienced and informed with the phenomenon of interest.⁴⁶ In addition, snowball sampling was applied to assist in locating

Table 1 Focus Group Participant Characteristics

1. Location ^a	2. Position Functional Areas	3. Organization
SA – 11	Clinical – 16	Metropolitan Hospital – 11
VIC – 8	Corporate ^b – 11	Regional Hospital – 3
NSW – 9	Technical ^c – 9	Rural Hospital – 1
QLD – 11	Research – 2	Community Hospital – 1
WA – 2	Quality/Risk – 1	Regional Support ^d – 28
TAS – 1	Program – 5	
ACT – 2		
NT – 0	n = 44	

Notes: ^aLocation = South Australia (SA), Victoria (VIC), New South Wales (NSW), Queensland (QLD), Western Australia (WA), Tasmania (TAS), Australian Capital Territory (ACT), Northern Territory (NT). ^bCorporate = Administration, Finance, Operations, Planning, Performance and Support. ^cTechnical = Infrastructure, Electronic Records – implementation and architecture, Data Management. ^dRegional Support = Role includes working across more than one public hospital.

supplementary key informants who were information-rich and had a certain attribute of research relevance with the target population.⁴⁷ The number of participants is consistent with the qualitative methodology being used to ensure data saturation, which was reached.^{48–50} As Carlsen and Glenton's (2011) methodological study of sample-size reporting in focus group studies recommends, "Guidance on group size is common and seldom goes beyond a minimum of 4 and a maximum of 12 participants per group".⁵¹ There is a disparate discourse in the literature regarding the number of focus groups required to reach data saturation, with Hennink et al's (2019) focus group sample size research positing that "The vast majority of codes (60%) were identified in the first focus group discussion, with a sharp decline in new codes after this".^{50,51} Further, having participants represented from both metropolitan and regional sites can improve the generalizability of results.⁵² The authors also note that reaching a point where new findings do not add additional insights – the point of "diminishing returns" – is more significant than aiming for a particular target. To allow the inductive process to guide this research, a sample size of six focus groups was agreed, aiming for six to eight managers to be included in each group. The diversity in participant characteristics is detailed in Table 1 Focus group participant characteristics.

Recruitment

Invitations for participation were announced by ACHSM and AIDH in their respective e-newsletters and websites for health service managers who are management levels 3 and 4, employed by a public hospital in Australia that are managing and leading in a digitally transforming environment, as described in the target population. The following exclusion criteria were applicable: (1) health service managers who were not employed at an Australian public hospital and (2) other healthcare management personnel who were outside of management levels 3 and 4. The principal investigator's contact details were included in the announcement. The announcement encouraged and invited potential participants to contact the principal investigator directly to express their interest in participating.

Upon receipt of the expression of interest, the principal investigator assessed eligibility. Expressions of interest were received from 73 people, three of whom were ineligible to participate. Eligible participants were contacted directly via Email to provide a formal invitation to participate in the focus group discussion, which contained a copy of the Project Information Sheet and Consent Form. Each participant responded to the Email invitation with confirmation of participation and consent to participate in the research project. The principal investigator then emailed those who expressed their interest in participating and who were not eligible to provide them with an explanation for not being selected. Prior to commencing the discussions of the pre-determinate questions at each focus group, participants were invited to ask

questions and/or seek clarification of the project or project details included in the Participation Information Sheet. Participants were also advised again of the option of withdrawing their consent at any stage.

Ethical Considerations

This research received ethics approval on October 20, 2022, by the James Cook University Human Research Ethics Committee (approval H8877; expiry December 27, 2024). Prior to the focus groups, personal information, including participant name, position title, name of organization, and Email address, was collected; however, names of the participants were replaced by a code in the focus group transcript to maintain their anonymity, and all identifiable information was not included in data extraction and analysis. Participants engaged in the focus group discussion without receiving any form of payment or remuneration.

Data Collection and Analysis

Six focus groups were conducted virtually using MS Teams (Microsoft) by two researchers. The principal investigator acted as facilitator, and one other member of the research team performed the roles of observer and notetaker. The focus groups were conducted from 14 February to 15 March 2023 for approximately 90 minutes each, and the discussions were digitally captured via the recording and transcription functionality of the MS Teams videoconference call. Five standardized questions were used to guide the discussions, as detailed in [Appendix 2](#), and consistency was maintained across the six focus groups by using the same questions by the principal investigator conducting the discussions, with the other member of the research team observing for reliability. Data analysis then occurred iteratively throughout 2023 where the automatically transcribed text was downloaded, reviewed and proofread for language and readability before a full transcript of each focus group was ready for data extraction and analysis. All of the focus group discussion participants were emailed copies of their transcripts and asked to delete any of their comments if they wanted to do so, especially to validate accuracy or clarify a statement, to confirm inclusion of their comments, and request any specific information in the transcript to be excluded from the analysis and reporting in any relevant publications.

All transcripts were analyzed using NVivo[®] software version 14 (QSR International) as a qualitative data analysis tool. Thematic analysis was conducted iteratively, using data from the focus groups to inductively develop concepts, categories and themes. Analysis was also undertaken deductively to categorize competencies against current national and international health service management and digital health competency frameworks. Enabling and inhibiting factors were analyzed using Braun and Clarke's (2019) six-phase, reflexive thematic analysis (TA) approach to distinguish, explore, organize and advance insight into themes or categories of the factors emerging,⁵³ as previously detailed in a published protocol the stages were as follows: 1) familiarization, 2) generating codes, 3) constructing themes, 4) revising themes, 5) defining, and 6) producing the report.⁴⁰

As Braun et al (2019) explain,

In reflexive TA, themes are conceptualized as meaning-based patterns, evident in explicit (semantic) or conceptual (latent) ways, and as the output of coding – themes result from considerable analytic work on the part of the researcher to explore and develop an understanding of patterned meaning across the dataset.⁵³

This approach guided the coding and data analysis methods employed in this research. The data was thematically coded in NVivo 14 software by the primary author. Initial codes emerged from the focus group discussion participants' responses, which were identified iteratively via inductive coding. The two other co-investigators then collaboratively considered and compared the codes, which were then able to be collapsed into candidate themes for analysis. Consensus discussions were used to resolve any differences in coding.

Results

Focus Group Participant Characteristics

Forty-four mid-level managers from all Australian states and the Australian Capital Territory who were responsible for the day-to-day operations in Australian public hospitals participated in six different focus groups. Participants held various management positions in clinical, corporate, technical, research, quality, and program management roles (as detailed in [Table 1](#)).

Difficulties in Realizing the Benefits of Digital Health – Summative Findings

During the focus group discussions, participants were asked about the barriers encountered in realizing digital health benefits in their workplace. As a result, twenty-three barriers were raised. The following nine initial codes emerged from these 23 barriers at the first round of content analysis: (1) change resistance, (2) digital literacy, (3) procurement, (4) resourcing, (5) right roles, (6) siloed systems, (7) trust, (8) uniformity, and (9) usage. Based on the shared meanings of these initial codes in answering the research questions, they were then consolidated into five major themes: (1) change resistance and usage, (2) trust and uniformity, (3) resourcing and procurement, (4) digital literacy, and (5) siloed systems. For each of these five major themes, 4–9 sub-themes emerged, classified as “key difficulties”, as detailed in Table 2. These will be further elaborated on in the next section, supported by relevant health service manager participant exemplar quotes.

Table 2 Organizational Barrier Themes and Key Difficulties Identified by the Focus Groups

Barriers (Themes)	Key Difficulties Identified (by Number of Focus Groups)
Change resistance and usage were highlighted as barriers to realizing benefits from digital health in the workplace by all 6 of the focus groups	1. inadequate forecasting and budgeting of the required resources to effect competency-based digital training (4) 2. data integrity, quality and provenance, upon which required clinical and business decisions are rapidly made (3) 3. interdisciplinary digital competence expectations of health service managers (3) 4. challenges faced with consumer access to personal digital health records and online appointments (1) 5. contextual authority concerns as to who now has the responsibility for making the just-in-time clinical and business decisions (1) 6. contextualizing information to make data-informed, clinical and business decisions (1) 7. inadequately articulated and poorly embedded organizational digital innovation policies and values (1) 8. operational and technical complications faced through sub-optimal communication of the organizational and operational digital framework (1)
Trust and uniformity were highlighted as barriers to realizing benefits from digital health in the workplace by 5 of the focus groups	1. disparate organizational data governance requirements (2) 2. accelerating digital innovation agendas and the actualities of modern-day healthcare service delivery (1) 3. ability to provide competency-based, role-based digital training that is effective and efficient (1) 4. heightened security and confidentiality assurances required when dealing with personally identifiable health information (1) 5. integrity and confidence in the data collected, with the resultant surety of decision-making (1) 6. lack of technical aggregation or integration (1) 7. need to be digitally omniscient as HSMs (1) 8. organizational and data threats posed digitally, necessitating increased cybersecurity awareness and assurance (1) 9. the various ways data definitions are used or omitted (1)

(Continued)

Table 2 (Continued).

Barriers (Themes)	Key Difficulties Identified (by Number of Focus Groups)
Resourcing and procurement were highlighted as barriers to realizing benefits from digital health in the workplace by 4 of the focus groups	1. differential understanding of data governance across stakeholders (2) 2. understanding of and alignment to organizational digital governance and procurement policies (2) 3. increased resource implications of competency-based digital training (2) 4. digital vulnerability considerations for data quality and the digital security of information (2) 5. procurement knowledge required of the digital health system life cycle (2) 6. both capital and recurrent resourcing requirements were not always accurately forecasted (1) 7. capable and contiguous change management expertise (1) 8. physical, technical and financial barriers marginalizing access to digital health (1) 9. resourcing challenges of promoting digital connectivity (1)
Digital literacy was highlighted as a barrier to realizing benefits from digital health in the workplace by 4 of the focus groups	1. inadequate and insufficient digital training provided for all types of users (3) 2. contextualizing the volume and veracity of information presented digitally (1) 3. individual, team and organizational vulnerabilities exposed through enhanced digital literacy requirements (1) 4. integrity of the data captured, stored and aggregated to form information upon which business and clinical decisions are made (1) 5. required resourcing to address the challenges of digital literacy in supporting digital transformation (1) 6. the paucity of digital frameworks that organizations have adopted to guide digital health transformation (1) 7. various data definitions used or implied (1)
Siloed systems were highlighted as a barrier to realizing benefits from digital health in the workplace by 3 of the focus groups	1. digital governance barriers that prevent the efficient and effective transfer of required information within jurisdictional boundaries (2) 2. increased digital training across multiple disconnected systems (1) 3. organizational, technical and regulatory barriers to digital connectivity required across healthcare services and locations (1) 4. technical aggregation challenges in accessing and using digital data being captured and stored in these different systems (1)

Elaboration on the Five Key Themes

Change Resistance and System Usage

Under this theme, three key difficulties were mentioned by participants from more than one focus group. Firstly, barriers to effective digital health usage were explored when participants discussed inadequate forecasting and budgeting of the required resources to effect competency-based digital training. The concern was articulated from both a financial forecasting and human resourcing perspective. Ensuring adequate financial and personnel budgets necessary for the scope and scale of competency-based training needed to deliver safe healthcare with digital health was not always seen as being appropriately budgeted in the initial digital technology business case. As managers highlighted, the recurrent human and fiscal resourcing allocations were also often inadequate. In illustrating this view, one manager stated:

So, I feel we don't forward plan enough and show people how's your workflow going to be different. We just sit them in front of a computer and then expect them to know how their new work is going to be imagined. And then it's very tricky. I think on our learning curve, we know that people lose it and so we spend so much time on training ... It's a foundational knowledge of how health, digital health works and then how do we train it. (FGD5-P7)

Secondly, participants described challenges in making data-informed, clinical and business decisions, particularly when facing the reality of unknown data integrity, quality and provenance. The surety of using system-sourced information to make just-in-time management decisions affecting practitioners, providers and patients was a pronounced issue. Managers in this study expressed their concerns about the expected accountabilities, including using information of unknown or unconfirmed provenance, to manage in the digital health environment effectively. Digital vulnerability and the associated risk with potential errors in accuracy were typically echoed by one participant:

I was going to look at something at a base level and that's (when) we really have become highly reliant on data quality. If it's not in the place where we expect it to be in the digitized system, using that is we're not going to get the value or we're going to miss things. (FGD2-P2)

Thirdly, managers are expected to be able to assist all types of system users with their issues in effectively using digital health technologies, exemplifying the actual need to know different practitioners' processes and information needs transposed in the workflow of delivering healthcare services. Hence, managers are challenged to be all things to all people and be able to provide just-in-time digital health support to other system users. This includes the ability to problem-solve a range of user issues when faced with digital technology challenges in accessing and using digital tools. As highlighted by one of the managers:

Keeping up to date with the technology itself and being able to interpret that on the ground level. So, I've become a resource person for everything and have to be more up to date or more technical because as they encounter some sort of question you interpret, and you help them navigate that kind of technology. So, I find myself being one foot forward and ahead of my staff in order to be able to respond to that in a timely manner. (FG2-P5)

Trust and Uniformity

Nine barriers are related to the lack of trust in and uniformity of the digital data, with only the barrier of "disparate organizational data governance requirements" being mentioned by participants from more than one focus group. Healthcare is based on trust in delivering safe, quality care, which is underpinned by having access to the right information at the right time, in the right place, for the right purpose. The concerns raised about the provenance and accuracy of the system-generated digital information were voiced by managers in this study, including their caution in trusting key performance indicators available in dashboards and management reports, reinforced by the lack of uniformity in definitions of the data being used. This was well summarized by one participant in emphasizing that:

the data is coming out at a really high level, but we're not putting the time and effort into actually making sure that data is correct and that starts at the very bottom line that is your financial data, that's your clinic data that is your patient data that is everything and we don't have the resources or the thought processes right now to actually make sure that data is right ... the data is rubbish and I know the data is rubbish because we're creating rubbish data ... we aren't doing the groundwork to make sure that our data is right. To actually make sure that those numbers that people are making critical decisions on are actually valid. (FGD1-P3)

Additional concerns acknowledged the ever-present organizational and data threats posed digitally, necessitating increased cybersecurity awareness and assurance. Noting that healthcare cyber attacks are now more prevalent and prominent, managers in this study expressed escalating trepidation about the safety, security and surety of having reliable, accurate and timely personal and organizational information available when and where needed. Typical of this discussion was one participant who said:

And the second one I thought, of course, is cyber security issues. So, we already learned from a previous experience here in XXXX, where a lot of health services were hit with cyber-attacks. We try to think of how best can we insulate ourselves from some attacks. So maybe those are the barriers that we really face as managers. (FGD3-P8)

Resourcing and Procurement

Under this theme, five key difficulties were mentioned by participants from more than one focus group. Inadequate resourcing and a lack of digital procurement prowess were highlighted as barriers to realizing benefits from digital health in the workplace. This consistently included specific resourcing and investment to support governance and innovation across the digital health system life cycle.

The first barrier described by participants included a differential understanding of data governance across stakeholders in their healthcare environment, such that local digital data is often being managed corporately in statewide systems. Once data is entered locally into statewide digital systems, for example, the electronic medical record, managers mentioned that when implementing local digital health systems, they often had to pay for integration of their new system with the corporate system, just to be able to access their pre-existing data. This was noted as a very arduous procurement and governance process. Secondly, this difficulty was compounded by concerns about staff understanding of and alignment with organizational digital governance and procurement policies. This was evidenced by managers often having to take up lead roles in the governance of local digital health procurement on behalf of the executive sponsor. Additionally, the challenges presented by the lengthy bureaucratic procurement governance processes were highlighted by one participant when looking for contemporary and timely digital procurement:

And then we're fighting with time as well, like the governance processes. The governance processes that we actually have to go through takes so much time that by the time we actually get to actually implement something, that was three years ago, we've already got different technology at our hands already. So, things like cloud based (technology) was something that came really quickly, and we've never actually been able to really get a grasp on how to actually move towards using all those cloud-based services easily because of our cyber security constraints and our governance constraints. (FGD5-P5)

Thirdly, participants identified an additional barrier of the increased resource implications of competency-based digital training to ensure that staff had role-based digital capabilities to deliver safe, quality care. Managers expressed the budgeting and resource concerns they faced in being able to efficiently and effectively develop staff capability to demonstrate digital competence in the context of a rapidly changing digital technology environment.

Fourthly, managers in this study also discussed digital vulnerability considerations for data quality and the digital security of information, which directly impacted the resourcing required to deliver enterprise-generated information. The managers raised concerns about the cost of relying on this data in making clinical and business decisions. As one manager recounted when discussing the digital vulnerability impacting data surety:

So, one of the classic costs that we now have is when we get data inaccuracies because we've got such a highly integrated system, the time it takes to correct those inaccuracies is massive because you're moving clinical notes as well as changing the administrative documentation. And that obviously has a risk associated with it of incorrect adjustments. (FDG5-P6)

Finally, some of the resourcing challenges were further elaborated on by participants when describing the organizational, technical and procurement knowledge required of the digital health system life cycle. This was further complicated by the different interpretations of whole-of-life system costs the managers experienced from system funders and organizational executives. Participants also voiced the challenges faced in dealing with disparate system funding sources and the different regulatory and reporting requirements. This was articulated by one participant when describing:

Some of the challenges are we obviously have to fund these systems you've got, you've got to source these systems, one that's appropriate to your needs and you want it to be sustainable, upgradable to make sure you get the most out during the investment. So, there is the funding aspect and then you also need the subject matter experts that are going to actually work with you to do

the sourcing, installation, implementation and then do the maintenance side of it as well. So that really forces you to cut in the beginning. (FGD4-P3)

Digital Literacy

Seven barriers were related to digital literacy, with only the barrier of “inadequate and insufficient digital training provided for all types of users” being mentioned by participants from more than one focus group. The high turnover rate of healthcare practitioners further exacerbated this issue. Using nursing as an example, there are permanent, casual and agency staff, graduate and student nurses all on the one shift, which presents a challenge in terms of variance in digital literacy and being able to ensure all staff are digitally proficient in using the electronic medical record and other enterprise systems. Managers discussed how they had to shadow agency staff to ensure their data entry was accurate. The risk to patient safety of capturing and using incomplete clinical information was reported as a potential outcome. Inadequate and insufficient digital training provided for all types of users was reported as a barrier contributing to this potential consequence. This barrier was discussed by one participant:

There are also different levels of computer literacy amongst different staff. So, with things changing all the time and there's a new system to learn every few months, it can get a little frustrating ... So, there's a flip side of having these different levels of literacy, and how comfortable some people are with them because one way we're saying that it's not rapidly evolving, but the other way, even the little bit that we have is a bit too rapid for a few of them. (FGD4-P5)

In contrast, there was also a focus on the individual, team and organizational vulnerabilities that were being exposed through the enhanced digital literacy requirements associated with the increased use of digital technologies. As one participant recounted:

I think turning so many things digital has introduced a lot of vulnerabilities. And we have a heavy reliance on things going the way that they're meant to and as soon as one little thing breaks, we can lose so much capability, so many efficiencies, and introduces so many problems. Just to what was the vulnerability of people not necessarily understanding the difference between data and information. (FGD1-P2)

Siloed Systems

Four barriers mentioned by participants were related to siloed corporate, organizational and clinical information systems. Corporate, clinical, and digital governance alignment is required for digitally enabled healthcare enterprises to realize the benefits of a connected healthcare organization. Barriers presented by the digital governance challenges faced by accessing and using required clinical and business information from the siloed digital health systems were described by managers. As participants observed, this was being confounded by digital governance barriers preventing the efficient and effective transfer of required clinical information across practitioners and disciplines within their healthcare service. In illustrating this view, one participant stated:

I described it as being heterogeneous in the extreme at the moment and so the LHD (Local Health District) have said, Chief Information Officers were quite strong on locking that stuff down, and they've inherited legacy systems which are siloed as you know, so there's no integration between a clinical information system, gastroenterology system and the EMR. So, you can be reporting in Gastroenterology, but if you got the same patient in the different setting, you've got no idea what they've done. (FGD4-P6)

Discussion

This research has explored organizational barriers to realizing the benefits of digital health transformation that health service managers have encountered in the digital context. Digital transformation is seen as a strategic organizational necessity. Yet, contemporary healthcare research frequently focuses on the introduction and implementation of new and novel technologies rather than the strategic or systemic standpoint.^{28,54} Findings from this study demonstrate that in driving the realization of digital health transformation benefits, health service managers need organizational and system-

wide efforts to support managing in the digital health context. The key identified barriers to realizing the benefits of digital health transformation in the workplace experienced by health service managers have been detailed across five major themes, including facing human and technical challenges with system adoption and the governance of data-driven decision-making in the digital context.

Change resistance and system usage are factors affecting many transformation programs that are further accentuated when adopting digital technologies. This is particularly so when contextualizing information in healthcare to make data-informed, clinical and business decisions.^{12,22,55,56} Managers in this study described the contextual authority concerns regarding the uncertainty as to who is now responsible for making these just-in-time clinical and business decisions, using the system-generated information, and the consequent personal and litigative risks attached to these decisions. These concerns reflect the discourse in the contemporary literature about administrative harm, which can be defined as

the adverse consequences of administrative decisions within health care and directly influences patient care and outcomes, professional practice, and organizational efficiencies regardless of employment setting.⁵⁷

In the digital environment, health service managers must make dynamic decisions in a fast-paced, high-risk context.^{58,59} Appropriate organizational structures and processes are essential to support the best possible decision-making. Uniquely, this study has evidenced managers' contextual authority concerns in the digital environment as to who now has the responsibility for making the just-in-time business and clinical decisions. A novel finding regarding both a perceived and potential barrier to realizing benefits from digital transformation.

For health service managers, these barriers can be modulated by articulating and embedding organizational digital innovation policies and the required operational digital frameworks and procedures.^{37,60} The impact of changing responsibilities in a transforming workplace, the rapid pace of digital change, and the increasing amounts of electronic data available are seen to confound existing decision-making hierarchies.^{61–63} Within this dynamic decision-making milieu, the benefits of digital decision support are well documented in the healthcare literature,^{56,64,65} though, there is a paucity of evidence about the contextual authority concerns. This is compounded by the decision-ownership conundrum when implementing these digital policies, where ambiguity surrounds the accountable leader or decision-maker. This increases the difficulty in assigning ownership to decisions.⁵⁷

Realizing benefits from digital health presumes the need to address concerns about system-generated information's digital provenance, safety and security. This is acknowledged in the digital organizational literature, which accentuates the difficulties in providing surety of digitally generated insights and supporting information-enabled decision-making.⁶⁶ The implications are profound, and impact system, organizational and enterprise factors, and digital governance policies and decision-making frameworks must be confirmed, implemented and actualized in practice. Lack of trust in digital systems and the ability to safely communicate using a uniform language supported by consistent data definitions are seen as inhibiting factors for digital health transformation, as apparent in contemporary literature.^{67,68} Digital safety and cybersecurity are now more acutely evident across healthcare systems, and healthcare cybersecurity is currently considered a crucial state infrastructure in many countries.⁶⁹ In this study, health service managers identified associations between the need to be digitally omniscient across the various healthcare practitioner roles and endeavouring to establish a sense of trust and assurance for the system users so that they can have confidence and surety in the digital systems. This is a novel finding with implications for the efficacy and efficiency of data-informed decision-making in a timely and secure manner, directly impacting human and fiscal resourcing.

Resourcing and procurement for technology adoption are seen as confounding influences across multiple industries,^{12,25,70} although in the digital health context, the barrier to adoption was amplified in this study. The health service managers highlighted the procurement knowledge required of the digital health system life-cycle by them, as well as the organizational need for both capital and recurrent resourcing requirements to be accurately forecasted for digital health. In addition, managers described an increasing need to be able to manage technology vendors, the commercial and contractual nuances required, and the interplay needed between clinical, business, technology and commercial necessities. There are profound commercial and financial implications for

the healthcare organization, with increased knowledge required of health service managers in understanding how to get better value from the digital health system life-cycle and the return-on-investment metrics. Preparing business cases and planning for whole-of-life digital health investments necessitates digital product life-cycle aptitude.^{32,71} This finding has important implications for targeted health service manager capability development, the required educational course curricula, and competency certification program preparation.

Managers in this study acknowledged that digital literacy is a foundational skill for managing information in the digital age. Digital literacy is an important and much discussed phenomenon affecting digital technology users in the twenty-first century.^{13–16} However, the managers in this study raised concerns about the escalating digital literacy requirements they needed as health service managers. Indeed, the impacts seen across the individual, team, and organization exposed vulnerabilities that were increasingly evident as a result of the enhanced digital literacy requirements needed by managers and their colleagues. They emphasized the importance of supporting healthcare practitioners in developing digital literacy skills, including their ability to contextualize the volume and veracity of information presented, along with the organizational vulnerabilities exposed from the integrity of the data captured, stored and aggregated to form information, upon which business and clinical decisions are made in the healthcare environment. The criticality of these decisions can have life-changing effects for patients and deleterious outcomes for healthcare organizations.^{3,35,72}

Previous research has examined the broad management competencies required from primary healthcare managers in the context of digital health services,⁷³ though the barriers managers perceived included the need to be able to constantly maintain and learn new skills in using digital systems, which impacted their ability to then teach and support employees in using digital technologies. This research has demonstrated that health service managers in this study experience difficulties in being able to provide effective and efficient competency-based, role-based digital training for staff, which is a barrier to realizing digital transformation benefits. The managers also revealed the link between digital literacy, digital governance and digital vulnerabilities, which impacts the accuracy and reliability of the information available to drive data-informed decision-making. This can be addressed with increased organizational alignment between corporate, clinical and digital governance, which must be understood and enacted by the health service managers.

Siloed systems are seen as a technology barrier to information access in many enterprises, and in healthcare, availability and timely access to clinical and business information are essential for quality and safe service delivery.^{56,74} The various disparate and disconnected health information systems must be able to link together and exchange information in an integrated manner to ensure appropriate and pervasive access to clinical information to treat patients and business information to manage the organization.⁷⁴ This supports recent research that highlights “successful integration requires more than just adopting technology; it necessitates a cultural shift and strategic alignment with organizational goals”.⁴¹ Findings in this study identify the digital governance barriers that prevent the efficient and effective transfer of required information across siloed systems. These are confounded by the organizational, technical and regulatory barriers to digital connectivity across healthcare services and locations. This disconnect between systems is increasingly apparent, which results in decision-making silos that are known to inhibit necessary information sharing and constrain collaborative problem-solving among healthcare teams.⁵⁷ System, technical and regulatory barriers to the digital connectivity required across organizational services and locations are not unique to healthcare.⁷⁵ However, the impact these barriers have on clinical risk and patient safety was magnified by managers in this study when explaining their increased level of accountability required to ensure that the right information is available for the right patient, in the right place, at the right time. These findings have implications for the governance of healthcare delivery across providers and locations of care, as the challenges in accessing and using digital data being captured and stored in these different systems must be overcome to ensure that essential personal health information can follow the patient across their care journey. Improvements are required in the enterprise, organization and local digital governance mechanisms that can better align the information access, including requisite delegation frameworks to ensure that role-based access controls are better tuned to the information requirements of healthcare practitioners. This also

includes the health service managers' *prima facie* need for appropriate access to organizational, clinical and business information.

Barriers to realizing the benefits being rendered from digital health are influenced by the barriers to adopting digital health technologies, including infrastructure and technical concerns, psychological issues, and workload-related trepidations.^{4,20} The findings from this study underscore that digital benefits are enhanced by addressing the organizational barriers to digital health adoption from a macro-system level, including digital governance, innovation and investment frameworks, resourcing for digital literacy, and digital security; a meso organizational structure and process level for reducing digital vulnerabilities, aligning corporate, clinical and digital governance structures, and supporting managers with whole-of-life digital systems investment capability; and the micro-human factors level including digital transformation capabilities, contextualized-authority certainty for decision-ownership, and cyber-hygiene.⁸ Health service managers need to see tangible digital health benefits evidenced in their workplaces, whilst being cognizant of contextual factors that can hinder the realization of these benefits.³⁷ Ensuring that organizational barriers and factors are addressed and capitalized upon in supporting the realization of benefits for health outcomes, responsiveness, efficiency, quality and safety³⁶ in a digitally transforming environment is imperative.

Recommendations for Healthcare Organizations and Policymakers

Recommendations for required changes across health systems can be considered using the World Health Organization's (2010)³⁶ six building blocks of a health system, to align the global policy recommendations and resourcing implications for how these barriers could be addressed on a larger scale, ensuring optimal benefits can be realized from digital health transformation. These are presented in Table 3 as digital changes required for health service managers to optimize the health system outcomes resulting from digital transformation in their hospitals (reflected in the bolded outcomes, as modified from the WHO six building blocks by the authors).

Table 3 Recommendations for Aligning Policy and Resourcing Requirements with Health System Building Blocks and Overall Health System Outcomes

Building Blocks of a Health System	Digital Changes Required	Health System Goals	Health System Outcomes
• Service delivery	• Digital governance alignment between corporate and clinical governance.	• Access • Coverage • Quality • Safety	• Improved Health • Responsiveness • Social and Financial Risk Protection • Improved Efficiency
• Health workforce	• Training in vendor management and negotiation for managers. • Digital literacy training programs for healthcare workers.		
• Health information systems	• Organizational technology integration strategies.		
• Access to essential health-related commodities and products	• Contemporary digital health procurement guidelines need to be established and utilized.		
• Financing	• Financing available to incorporate and maintain digital systems.		
• Leadership/governance	• Integration of clinical decision support systems, data information exchanges, and analytics tools to enable data-informed decision-making.		

Conclusions

The importance of digital transformation in healthcare is evident and will increasingly become a necessity for organizational survival and success. The changing competencies for health service managers to lead and manage in this digitally transforming environment are never more apparent. Complex adaptive change is also required in the organization of work, including capacity and system drivers that will support health service managers in leading and managing in this dynamic context. Organizational capacity, health service workforce capability, and individual health service manager digital health competencies are synergistic necessities.

System investments could therefore include targeted investment for manager training in vendor management and negotiation, as well as digital literacy training programs for healthcare workers. In the governance field, digital governance alignment between corporate and clinical governance is required. Under commodities management, contemporary digital health procurement guidelines need to be established and utilized. Furthermore, organizational technology integration strategies could benefit from including both new and emerging technologies like artificial intelligence along with existing virtual health services, business and clinical decision support systems, data information exchanges and analytics tools to enable data-informed decision-making.

This study contributes to the theoretical understanding of digital health transformation for healthcare management by confirming the capabilities required for health service managers to lead and manage the adoption and implementation of digital health technology and initiatives in the healthcare sector. This research also makes a novel contribution to the management competency development discourse that healthcare organizations, professional institutions and tertiary education providers can incorporate into their continuing professional development and training curricula. This study further adds important insights into the organizational barriers faced by health service managers in the Australian hospital sector when realizing the benefits of digital transformation. Addressing these barriers requires macro-, meso- and micro-level system investments, ensuring benefits can be transformed into value within the healthcare context. These benefits are enhanced by enabling factors critical for digital health adoption that have been described in key categories involving: (1) policy and system, (2) organizational structure and processes, and (3) people factors.

Limitations and Future Research

It is important to note some limitations associated with this research. Firstly, the study uses a qualitative approach to develop a contemporary understanding of experiences and perceptions of the organizational barriers that health service managers have encountered when realizing the benefits of a digitally transforming environment in the Australian context. The methods detailed could be applied in other jurisdictions, though the results should not be generalized to other country contexts without acknowledging local conditions and contexts. Second, although the empirically validated methodology was applied to mid-level public hospital managers, considerations about validity and applicability to other healthcare sectors and domains would necessitate alignment with local factors and prevailing research priorities.

As this research was conducted during and immediately post-pandemic, future research might focus on the longer term influences of managing digital health in the contemporary milieu of rapidly emerging technologies, the way in which healthcare organizations are evolving and adapting to ensure efficient, effective, safe and sustainable service delivery, as well as the nature of health service managers competencies required to successfully steer digital transformation in this fast-changing environment. It would also be useful to extend this research into other elements of the broader system, including primary care, rehabilitative and aged care.

Abbreviations

ACHSM, Australasian College of Health Service Management; AHICF, Australian Health Informatics Competency Framework; AIDH, Australasian Institute of Digital Health; COREQ, Consolidated Criteria for Reporting Qualitative Research; EMR, Electronic Medical Record; FGD, Focus Group Discussion; HSM, Health Service Manager; LHD, Local Health District; WHO, World Health Organization.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

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Appendix 1: Consolidated criteria for reporting qualitative research (COREQ)

No	Item	Guide questions/description for this study
Domain 1: Research team and reflexivity		
<i>Personal characteristics</i>		
1.	Interviewer/facilitator	The principal investigator was Mr Mark Brommeyer, PhD candidate. The focus group discussions were supported by the PhD candidate's Supervisory Panel.
2.	Credentials	- Mark Brommeyer, MEdAdmin, GradDipNsgEd, BAppSc, FAIDH, AFCHSM, CHIA - Associate Professor Zhanming Liang, PhD, MSc, MBBS (Principal Advisor) - Professor Maxine Whittaker, PhD, MPH, MBBS (Secondary Advisor)
3.	Occupation	- Mark Brommeyer, PhD Candidate, Senior Lecturer in Health Care Management. - Associate Professor Zhanming Liang, Associate Dean, Research Education. Associate Professor, Health Systems Management and Policy. - Professor Maxine Whittaker, Co-Director WHO Collaborating Centre for Vector Borne and Neglected Tropical Diseases.
4.	Gender	- Mr Mark Brommeyer, Male. - Associate Professor Zhanming Liang, Female. - Professor Maxine Whittaker, Female.
5.	Experience and training	- Mark Brommeyer, formal research methods study, including qualitative, quantitative, and mixed-methods research. Research supervision and mentoring from PhD supervisors, including development and use of data collection instruments, recruitment of research participants, ethics, consent, analysis, and dissemination of research outcomes. - Associate Professor Zhanming Liang has more than 20 years of research experience in a similar field, including leading qualitative research incorporating focus groups and interviews. - Professor Maxine Whittaker has more than 30 years of research in similar fields and leading qualitative research incorporating focus groups and interviews.
<i>Relationship with participants</i>		
6.	Relationship established	A relationship between the focus group facilitators and the focus group participants was not established prior to the commencement of the study.
7.	Participant knowledge of the interviewer	At the start of the focus group discussions, the facilitators introduced themselves and provided a brief background to the study, with additional details explicated in the Participant Information Sheet, which was provided to each participant prior to the focus group.
8.	Interviewer characteristics	Select facilitator characteristics were provided at the start of each focus group. This positioned the PhD study with any potential sources of bias, assumptions about the topic based on past experience, as well as reasons and interests in the research topic.
Domain 2: Study design		
<i>Theoretical framework</i>		
9.	Methodological orientation and theory	Thematic analysis was conducted iteratively with data from the focus groups to develop concepts, categories, and themes, using Braun and Clarke's (2019) six-phase, reflexive thematic analysis approach to distinguish, explore, organize, and advance insight into the themes and categories of the emerging factors.
<i>Participant selection</i>		

10.	Sampling	Purposive sampling technique was used to facilitate a deliberate selection of participants for the focus groups, as well as the snowballing technique. The participants were mid-level managers who have the responsibility for the day-to-day operations in Australian public hospitals. These positions variously included Department Directors, Unit Managers, Corporate Managers, Program Managers and Ward Managers (as detailed in Table 1), representing management levels 3 and 4. The management levels are defined by the organizational reporting hierarchy, with level 1 being the Chief Executive Officer (CEO), level 2 reporting to the CEO, level 3 reporting to level 2 management, and level 4 reporting to level 3 management. Participant numbers are coherent with the qualitative methodology employed to ensure data saturation.						
11.	Method of approach	Participants for the focus group discussions were invited and recruited from members of the Australasian College of Health Service Management (ACHSM) and the Australasian Institute of Digital Health (AIDH) membership.						
12.	Sample size	It was estimated that for each of the six focus groups, there would be 8 participants. The final number of participants was 44.						
13.	Non-participation	No people refused to participate or dropped out.						
Setting								
14.	Setting of data collection	The focus groups were conducted via videoconference (Microsoft Teams). Due to existing work arrangements resulting from the COVID-19 pandemic, the researchers and the participants were physically located either at their place of work, at home, or elsewhere.						
15.	Presence of non-participants	Only the participants and researchers were present.						
16.	Description of sample	The purposive sampling and snowballing techniques were used to facilitate a deliberate selection of participants for the focus groups. The participants were mid-level managers who have the responsibility for the day-to-day operations in Australian public hospitals. These positions variously included Department Directors, Unit Managers, Corporate Managers, Program Managers and Ward Managers (as detailed in Table 1), representing management levels 3 and 4. The management levels are defined by the organizational reporting hierarchy, with level 1 being the Chief Executive Officer (CEO), level 2 reporting to the CEO, level 3 reporting to level 2 management, and level 4 reporting to level 3 management.						
Data collection								
17.	Interview/focus group guide	The focus group guide and questions were piloted with three healthcare management academics and one university professional services manager working in healthcare management. The guide was reviewed and revised prior to the commencement of the focus group discussions. Focus Group Guide <table><tr><th>Stage</th><th>Question/Wording</th></tr><tr><td>Benefits questions</td><td>1. We know that adopting digital health can create many benefits – please take a minute to identify <i>two (2) benefits</i> that you have experienced in your workplace.</td></tr><tr><td>Influencing factors questions</td><td>2. Have you experienced any <i>difficulties</i> in realizing the benefits of introducing digital health in your organization? Any examples of the sort of difficulties you have experienced in practice?</td></tr></table>	Stage	Question/Wording	Benefits questions	1. We know that adopting digital health can create many benefits – please take a minute to identify <i>two (2) benefits</i> that you have experienced in your workplace.	Influencing factors questions	2. Have you experienced any <i>difficulties</i> in realizing the benefits of introducing digital health in your organization? Any examples of the sort of difficulties you have experienced in practice?
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		Required competencies questions	3. As a manager, what <i>skills</i> and <i>knowledge</i> do you feel you <i>need</i> to have, to perform your management work? 4. As a result of adopting digital technologies, have you noticed any <i>changes</i> in the skills and knowledge you require as a manager – what are they?
		Additional responsibilities questions	5. In the last five years, as a result of introducing digital health into your organization, have your <i>responsibilities increased</i> , as a manager?
18.	Repeat interviews	No repeat focus group discussions were conducted.	
19.	Audio/visual recording	The focus groups were digitally captured via the recording functionality of the Microsoft Teams videoconference call. The automated transcribed text was then reviewed and proofread for accuracy to provide a full interview transcript for data analysis.	
20.	Field notes	Field notes were made during the focus groups.	
21.	Duration	Each focus group ran for 90 minutes in duration.	
22.	Data saturation	Participant numbers are coherent with the qualitative methodology employed to ensure data saturation.	
23.	Transcripts returned	Each participant was provided with a copy of their individual transcript and invited to amend or delete any of their comments, should they wish to do so, particularly for validation of accuracy or to clarify a statement.	
Domain 3: Analysis and findings			
Data analysis			
24.	Number of data coders	Primary coding in NVivo 14 was undertaken by the principal investigator, from which the initial concepts provided insights to inform the identification of initial themes. The initial themes were compared and contrasted with the two co-investigators to search for coherence of the themes in addressing the research questions.	
25.	Description of the coding tree	A description of the coding tree is available.	
26.	Derivation of themes	Themes were generated inductively by breaking down focus group participants' responses to finer and more discrete concepts for coding, thus using a bottom-up approach to identify meaning.	
27.	Software	NVivo software version 14 was employed as a qualitative data analysis tool.	
28.	Participant checking	All participants were emailed their cleaned-up transcripts and invited to amend or delete any of their comments, should they wish to do so, particularly to validate accuracy or clarify a statement, as well as receiving a copy of the final results.	
Reporting			
29.	Quotations presented	Participant quotations were presented in the manuscript to illustrate the themes. The quotations were identified by participant number.	

30.	Data and findings consistent	The researchers established a consistency between the data presented and the results in the manuscript.
31.	Clarity of major themes	The major themes were explicitly detailed in the results of the study.
32.	Clarity of minor themes	A description of diverse cases and discussion of minor themes are presented in the manuscript.

5.3 Key success factors and barriers for health service managers to demonstrate digital health competence in the workplace

Health service managers require contemporary and contextual competencies that allow them to be responsive and adaptive to the environment in which they work. Environmental factors can both enable and inhibit demonstration of competence in the digital health context. The factors that are critical to successful digital health adoption have been confirmed and builds on empirical evidence (Brommeyer et al., 2023b, Brommeyer et al., 2024b) and industry knowledge to develop a greater understanding regarding the key factors and strategies that enable development of health management workforce competency and capacity in today's digital context. Health service managers need systemic, organisational and institutional efforts in support of effectively working with and managing in the digital environment, which focus on enabling factors that have been described in key categories namely (1) policy and system, (2) organisational structure and processes, and (3) people factors (Brommeyer et al., 2023b). By addressing known organisational barriers, including (1) change resistance and usage, (2) trust and uniformity, (3) resourcing and procurement, (4) digital literacy, and (5) siloed systems (Brommeyer et al., 2024b), health service managers can demonstrate competence in the complex, adaptive and transforming digital context.

Some success factors and barriers are interchangeable, for example: (1) ensuring data privacy and integrity is an identified success factor, with heightened security and confidentiality assurances required when dealing with personally identifiable health information having been described as organisational barriers being faced; and (2) empowering users to take up innovation and embrace change was recognised as a success factor, with the accelerating digital innovation agendas conflicting with the actualities of modern-day healthcare service delivery being described as an organisational barrier to health service managers demonstrating digital health competence in the workplace.

5.3.1 Implications for healthcare systems

Addressing key factors that enable and inhibit health service managers to demonstrate digital health competence in the workplace requires macro-, meso- and micro-level system investments, ensuring benefits can be transformed into value within the healthcare context. These benefits are enhanced by enabling factors critical for digital health adoption, which were described in key categories, including (1) policy and system, (2) organisational structure and processes, and (3) people factors. Factors that are critical for health services managers to effectively work with and manage in the digital health context include a systemic recognition and investment in targeted workforce development; engendering an organisational culture of trust and investing in innovation; building supportive team cultures to reduce digital fear and uncertainty; developing contextual frameworks that

measure the impact and value of digital health technologies; and organisational executive and leadership interest in and positive attitude towards mainstreaming digital technologies and innovation.

Health service managers need systemic and organisational investment to support managing in the digital health context. The key identified barriers experienced by health service managers include facing human and technical challenges with system adoption and the governance of data-driven decision-making in the digital context. Addressing these barriers will support the realisation of digital health transformation benefits, which can assist health service managers in delivering the digital health potential and achieve the health system gains of efficacy, value, safety and effectiveness.

5.3.2 *Potential impacts of AI on managing health services*

Literature from the desktop review exploring developments in the transformation of Artificial Intelligence (AI) in healthcare, and potential impacts of AI on managing health services, on managing the workforce, and on managers, detailed resourcing issues resulting from COVID-19 impacts, emphasising AI's potential to identify gaps in epidemic reporting, facilitating evidence-based resourcing interventions across regions (Chen and Ding, 2025), predicting the risk of hospitalisation (Barbieri et al., 2024) and facilitating diagnostic and decision support for managing COVID-19 patients, along with public health decision making to ethically and effectively manage and resource the impacts (Bartenschlager et al., 2024, Syrowatka et al., 2021). In addition, the use of AI to assist in managing COVID-19 backlog surgical waiting lists, enhancing theatre scheduling, improving perioperative planning, resourcing and patient outcomes (Henderson et al., 2024) was featured, along with COVID-19 disruptions to the global medical supply chain where the use of AI in manufacturing technologies could provide assurance of better connectivity among supply chains (Kim and Lee, 2021). Further, the use of AI to integrate data-driven, real-time management dashboards to reduce patient no-show appointments (AISerkal et al., 2025), as well as enhancing operational efficiency with AI predicting patients having a high probability of not attending, to improve ambulatory scheduling and resourcing systems were described (Liebowitz and Robertson, 2024). The use of AI for improving resourcing efficiencies in radiology by shortening imaging scan times, optimising scheduling efficiency of scanners, and reducing low value imaging with enhanced decision-support tools were also evidenced (Doo et al., 2024a). These potential impacts are reflective of the broader digital health discourse and findings in this study.

Further, literature from the AI desktop review also highlighted that, as a result of the need for physical distancing requirements during the pandemic, a rapid adoption of

telemedicine and virtual care was witnessed that resulted in changes needed to manage a hybrid healthcare workforce (Dulaimy et al., 2024, Yoo and Lee, 2022). The strategic adoption of AI into healthcare innovation and investment strategies increasingly requires support for a workforce experiencing digital transformation. This includes contemporary career pathways and the digital health core competencies necessary to practice effectively and ensure technology can add value in the healthcare environment (Zakaria et al., 2023). AI has accelerated the need to develop a workforce capable and confident in using contemporary digital health solutions (Holland Brown and Bewick, 2023, Aerts and Bogdan-Martin, 2021), influencing the education and training preparations required for practitioners to deliver safe, quality healthcare in the digital age (Lattouf, 2022). Contextualising educational interventions to develop AI literate healthcare practitioners was also detailed, including a focus on the application of AI in health care, AI fundamentals, ethics and data science (Wiljer et al., 2021, Shinnars et al., 2020). A recent study also illustrated the need to integrate new competencies to guide the use of AI in healthcare management, including digital literacy, integrating organisational strategy, change management skills, ethical decision making, and supporting patient choice and needs (Ennis-O'Connor and O'Connor, 2024). These findings are also aligned with the barriers and enablers for digital health transformation experienced by health service managers in this research study.

5.4 Chapter Summary

Chapter 5 details the qualitative findings reported from six focus group discussions conducted virtually with health service managers from public hospital settings across Australia. The findings indicate that the importance of digital transformation in healthcare is evident and will increasingly become essential for organisational sustainability. The changing competencies for health service managers to manage in this digitally transforming environment are never more apparent. Complex and responsive change, including capacity and system drivers, is also required in the workplace to support health service managers in managing in this dynamic context. Organisational capacity, health service workforce capability, and individual health service manager digital health competencies are symbiotic requisites.

In exploring barriers to the benefits of digital health transformation being realised, as encountered by health service managers in the digital context, five major themes emerged (1) change resistance and usage, (2) trust and uniformity, (3) resourcing and procurement, (4) digital literacy, and (5) siloed systems. The findings add important insights into the organisational barriers health service managers face in the Australian hospital sector when realising the benefits of digital transformation. Addressing these barriers needs macro-, meso- and micro-level system investments, ensuring benefits can be transformed into value

within the healthcare context. These benefits are enhanced by enabling factors critical for digital health adoption, which were described in key categories, including (1) policy and system, (2) organisational structure and processes, and (3) people factors.

The focus group discussions then elucidated the competencies required for health service managers to manage in a digitally transforming context, which is the focus of Chapter 6, acknowledging the changing digital health context, roles, responsibilities, and competencies that health service managers must demonstrate in practice. In addition, findings regarding the increased role responsibilities that are associated with working and managing in a digital health context are also presented.

Chapter Six – Findings 2

6.1 Chapter Introduction

The purpose of this chapter is to present focus group discussion findings addressing the required health service managers' competencies in a digitally transforming context. This chapter addresses Research Question 2: What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context? The results will be presented by addressing three interrelated components: firstly by identifying current health service managers' capabilities in enabling transformation in a digital health context; secondly, detailing the changing context, roles, responsibilities, and competencies health service managers need to demonstrate in practice, which supports the realisation of benefits from digital health transformation; and thirdly, making recommendations regarding systemic factors that support health service managers in enabling this transformation.

This chapter is structured in two parts, which includes firstly a peer-reviewed publication (Brommeyer et al., 2025) that “confirmed the changing responsibilities and competencies that health service managers need to exhibit, along with the need to acquire additional skills and knowledge to complement existing competencies developed” (Brommeyer et al., 2025, p.10), when working in a digitally transforming environment. Secondly, the chapter focusses on adding depth to relevant key findings with further elaboration and the inclusion of participant quotations, captured from the focus group discussions, to provide more comprehensive understanding of the nuances of the digital competencies required for health service managers.

Figure 6 situates this chapter in the map of the broader thesis structure:

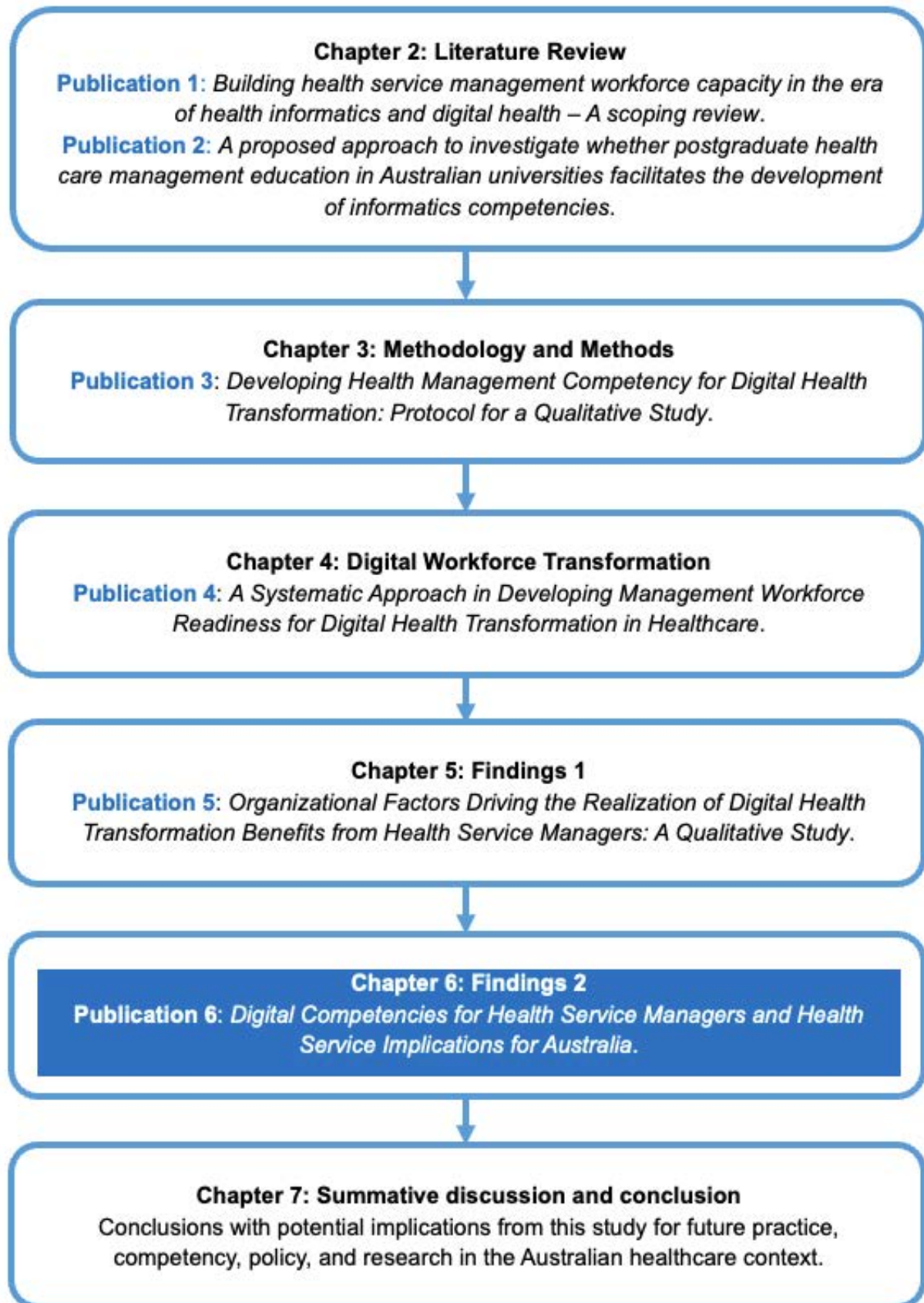


Figure 6: Thesis structure map Chapter 6

To avoid any terminology confusion when conducting the focus group discussions, the terms 'skills' and 'knowledge' were used, with the focus group introductory comments including "The purpose of this study is to explore the changing *management requirements*, including the *skills* and *knowledge*, for health service managers to work and manage in the Digital Health context, and to identify *key factors* that enable and inhibit your ability to be successful in your role". The skills and knowledge described by the focus group participants then thematically informed the analysis about what this means for the digital competencies, with recommendations including suggestions across the health systems environment in which the management workforce operate that can enable or hinder utilisation of their digital competencies.

In 2007 the World Health Organization proposed a framework for considering the health system as a holistic interconnected system composed of six major components (World Health Organization, 2007). These are: service delivery; health workforce; information; medical products, vaccines and technologies; financing; and leadership and governance (stewardship). A change in one part of the health system, e.g. a move to digital health, has ramifications more broadly across all of the system and beyond just the changes required directly to be digitalised. For example, if digital health applications change the roles and responsibilities of a frontline healthcare worker, then there needs to be a review of what these changes mean for the roles of responsibilities of all other healthcare workers within the system, both in terms of the digital health related changes on all other aspects of their work, workloads, training and supervision, and whether there needs to be tasks shifted from one to another to allow the workload of managing digital health applications.

By using the World Health Organization's six building blocks of a health system as a conceptual scaffold to align the digital competencies required from a global perspective, support for incorporating the objectives of digital health in efficacy, value, safety and effectiveness is detailed. This includes the digital and health system changes required for health service managers to advance the health system outcomes arising from digital transformation in the public hospital context, with the digital changes evidenced being detailed at the macro-system level, meso-enterprise structure and process level, and the micro-human factors level.

As this study was conducted in the Australian context, the importance of the healthcare system funding and functioning must be acknowledged. With tertiary (and hospital) care mainly funded through Australian state and territory health departments, and primary care funded by the federal government, there are policy, resourcing and governance priorities that are particular to each independent jurisdiction. The six focus group discussions

(FGDs) were not each individually representative of the state and territory jurisdictions, some of the FGDs had participants from several different jurisdictions in them. However, the six FGDs were also reviewed through the lens of healthcare jurisdictional variances to identify any substantial differences across jurisdictions. This second round of data analysis found there were no substantial differences identified between focus groups. This means that there were, at the time the research was conducted, minimal substantive differences of the jurisdictional variation on the respondents experiences or opinions on the competencies. The themes therefore can be understood as reflecting Australian public hospital setting universal themes.

This first part of this chapter contains one peer-reviewed publication. This is inserted as published. The citation is:

- Brommeyer, M., Whittaker, M., Mackay, M. & Liang, Z. (2025). Digital Competencies for Health Service Managers and Health Service Implications for Australia. *Health Information Management Journal*, pp.1-13. <https://doi.org/10.1177/18333583251396573>
- This is to confirm that the PhD candidate contributed 75% of the development of the manuscript.

6.2 Publication 6: (Brommeyer et al., 2025)



Digital competencies for health service managers and health service implications for Australia

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Abstract

Background: As the healthcare delivery landscape evolves and the impact of digital technologies and transformations becomes increasingly apparent, a competent healthcare management workforce, confident in the capabilities to employ and effectively incorporate digital health technologies into health service delivery is imperative. **Objectives:** The article explores the perceptions and experiences of middle-level health managers in their responsibilities and competency requirements in the context of digital health transformation. **Method:** Six focus groups were conducted with mid-level managers recruited across Australian public hospitals in 2023. Braun et al (2019) six-phase, reflexive thematic analysis approach was used to distinguish, explore, organise and advance insight into themes and categories of the factors emerging. **Results:** Findings indicated that the digital competencies managers are required to demonstrate include a much broader and expanded competence across eight identified competencies. **Discussion:** The unique attributes identified highlight and underscore the importance of enhancing digital competencies for health service managers to lead and manage in the digital health context. **Conclusion:** This study reveals two key areas of health service manager competency enhancement required: (i) competence in digital data management and security, and (ii) the management of digital technologies in practice. These findings can inform institutional competency frameworks that guide the development of management capability in the digital health environment, as well as illuminate the system and human resource implications for organisations to facilitate the application of these competencies in the workplace and optimise the benefits of digital health. **Implications for health information management practice:** The competency enhancements detailed have implications for health service, digital and information management regarding institutional competency frameworks and systems requirements that may need to be upgraded, expanded or introduced, and the continuous professional development that may need to be provided within the institutional or accreditation authorities to health service managers and health information managers.

Keywords (MeSH)

health service manager; digital health; digital transformation; competency; health services administration; workforce development; health information management

Background

As the evolving healthcare delivery landscape is increasingly impacted by digital technologies and the transformations they bring (World Bank, 2023), a competent healthcare management workforce, confident in their capabilities to employ and effectively incorporate digital health technologies into health service delivery, is imperative (Australian Government, 2023; Brommeyer et al., 2023b; Laukka et al., 2022; Monkman et al., 2023). Yen and Anderson (2023) suggested that digital health is increasingly becoming a dominant knowledge area in the healthcare industry, thus warranting distinct prominence in health services management courses.

There have been a variety of pathways for health service managers to develop knowledge and skills, including university programs tailored for health service managers and

programs developed by professional associations, such as the Australasian College of Health Service Management. It is essential to understand the existing structures and factors that can enable competency development and education in digital health management, particularly the extent to which organisational factors, institutional elements and postgraduate healthcare management education in Australian universities facilitate the development of knowledge and skills

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for digital health competency development. Competency mapping of the existing Australasian College of Health Service Management (ACHSM) Master Health Service Management Competency Framework competencies to the existing health informatics competency statements from the Australian Health Informatics Competency Framework (AHICF) was undertaken to investigate whether postgraduate healthcare management education in Australian universities facilitated the development of informatics competencies (Brommeyer et al., 2021). The mapping indicated that some of the competencies for health informaticians may be important for health service managers, but no research to our knowledge has confirmed to what extent they are relevant to health service managers. Furthermore, previous research has confirmed that integrating infrastructure, frameworks, systems, processes, resources and strategies is required to develop digital health competencies (Fernández-Luque and Ramírez-Montoya, 2024). Within the changing context of digital health, health service managers should demonstrate a clear understanding of the interdependent elements of roles, responsibilities and competencies. Managers must also recognise the growth in their organisation's local digital technology expertise and how to access these resources. This is particularly true for how these needed competencies and capabilities translate into contextual competence in a digitally transforming environment (Borges do Nascimento et al., 2023b; Iyamu et al., 2025). In addition, with these digital health capabilities come increased responsibilities for the manager's role associated with leading and managing in a digital health context, both regarding digital information systems and the transformation of data into decision-making for various aspects of their health system context.

Competencies now require health service managers to be cognisant of this rapidly changing digital environment in which health care is delivered and managed. Existing health service management and digital health competency frameworks need to be contemporary, contextual and aware of the increased complexity in the changing landscape to more accurately reflect these changing work priorities (Bouwman et al., 2024; Jarva et al., 2024; Khan et al., 2025). A recent study elucidated the organisational barriers confronting health service managers in the Australian public hospital sector in realising digital transformation benefits, noting that these barriers require system, organisational and local investments, assuring that benefits can be transformed into value within the healthcare environment (Brommeyer et al., 2024b). Addressing these barriers includes institutional investment in workforce digital capability development and individual health service management competency enhancement.

The current research

The current study focussed on identifying the additional requirements, responsibilities and competencies for managers working in the digital health context. The study was

situated in the Australian context, focusing on mid-level health service managers who have the operational responsibility to manage the overall provision of service in the public hospital setting. Acknowledging the increasing investment in digital health during and post the COVID-19 pandemic, particularly in the public healthcare environment (D'Anza and Pronovost, 2022; Sturgiss et al., 2022), there are important implications for healthcare management in the global context of digital transformation. Contextualisation of the findings against other territories and environments would require calibration with local priorities and prevailing jurisdictional settings. The study adopted the following definitions to conceptualise the key terminologies of the complex human behaviours required to enable digital healthcare to support the outcomes required from "multiple person-centred care requirements" (Brice and Almond, 2020: 1375) as applied to mid-level health service managers in the Australian context. Competency is seen as "The observable ability of a person, integrating knowledge, skills and attitudes in their performance of tasks" (Mills et al., 2020: 12). Capability can be considered as a broader concept that describes the ability to use transferable skills in both new and familiar situations (Brunner et al., 2018; Rimpiläinen, 2024). Responsibilities are conceptualised as the obligation or duty to ensure that particular tasks are performed to achieve specific results (McGrath and Whitty, 2018). Roles are viewed as "A category that characterises certain groups of activities . . . that serve a common purpose . . . (and) determines scope of practice" (Mills et al., 2020: 12).

The aim of the study was to explore perceptions and experiences of middle-level health managers regarding changing responsibilities and competency requirements in the digitally transforming context, and to develop recommendations for how to support health service managers in demonstrating the required competencies for digital transformation. In addition, implications for the Health Information Manager (HIM) Professional Competency Standards version 4.0 (Health Information Management Association of Australia, 2023) were explored, with an aim to complement the existing literature by academics and researchers in the field of digital health by adding the lived experiences of middle-level managers who implement the digital health systems in real life practice on a daily basis. The article presents key findings from data collected from responses to three questions addressed at focus group discussions (FGDs):

- As a manager, what *skills and knowledge* do you feel you need to have to perform your management work?
- As a result of adopting digital technologies, have you noticed any *changes* in the skills and knowledge you require as a manager – what are they?
- In the last 5 years, as a result of introducing digital health into your organisation, have your *responsibilities increased*, as a manager?

Method

Six online FGDs were conducted, guided by the protocol detailed in Brommeyer et al. (2023a), each with an approximate duration of 90 minutes. Mid-level managers were recruited across Australian public hospitals. The discussions were digitally captured using the recording and transcription features of the Microsoft Teams videoconference call. The FGD participants' characteristics are detailed in Box 1.

Middle-level health service managers were selected as the focus of this study as they provide an important understanding of the knowledge and skills required in the implementation of digital health, as well as the link between strategic and operational decision-making with the day-to-day use of digital health. Demographic details collected included participant name, position title, name of organisation, and the Australian state or territory in which they work. As the number of FGD participants was small (44) and in a small and identifiable community, it was important to maintain anonymity and ensure participants could not be identified based on this sample size. Eligible participants were contacted directly via email to provide a formal invitation to participate in the FGD, which contained a copy of the Project Information Sheet and Consent Form. Each participant responded to the email invitation with confirmation of participation and consent to participate in the research project.

To avoid any participant terminology confusion, during the FGDs, the terms "skills" and "knowledge" were used instead of "competency." During the analysis, previously confirmed core competencies were used to group the identified skills and knowledge (ACHSM, 2022; Australasian Institute of Digital Health, 2022; Liang et al., 2018). Those that could not fit into the existing core competencies were itemised and grouped into new competency statements. Deductive data analysis was then undertaken against empirically validated and industry-based competency frameworks, including the 2022 ACHSM Master Health Service Management Competency Framework, the AHICF Second Edition, and the management competency assessment tool (ACHSM, 2022; Australasian Institute of Digital Health, 2022; Liang et al., 2018).

Braun et al (2019) reflective thematic analysis process guided the data coding and analysis. As previously detailed in a published protocol (Brommeyer et al., 2023a), the stages included: (i) familiarisation, (ii) generating codes, (iii) constructing themes, (iv) revising themes, (v) defining and (vi) producing the report. This refined the themes as meaning-based patterns in both explicit and conceptual ways, supporting the development of patterned meaning across the dataset (Braun et al., 2019). Transcripts of all FGDs were analysed using NVivo software (Lumivero, version 14). Thematic analysis was conducted iteratively, with data from the FGDs to inductively develop concepts, categories and themes. These initial themes were thematically coded in NVivo 14 software by the lead author, then compared and contrasted with the two co-investigators (ZL and MW) to search for coherence of the themes in addressing each research question. Analysis was undertaken to categorise competencies against current national

and international health service management and digital health competency frameworks (ACHSM, 2022; Australasian Institute of Digital Health, 2022; Liang et al., 2018). Braun et al (2019) six-phase, reflexive thematic analysis approach was used to distinguish, explore, organise and advance insight into themes and categories of the factors emerging (Braun et al., 2019).

Ethical considerations

This research received ethics approval from the James Cook University Human Research Ethics Committee on 20 October 2022 (approval H8877). Before commencing the FGDs, personal information, including participant name, position title, name of organisation and email address, was collected. However, participants' names were replaced with a code in the FGD transcript to maintain anonymity. Identifiable information was not included during data extraction and analysis. Participants did not receive any type of payment or compensation for their participation.

Results

Changed responsibilities as a result of introducing digital health into the organisation

Twenty-two broadened responsibilities were raised by FGD participants as a result of adopting digital technologies, which were grouped into six initial major themes: (i) accountability,

Box 1. Focus group discussion participant characteristics.

1. Location ^a	SA – 11 VIC – 8 NSW – 9 QLD – 11 WA – 2 TAS – 1 ACT – 2 NT – 0
2. Position functional areas	Clinical – 16 Corporate ^b – 11 Technical ^c – 9 Research – 2 Quality/risk – 1 Program – 5
3. Organisation	Metropolitan hospital – 11 Regional hospital – 3 Rural hospital – 1 Community hospital – 1 Regional support ^d – 28

^aLocation: South Australia (SA), Victoria (VIC), New South Wales (NSW), Queensland (QLD), Western Australia (WA), Tasmania (TAS), Australian Capital Territory (ACT), Northern Territory (NT).

^bCorporate: administration, finance, operations, planning, performance and support.

^cTechnical: infrastructure, electronic records – implementation and architecture, data management.

^dRegional support: role includes working across more than one public hospital.

(ii) confidentiality, (iii) decision-making, (iv) expectations, (v) governance, and (vi) staff training. These themes were then aggregated into four major themes, namely (i) governance and confidentiality, (ii) digital expectations, (iii) accountability and digital decision-making, and (iv) staff training. This reduction was necessary because there were insufficient data in some themes; some themes were actually subthemes of another, and the iterative process helped to identify a manageable and meaningful set of significant themes that were clearly distinct from each other and reflected clearly the key patterns and meanings from the data (Nowell et al., 2017). See Figure S1, online supplement.

Governance and confidentiality. Many of the FGD participants described how adopting digital technologies has increased their responsibilities for governance and confidentiality. This included balancing the need to access and share personal and organisational data, relying on the integrity of the data for collaborative problem-solving and assuring the confidentiality of the digital data. Additional digital governance responsibilities articulated by the participants reflected the juxtaposition between digital innovation, digital strategy and digital system integrity requirements. Participants also discussed the increasing need to support executive management's capability for digital health strategy and governance.

Digital expectations. Most FGD participants noted an increased requirement to be contactable 24/7 for both urgent and emergency situations, and to work out-of-hours on the "business-as-usual" operational matters such as catching up on routine emails and electronic communications, so as to keep up with day-to-day work requirements. These have caused constant interruptions to the home-life-work balance. Participants were also expected to engage in organisational digital technology workshops and meetings, and to be available, informed and digitally omniscient to represent multiple stakeholder views and technology requirements.

Several participants illustrated the increased responsibilities experienced with digital decision support that was often seen as not being fit-for-purpose, not supporting contextual decision-making, and increasing, not decreasing, the manager's responsibility for manually having to remember additional information. These participants also discussed the challenge of balancing the increased day-to-day tactical decision-making required from increased digital information availability, with the need to strategically innovate and operationally resource digital technology adoption. Participants discussed the growing expectations also being experienced with understanding the health and management information implications of increased access to digital technologies for patients, staff and the organisation. Participants noted that the more information that was available to the individuals and the organisation, the more communication and clarification obligations the managers experienced, particularly if they had a clinical background. Participants identified increased complexity in needing to balance the greater accountability expected of prioritising

digitally augmented business and clinical decisions with the organisational goals of technology innovation. In addition, participants discussed concerns regarding executive expectations of them to be able to implement digital technologies used in other hospitals, for example, and to support executive decision-making for innovation investments without an in-depth understanding of the digital landscape.

Accountability and digital decision-making. Many of the FGD participants perceived that a number of increased accountabilities were required, including having to balance conflicting organisational imperatives and priorities for ensuring the digital information available for decision-making (strategic and client levels) is contemporary, contextual and trusted. This demanding environment was often exacerbated by the increasing rapidity of decisions required, often with insufficient information. The urgency and reprioritisation of operational activities by external agents, including health department executives and government ministers, were highlighted by many of the participants as challenging to navigate, particularly when the constant need to embrace digital innovation is seen as a strategic imperative by the organisation and departmental executives.

Increased accountabilities were also discussed by some participants, who saw escalating amounts of digital information available and a growing concern about the quality of data used to make decisions and the accountability for such decisions. As FGD participants expressed, this sense-making of the data coming from digital systems was demonstrated in practice with the ability to clearly present this digital data in a format that can support both executives and clinicians in their decision-making. These participants discussed increased expectations of being a digital innovation expert to answer executive, strategic questions on-the-fly and the growing expectation that with every new digital technology comes increased performance expectations to manage resources, risks and outcomes. For example, one participant explained that when a new virtual care service was rolled out across an organisation, there were additional governance and accountability measures expected of the manager to ensure that the clinical benchmark of the 30-minute timeframe to service was achieved. The sense that with every new technology comes a new personal health manager's performance measure was verbalised, as well as the growing number of digital health performance measures that managers increasingly need to manage on a day-to-day basis.

Staff training. Increasing responsibilities for staff training were explained by the FGD participants, including supporting skills and knowledge acquisition for team members in being able to use the available digital tools in real time. Participants also discussed how they are now experiencing an increased responsibility for educating staff about proper governance arrangements for all digital assets used, as well as feeling an obligation to mentor executive management about digital health capabilities. This is in addition to the increased need for managers to train staff in real-time

reporting and developing digital dashboards for executive reports.

Changes in the skills and knowledge required to perform health service management work in a digital health context

When FGD participants were asked about the *changes* in the skills and knowledge they required to perform their healthcare management work as a result of adopting digital technologies, eight initial themes emerged. These were (i) change management, (ii) data management, (iii) educating staff, (iv) governance, (v) negotiating, (vi) security, (vii) system knowledge, and (viii) vendor management. These initial themes were then aggregated into six major themes, including (i) applying digital system knowledge, (ii) data management, (iii) change management, (iv) supporting digital development, (v) vendor management and negotiating, and (vi) governance and security. This distillation into a few themes addressed the need for more coherence and adequacy of data. Under each of the six themes, between three to six changing capabilities were identified through iterative coding. (See Figure S2, online supplement).

Applying digital system knowledge. As a result of adopting digital technologies, knowledge of the various health system workforce requirements for digital data, technology and literacy was highlighted as an additional skill that is increasingly required by many of the FGD participants. As the participants explained, they are often the “go to” person to support the various healthcare professionals in their workplace being able to access, use and manage the digital tools available, particularly where timely clinical and management decision-making is needed. A few participants acknowledged that the digital governance of these systems is not always clearly delineated, particularly when using multiple systems from different vendors to provide integrated information required for business and clinical decision-making. For example, which system is seen as the source of truth in the fast-paced, dynamic healthcare environment?

Data management. Data management was highlighted as an enhanced skill by many FGD participants. This included driving and supporting the need for a common language and an understanding of transdisciplinary data requirements across the organisation. Importantly, the accuracy, provenance and reliability of the data were discussed by some of the participants. The ability to contextualise the data to explain the meaning of the aggregated information, made visible in performance indicators and dashboards, was emphasised as part of this discussion. Several participants observed that an increasing breadth of data literacy is required to manage effectively, with evidence-informed decision-making being predicated on access to timely and accurate digital data. A few participants observed that managing healthcare performance also requires dealing with additional ambiguity when using multiple datasets from

various digital systems that may not have standard data definitions to populate performance dashboards.

Change management. As a result of adopting digital technologies, change management was highlighted as an enhanced skill requirement needed to lead and manage in the workplace by some of the FGD participants, particularly across different staff with digital literacy levels, to provide additional support through the digital changes occurring in the workplace. As the FGD participants described, there was a consistent message that change management was broader in scope than before and that this entailed the integrated application of change, project, stakeholder, and risk management in the digital health setting, which was required to support digital transformation across multiple digital projects.

Supporting digital development. Increased skills and knowledge are required to educate staff, which was emphasised by a few of the FGD participants, including the changing role requirements of the various practitioners operating in the digitally transformed workplaces. Seen as the “go to” person, the participants also illustrated the increasing need to support staff with digital and data literacy education across the multidisciplinary team. These participants further discussed the need to lead and support a standard digital vocabulary across the workforce to facilitate a shared understanding.

Vendor management and negotiating. The adoption of digital technologies also required additional skills for vendor management and negotiating in the technology field. This was elaborated by a number of FGD participants in describing the need for self-sufficiency in supporting local digital solutions to meet the information requirements for rapid, data-informed decision-making. The importance of being able to negotiate with digital technology vendors and acknowledging the need for a heightened awareness of contract management in the digital environment was also expressed by these participants. The increased complexity of technology, terminology and timeframes for digital health procurement included an additional understanding of the commercial nuances required across the digital system development lifecycle.

Governance and security. Increased knowledge and skills supporting digital governance and security are essential, as was brought to light by some of the FGD participants. As the FGD participants expressed, there was a recurring message that digital security was now broader in scope for two major reasons. The rising number and impact of health-related cybersecurity breaches (Argyridou et al., 2023; Salama et al., 2024), along with the unwanted and increased media scrutiny, posed a deeper concern to the participants. These omnipresent cybersecurity threats are additionally amplified due to the electronic personal health information privacy, security and governance requirements. One of the major issues recounted by a few of the participants was the

need for individuals to have heightened awareness of cyber-hygiene, and that cybersecurity is everyone's business.

Contextual skills and knowledge required to perform health service management work

When FGD participants were asked about the skills and knowledge they needed to perform their healthcare management work in the digital health context, 23 key skills and knowledge domains were identified. Nine initial codes emerged from the FGD participants' responses, these were (i) agility, (ii) change management, (iii) common language, (iv) data management, (v) decision-making, (vi) governance, (vii) project management, (viii) risk management, and (ix) system capability. To address the need for more coherence and inadequacy of data in some themes, these initial themes were then aggregated into five major themes, namely (i) change project and risk management, (ii) contextualising digital system functionality, (iii) data management, (iv) governance and decision-making, and (v) digital agility and shared digital language. Under each of the five major themes, three to six key skills and knowledge characteristics were categorised through iterative coding. Key skills and knowledge characteristics under each of the themes are outlined in Figure S3, online supplement.

Change, project and risk management. Change, project and risk management were highlighted as significant requirements by some of the FGD participants. They discussed the need for applied knowledge of related digital capability frameworks and maturity models required to manage the digital ecosystem in the workplace. Knowledge of organisational data provenance was underscored by these participants when describing the need to have sound knowledge in the application of digital governance to manage business and clinical risk.

Contextualising digital system functionality. Contextualising digital system functionality was highlighted by most of the FGD participants as an essential skill increasingly required to manage in the workplace. Many of the participants reinforced the business and technical knowledge required, including a necessary understanding of the link between decision support and digital knowledge.

Data management. Most of the FGD participants highlighted that the skills and knowledge required for data management were increasingly needed. Discussions with the participants explored the complementary roles necessary to manage a discipline-based workforce, supported by the broad ability to position data in context. Many of the participants emphasised this discussion by describing the data definitions needed to ensure data quality to support decision-making, further illuminating the importance of data literacy skills. In ensuring the consistency and accuracy of data used to inform contextual decision-making, some of the participants again observed that foundational knowledge of data provenance is essential, not only from a risk management perspective (as mentioned in *Change, project and risk management*, above) but also for system-generated

decision support surety, and increasing information quality for improved patient and operational safety (Fadahunsi et al., 2021).

Governance and decision-making. Accountabilities required in the current health service management context necessitate a heightened awareness of governance and decision-making, particularly when it comes to improving the safety and surety of digital decision-making in the workplace. There was also the expressed need to bridge the divide between business, clinical and technical domains, with digital knowledge and technical dexterity to support real-time decision-making based on the various digitally generated information. The ability to support key stakeholders in digitally applying organisational knowledge was also discussed by several participants as an important skill needed in the healthcare manager's toolkit, to assist in strategically influencing corporate digital decision-making.

Digital agility and shared digital language. Some FGD participants emphasised a manager's adaptive ability and digital agility as a required capability. With the rapid pace of digital transformation, disruption to existing work practices requires managers who can demonstrate agility in adapting to these emerging challenges and opportunities for sustainable health care in the digital age. These participants discussed the strategic link between data quality to supporting business and clinical decision-making, and using the proper digital tools to provide accurate management information. Acknowledging the strength in diversity of multidisciplinary teams, a few of the participants also recognised the importance of having an operational understanding of various healthcare roles across the organisation, and the need to champion a standard, shared digital language.

Competency requirements for health service managers working in the digital context

Previously confirmed core competencies were used in this study to group the identified skills and knowledge, from both the changing and contextual skills and knowledge required, to perform health service management work in a digital workplace (ACHSM, 2022; Australasian Institute of Digital Health, 2022; Liang et al., 2018). Those that could not fit into the existing core competencies were itemised and grouped into new competency statements. Table 1 categorises the competencies identified with their associated competency statements developed from the study findings, for health service managers working in the Australian public hospital context.

Discussion

Changing competency requirements for health service managers working in the digital context

The findings of this study indicate that the digital competencies managers need require demonstration of much broader competence across eight identified competencies (Table 1).

Table 1. Digital competencies for health service managers.

Digital competency	Competency statements	Existing or enhanced skills
1. Applying digital system knowledge	a. Ability to support various healthcare professionals in their workplace to access, use and manage digital tools available	Existing
	b. Understanding of different healthcare professionals' digital literacy, data and technology requirements	Enhanced
	c. Supporting executive reporting, with the surety, analysis and interpretation of organisational data	Existing
	d. Capability in aligning corporate, clinical and digital governance, in context	Enhanced
2. Data management	a. Understanding the accuracy, provenance, surety and reliability of digital health data, in context	Enhanced
	b. Ability to digitally turn data into information for business and clinical insights	Existing
	c. Applying a common language to support the multidisciplinary workforce's digital health data needs	Existing
	d. Supporting the healthcare workforce with data literacy to enhance the value of data-informed insights	Enhanced
3. Change, project and risk management	a. Skills in leading digital health change with integrated project, change, stakeholder and risk management for digital transformation across multiple digital projects	Enhanced
	b. Proficiency in supporting the digital transition of evidence into healthcare practice	Enhanced
	c. Ability to apply digital governance in managing business and clinical risk	Enhanced
	d. Capability to manage digital health data breaches and litigation risk challenges	Enhanced
4. Supporting digital development	a. Applying a digital capability framework to manage the application of digital health in the workplace	Existing
	b. Supporting the workforce to safely access, use and manage digital health tools in the workplace	Existing
	c. Capability to contextualise the language of transformation and digital health technology disruption for the workforce	Enhanced
	d. Supporting the workforce in assessing the validity, integrity and relevance of digital health data in relation to their work	Existing
5. Vendor management and negotiating	a. Understanding of technical self-sufficiency in supporting local digital solutions and understanding own limitations	Enhanced
	b. Capabilities in stakeholder management to support digital data-informed healthcare decision-making	Existing
	c. Enhanced skills in digital health technology lifecycle contract management	Enhanced
	d. Ability to represent local healthcare context and needs when negotiating with digital technology vendors	Enhanced
6. Governance, security and decision-making	a. Applying cyber-hygiene practices and organisational cybersecurity measures in the healthcare setting	Existing
	b. Addressing healthcare data security and digital privacy requirements	Existing
	c. Contemporary knowledge of data custodianship and digital stewardship, for governance of digital health systems	Enhanced
	d. Supporting appropriate digital access for clinical, business and secondary uses, including managing digital downtime and business continuity planning	Enhanced
7. Contextualising digital system functionality	a. Employs appropriate digital technologies and methodologies to make data-driven decisions and solve problems	Existing
	b. Ability to integrate digital health tools to improve the effectiveness and efficiency of own work	Existing
	c. Knowledge needed to apply healthcare business and clinical decision support	Enhanced
	d. Maintaining contemporary knowledge in applying new tools, latest technologies and best practices in the digital health environment	Existing
8. Digital agility and shared digital language	a. Understanding of the strategic link between digital health technology and management information	Existing
	b. Ability to link data provenance and data quality, in support of business and clinical decision-making using a shared digital language	Existing
	c. Enhanced capabilities in leadership, agility and influence to link healthcare organisational governance and digital integration	Enhanced

It should be emphasised that the purpose of the AHICF is to define competencies required for healthcare workers more generally to specialise as health informaticians (Brommeyer

et al., 2024a); hence, it is important that this study identifies the required competencies for health service managers working in the digital health context. Our findings are also

relevant to HIMs who take on leadership and operational management roles in healthcare organisations, which require them to possess competencies not only relevant to their own profession but also as health service managers. While a number of these eight identified competencies are reflective of health service management and digital competencies more generally (Laakkonen et al., 2024), the unique attributes identified in this study highlight and underscore the importance of enhancing digital competencies for health service managers. Therefore, refinement of these manager skills and knowledge domains, under each of the existing competencies, is required for health service managers to lead and manage in the digital health context. The unique attributes identified can augment existing competency frameworks to ensure they remain contemporary and comprehensive, reflective of the dynamic digital environment in which health care is managed and delivered. The recent and rapid adoption of generative artificial intelligence at scale in the health sector further highlights the dynamic nature of the work of health service managers and the need for competency frameworks to be amended as work practices change and evolve.

The results of this study point to two main areas of management competency enhancement required. First, competence in digital data management and security, and second, the management of digital technologies in practice. These findings indicate that institutional management competency frameworks may need to be upgraded, and continuous professional development may need to be provided within the institutional or accreditation authorities to managers and the healthcare provider users of digitally enhanced information systems. Implications for HIMs have been included in relevant sections, in relation to the HIM Professional Competency Standards version 4.0 (Health Information Management Association of Australia, 2023). Consequently, the following elements need to be considered to empirically enhance existing competency frameworks.

Digital data management and data security. Managing information in health care is fundamentally important in supporting practitioners to achieve the required clinical and business outcomes. Personal health information, which is a highly valuable resource requiring security and sensitivity, is created, captured, communicated and considered across provider disciplines and service locations (ACHSM, 2022; Australasian Institute of Digital Health, 2022; Chidambaram et al., 2024; Pool et al., 2024; Woods et al., 2023). Participants in this study highlighted the complementary roles that are required to be able to work with a multidisciplinary workforce, including the ability to position digital data in context for different members of the team. The accuracy, provenance and reliability of the data, along with the ability to contextualise the data to explain meaning, particularly when using performance indicators and dashboards, were identified as important skills to possess in the digital health environment. This has potential implications for HIM competencies, including *data quality*.

In health service management, data-led decision-making is one of the critical contributors to effective and efficient management and supports the provision of safe, quality care (Enticott et al., 2021; Pool et al., 2024; Travaglia and Debono, 2023; Woods et al., 2023). In the digital environment, this decision-making ability is transformed by the veracity and volume of digital data used and the surety required in practice to deliver quality data, which is predicated on managers' digital health literacy and awareness of advances in digital health technologies (Brommeyer et al., 2023b; Stoumpos et al., 2023; World Health Organization, 2023). As this study highlighted, public hospital managers need influence and agility to support digital integration and governance across multiple digital systems and technologies, while ensuring that digital governance principles are promoted and applied locally. This will assist in improving the accuracy, provenance and reliability of the data being used to support data-led decision-making. Potential implications for HIM competencies include the *use and impact of technology and health project management*.

The language of health care is complex and presents communication and interpretation challenges for patients and practitioners alike (Arias López et al., 2023; Ghorbanian Zolbin et al., 2022; Kim et al., 2023; Wang et al., 2022). A shared digital language is vital in the digital health workplace and is recognised as an important instrument in supporting the sharing of digital transformation knowledge across organisations (Cresswell et al., 2021; Kaihlanen et al., 2022; Srivastava et al., 2023). This study reiterated this need, underpinned by an operational understanding of various healthcare roles across the organisation. As others have noted (Duvivier and Gupta, 2023; Mainz et al., 2024; World Bank, 2023), managers will have to "champion" the need for and use of standard data definitions, which are supported by appropriate data provenance for effective decision-making. This has potential implications for HIM competencies, including *health information system and technology terms and concepts*.

As this study elucidated, managers found that the ability to demonstrate digital system knowledge included the technical knowledge of how the system works in practice, operational knowledge of business and clinical needs for digitally enabled decision-making, and strategic knowledge of digital governance was important. The implications for managers include developing additional knowledge in the data, technology and strategic domains. Further, there was a need to support local and executive system users in harnessing the power of digitally enabled clinical and business decision-making in a safe and efficient manner. Potential implications for HIM competencies include *health business operations*.

Our results also identified that increased skills and knowledge in supporting digital governance and security are essential. Healthcare service delivery is premised on the availability of information, when and where it is needed, to make effective business and clinical decisions (Petrakaki et al., 2025). The surety of this digital information is also premised on managers' knowledge of data custodianship and the digital stewardship required with digital systems.

This study found that data custodianship is important in ensuring the responsibility for managing and approving the use of specific data in the digital environment, which is overseen by a senior responsible officer who understands the legislative and data privacy obligations. Further, managers' awareness of digital stewardship is critical to safely acquiring, managing, organising, protecting and granting appropriate access to digital information in health care. Stewardship is increasingly being seen as a governance requirement in the digital world (Kolawole et al., 2025; Sama et al., 2022), with the importance of stewardship protocols being posited in mitigating against the misuse of digital healthcare data, which can result in potential harm. These stewardship protocols establish safeguards against the incorrect use of digital data and unintended consequences (Abernethy et al., 2022; Bartlett, 2025). Implications for health service managers include developing increased skills and enhanced knowledge in data stewardship in the digital environment. This has potential implications for HIM competencies, including *health business operations*.

Managing digital technologies in practice. There is a range of associated challenges that must be concomitantly addressed during digital transformation, including supporting workplace change for practitioner and consumer access to personal digital health records and online communication, as evidenced in this study. This challenge is also manifested when presented with digital data of unknown integrity, quality and provenance, from which just-in-time business and clinical decisions are routinely made. Digital information improves communication between patients and practitioners, which supports shared decision-making that can reduce the risk of suboptimal patient outcomes (Song et al., 2025). The enhanced patient engagement seen with access to personal digital health records was also associated with improved health outcomes and greater patient and provider satisfaction (Alomar et al., 2024). Considerations for health service managers include increasing knowledge of consumer digital access requirements and the skills required in supporting patients to securely access personal health information. Implications for HIM competencies include *health information systems and informatics*, and *health business operations*.

Supporting the digital transition of evidence-into-practice is becoming increasingly important as a managerial competency required in the digital age (Cross and Adler-Milstein, 2022; Knight, 2025). Being able to effect integration and the usage of evidence-informed clinical guidelines and protocols in the workplace is crucial to delivering quality, safe care using digital health systems. This study highlighted the need for health service managers to develop knowledge translation skills in the digital health context to assist in evidence contextualisation (Khatri et al., 2025). Developing these skills has been shown to benefit workflow efficiencies and improve patient outcomes (Campione et al., 2025).

Findings from this study demonstrated the need for health service managers to have an expanded awareness of governance and decision-making, particularly to improve

the safety and surety of decision-making in the workplace. This spanned the need to bridge the divide between the business, clinical and technical domains with digital knowledge and dexterity, to supporting governance over the digital health systems. Compliance needs to be evidenced in the way data are digitally captured, stored and shared. How data are then digitally aggregated to translate into information for informed decision-making (Butler-Henderson et al., 2020) is an essential skill for managers to support healthcare practitioners. Further, the increased need to effectively employ and support the use of data analytics in the digital health context is an important skill to develop in the digital age (Pang et al., 2023). This has potential implications for HIM competencies, including *health business operations*.

To be successful in adopting digital technologies, health service managers recognise that additional skills are required for vendor management and negotiating. This is reflected in this study when participants described the need for self-sufficiency in supporting local digital solutions to meet the information needs of business and clinical decision-making. As explicated in this study, being able to manage technology contracts and negotiate with digital technology vendors is a specific skill set required by managers. A manager's ability to accurately represent organisational business and operational requirements in digital system design and delivery is becoming increasingly relevant in navigating the rapidly changing digital healthcare environment (He et al., 2023). Potential implications for HIM competencies include *health information systems and informatics*.

Developing the health service management workforce in the digital health context

The participants confirmed that there are increased responsibilities, skills and knowledge needed for contemporary practice that require systemic changes across policy and regulation, organisational, governance, technical, commercial and people factors. As previously reported, investments are required to facilitate these changes (Brommeyer et al., 2024b). The implications include supporting workplace change for practitioner and consumer access to personal digital health records and online communication. In addition, being able to effect integration and usage of evidence-informed clinical guidelines and protocols in the workplace is crucial to delivering quality, safe care using digital health systems. As health care is traversing digital transformation with the associated decentralisation of data, there is an increasing expectation of the public, patients, consumers and carers to be able to access personal health information (Hendl and Shukla, 2024; Saelaert et al., 2023; Topp et al., 2023). The implications are profound, as is the importance of exposing the value residing in the data while ensuring the necessary levels of governance and control remain (Williams et al., 2024). This has potential implications for HIM competencies including *health business operations*.

The study findings also revealed the importance of increased skills and knowledge needed in digital decision

support. An important component of health service and health information management is managing key stakeholders, including the organisation's executive (Butler-Henderson et al., 2021; Haller and Reynolds, 2025; Recendes et al., 2024). In the digital world, this now includes the ability to demonstrate the central role of digital health in supporting real-time strategic, operational and tactical decision-making (Alhashmi, 2025; Katapally and Ibrahim, 2023). Implications for health service managers include developing digitally enabled problem-solving prowess and the demonstration of this performance in practice. The potential implications for HIM competencies would include *health information systems and informatics*, and *health business operations*.

As evidence-informed decision-making is predicated on access to timely and accurate data, this is an increasingly required skill set for health service managers. Being innovative, digitally dextrous and agile are necessities required during times of transformation to promote knowledge sharing and experimenting, rewarding consumer-focussed innovation and demonstrating flexibility, resilience and determination to change (Muduli and Choudhury, 2024; Quinhões et al., 2024). As this study revealed, the need to demonstrate digital agility, as well as influencing and understanding the importance of a shared digital language in the transforming landscape, is indispensable (Borges do Nascimento et al., 2023a; Longhini et al., 2022; Ruh, 2025).

At an organisational level, there needs to be alignment between corporate, clinical and information governance to ensure that digital health investment reinforces the strategic value being sought. Corporate and clinical governance in the digital world must also be underpinned by, and increasingly dependent on, the integrity and surety of electronic data and digital assets availability (Hanisch et al., 2023; Mehanoor and Ahmed, 2024; Zarour et al., 2021). Acknowledging the strategic importance of, and the associated investment required in, digital health governance is increasingly needed to drive organisational and service delivery value (Saheb and Saheb, 2024; Thatcher, 2024; Zhang et al., 2025). Implications include being able to provide public assurance of effective governance for sustainable healthcare management in the digital environment. Potential implications for HIM competencies include *healthcare financial and resource management*.

In the digital world in which we now work, practitioners are witnessing enhanced digital expectations of anywhere, anytime information availability (Petrakaki et al., 2025; Alves et al., 2024; Györfy et al., 2023). Health service managers have a responsibility for managing resources and risk, which includes the contemporary need to ensure that information and digital health technologies are available to support the delivery of healthcare across 24/7 operations (Alawiye, 2024; Abernethy et al., 2022; Osipov and Skryl, 2021). Study findings emphasise the increasing responsibility health service managers have for ensuring the workforce is capable of managing information and service provision in the event of a disruption to digital health services and data availability. The resultant organisational

capabilities for digital continuity, as found in this study, incorporate the need to manage digital downtime and the business continuity planning necessary for digital governance. Implications include empowering the workforce across business continuity planning and management of digital downtime in practice.

At an individual level, health service managers need short-term training opportunities to enhance their skills and knowledge in managing digital technology contracts and negotiating with technology vendors. Study findings highlighted the increasing need for managers to navigate the digital health vendor landscape and the commercial nuances required in representing the local healthcare context and needs when negotiating contracts and performance expectations. This includes the enhanced skills needed in digital health technology lifecycle contract management. The implications are far reaching and require investments in enhancing knowledge in collaborative innovation and shared value, negotiating skills and the ability to realise contract accountability across the digital health technology lifecycle (Avinash and Joseph, 2024; Callens and Hans Klijn, 2024; Smith et al., 2024). This has potential implications for HIM competencies, including *human resource management strategies*.

Limitations and future research opportunities

There are some limitations associated with this research. FGD participants may have had a particular motivation to contribute specific insights into the study, which could have generated bias. As this research was undertaken throughout and shortly after the global COVID-19 pandemic, any future research could focus on the continuing impact of managing digital health in the rapidly changing, dynamic technology environment. This will necessarily include addressing the rapid uptake of various clinical and corporate artificial intelligence tools, which will require human intelligence oversight to ensure appropriate governance, ethical decision-making and implementation guardrails are instigated to equitably manage the safe and effective use of artificial intelligence in healthcare. Future research could also consider how the evolving nature of health service managers' competencies will continue to unfold to support digital transformation in this rapidly innovating environment.

Conclusion

With increasing complexity in the digital workplace, this study confirmed the changing responsibilities and competencies that health service managers need to exhibit, along with the need to acquire additional skills and knowledge to complement existing competencies developed, based on six FGDs held in 2023. Findings revealed two key areas of management competency enhancement required: firstly, competence in digital data management and security; and secondly, the management of digital technologies in practice. These findings yield important insights for health service managers to demonstrate and develop skills and knowledge differently in a digitally transforming health

context. Recognising organisational capacity, health service workforce capability and individual health service manager digital health competencies as synergistic necessities was established. This research contributes to the corpus and health service, digital and information management prevailing practice environment by elucidating the enhanced competencies required to effectively manage in the Australian digital health context, which can guide professional credentialing, industry certification and competency framework validation activities. This requires system, organisational and local support, including institutional investment in workforce digital capability development and individual health service management competency enhancement.

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Supplemental material

Supplemental material for this article is available online.

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Figure S1: Increased responsibilities required as a result of adopting digital technologies by major theme, identified by the focus groups

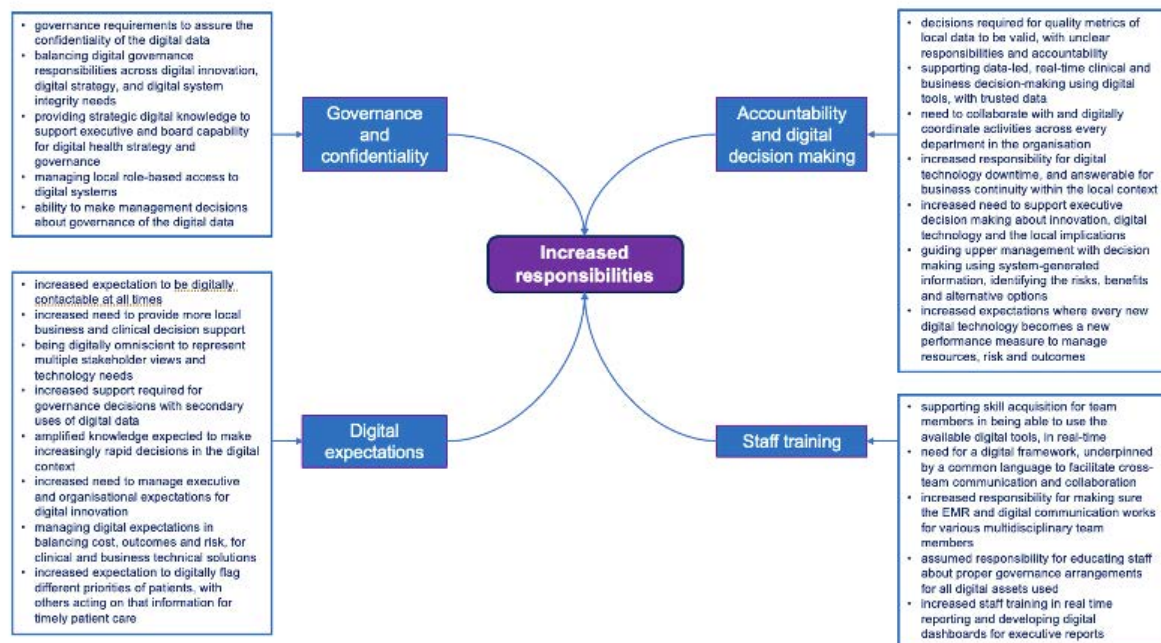


Figure S2: Enhanced competencies required as a result of adopting digital technologies by major theme, identified by the focus groups

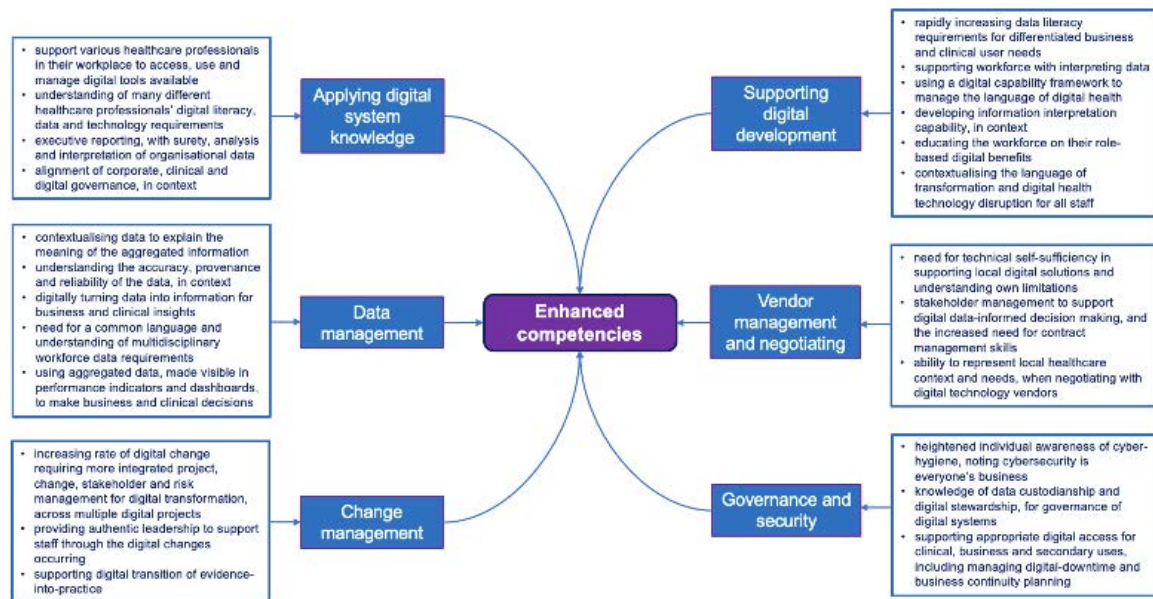
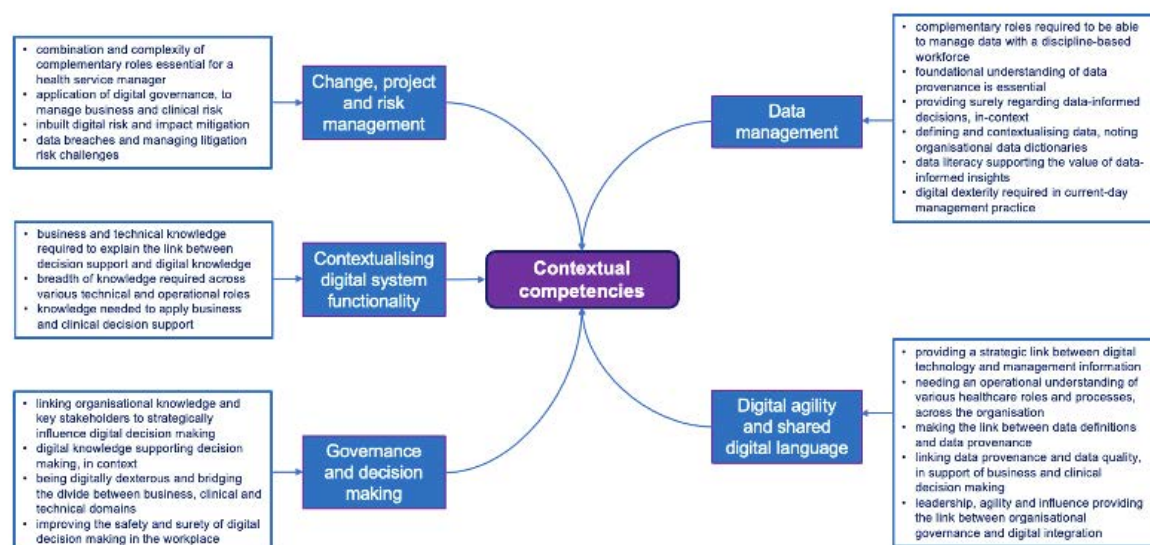


Figure S3: Contextual competencies required to perform health service management role by major theme, identified by the focus groups



6.3 Results

6.3.1 *What are the competencies, (existing and enhanced) that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context?*

Health service managers require competencies in both health service management and digital health. Existing industry-based competency frameworks that guide practice in Australia are the Australasian College of Health Service Management Master Health Service Management Competency Framework (Australasian College of Health Service Management, 2022) and the Australian Health Informatics Competency Framework (AHICF) (Australasian Institute of Digital Health, 2022). In addressing the study's question of the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context, the changing responsibilities seen by health service managers as a result of adopting digital health were explored with the focus group participants. The competencies required to lead and manage in the digital health context were also illuminated, informing the resultant healthcare implications at a system, organisation, team and individual level.

6.3.2 *Changed responsibilities as a result of introducing digital health into the organisation*

When focus group participants were asked about any increased *responsibilities* seen as a manager as a result of the health care organisation in which they work adopting digital technologies, the participants described 22 responsibilities. The six initial codes that emerged from the focus group participants' responses were (1) accountability, (2) confidentiality, (3) decision making, (4) expectations, (5) governance, and (6) staff training.

These initial themes were then aggregated into four major themes: (1) governance and confidentiality, (2) expectations, (3) accountability and digital decision making, and (4) staff training. Under each of the four major themes, increased responsibilities were identified through iterative coding.

6.3.2.1 Elaboration on the four key themes

6.3.2.1.1 *Governance and confidentiality*

Many of the focus group participants described how, as a result of adopting digital technologies in the health service management context, there are increasing responsibilities for governance and confidentiality. This included balancing the need to access and share personal and organisational data, being able to rely on the integrity of the data for collaborative problem-solving, and the governance

requirements to assure the confidentiality of the digital data. Illustrative of this was one manager's comment:

"We are dealing in confidence, and I will say that yes, the incidence of where we see, and I won't even say inadvertent, but the sharing of sensitive confidential information under the guise sometimes of being an emergency or something, but it is confidential and most of the people there on a list, it comes out to our whole section. And reportedly, only those people who were actually dealing with those issues were to open the e-mail and look at it. So, it's a significant risk and not pertinent in the sense that it could have been managed better but in the interest of time, someone made a decision to do that, and we have to watch that." (FGD6-P4).

Additional digital governance responsibilities articulated by the participants reflected the juxtaposition between digital innovation, digital strategy and digital system integrity requirements, as one manager said:

"I think it's a really interesting question that you've posed around change and responsibility, we're really talking about having to take on a more strategic perspective, which to me feels a bit like it's a deficit that's sitting in those higher levels, of actually understanding digital and digital engagement, which is driving the additional responsibilities to a level where they wouldn't normally sit now. Hopefully, what you'd see now in a maturing system is that the knowledge at the executive level would increase and that responsibility would then shift back up." (FGD5-P6).

These participants discussed the increasing need to support executive and board capability for digital health strategy and governance, as explained by one manager:

"Managing governance and ensuring our stakeholders understand their responsibilities is a little bit similar around sponsors and SMEs (Subject Matter Experts); like an executive sponsor for example. (The executive sponsor) ... is going to have to sign off on 10 documents, probably in the life of the project. We're going to need you to probably be the chair of our steering committee. So that's quite a big impost for all those people. Understanding policies and standards, that's just government kind of stuff, and being able to articulate these is essential. We need to do personal information. That's just stock standard. We can't bypass those, but we need to share our messaging with the business saying – you don't need to worry about that. We do that. We'll do that for you. So just really managing all those parties is the big skill, I think." (FGD5-P3).

Participants also discussed the operational abilities required to make management decisions about the governance of the digital data, as well as the tactical need to manage local role-based access to digital systems. When talking about digital system access, as one participant described:

"So, we've got with the Productivity Commission, they did a piece around that a couple years ago and the department developed a process called a research affiliate role. And so that does provide them access. The thing is they need consent from people to access their records, and that is

auditable, so you know user interaction with patients in the electronic medical record is tracked and that needs to correlate with a list of consented members of the public. From that perspective, it's a lot stronger than a random paper record hanging around being caught up to someone's office." (FGD1-P5).

6.3.2.1.2 Digital expectations

A variety of increased expectations were seen by various stakeholders in the hospital organisation of what business as usual is for their managers in the digital workplace. Most of the focus group participants noted an increased requirement to be contactable 24/7 to not just manage urgent and emergency situations but also business-as-usual operations out-of-hours. Perceptions expressed by participants included the constant interruption to home-life- work balance when you are 'constantly on'. Typically, one participant said:

"I think you become more accessible with technology, as well and you don't get that ability to be able to switch off because you do get your messages after hours, or people expect you to be available at certain times. So, you're not having that complete switch off from your work. So, there's more pressure on you; you're accessible wherever you go. You know, if you're at home, you're sick or whatever, and you're at home you've got an ability to access Zoom and attend meetings." (FGD3-P1).

These perceived increased expectations were further detailed by participants when identifying the need for engagement in various organisational digital technology workshops and meetings and to be available, informed and digitally omniscient to represent multiple stakeholder views and technology requirements. This expectation was reflected upon by one of the participants:

"So, I think that's the other sort of increased responsibility, and the other thing is just the increased responsibility as a manager. You're often the people that are called on when informatics is trying to be informed and planned. Particularly if your role is one that works across the organisation, it just increases responsibilities around workshops for planning for new technologies that are being implemented, and how they're going to be the best fit. Obviously, managers are people who are often at those workshops, so there's a lot of workshops, particularly when there's a tender process and there's a lot of work in a short space of time, that's just considered to be business as usual, just something to fit in." (FGD3-P4).

The participants described the increased responsibilities experienced with digital decision support, the rising need for strategic governance, operational resourcing, and increasingly rapid tactical decision making that is now being seen in the digital health context. There was an increased complexity discussed in needing to balance the greater accountability expected for prioritising digitally-augmented business and clinical decisions, with the organisational goals of technology innovation.

6.3.2.1.3 *Accountability and digital decision making*

Many of the focus group participants perceived that an increased scope of accountability was now being required by managers in the hospital organisation to lead and manage in the digital workplace. This included the digital discord being seen with conflicting imperatives and priorities for ensuring the information available for decision making is contemporary, contextual and trusted. The urgency and reprioritisation of activities by external agents, including health department executives and government ministers, was described by a few participants as a challenging governance environment to navigate, particularly when the constant need for embracing digital innovation is seen as a strategic imperative. The increased accountability and performance expectations of managers in the digital environment were illustrated in this typical comment:

“So, what does this look at where the coordination and where the clinical care is required, and then transfers the accountability back to the manager on the frontline saying now you've got to do these three things for that patient, make sure they're planned and coordinated, make sure you've got the human resources to match the transfers. Make sure that you get it done on time. Enter it into the data system and we'll just sit back and take it from there. Thank you very much. More accountability for me.” (FGD4-P7).

Furthermore, with the increased digital visibility across healthcare organisations, several participants expressed their concern at being able to both strategically plan for required resources in the long-term, as well as being accountable to resource the day-to-day, operational needs. This concern was expressed by one manager:

“The thing that's missing here is that traditional role as a manager sitting there, marshalling the resources and thinking more in the sort of medium term and long term, and doing and thinking about strategically where is the hospital going? Then there's getting bogged down in the day-to-day operations because you're now more accountable than you have ever been and people have visibility over things that you're supposedly responsible for. It makes it really, really hard to do what their proper job is.” (FGD4-P1).

Increased accountabilities were also discussed by a few of the participants who now need to decide the quality metrics for local data to be valid, with unclear responsibilities and lines of accountability for the integrity of digital data from which decisions are made. Furthermore, participants were concerned about the greater expectations of collaborating with and digitally coordinating activities across every department in the health service. With increasing use of the early digital warning signs system for clinical decision making in the hospital setting, participants described the expectation of enhanced accountability for meeting the associated service delivery and clinical performance targets with, while being able to hold

other local service delivery stakeholders accountable for their role in meeting these targets. This was described by one participant:

“It's a sense of who's responsible for the data entry, because either the clinician who's entering it in the systems, or people that are setting it up. But it's sort of almost seems to fall into an operational space now that it is somehow my responsibility because, generally, I'm the one with the numbers, be they clinical or financial. But it's like it's this responsibility for it. But in fact, nobody's actually said you're responsible for it or you got the power to fix it.” (FGD1-P3).

In addition, some of the participants described an increased responsibility being felt for digital technology downtime in their organisational context, for example, the EMR being offline, and being answerable for business continuity to executives within the local context. Some of the participants discussed increased expectations of being a digital innovation expert to answer executive, strategic questions on the fly and the growing expectation that every new digital technology becomes a new performance measure for the health service manager to manage resources, risk and outcomes. As one manager emphasised:

“Recently, the tele-stroke service has been rolled out ... All of a sudden, I have governance and accountability for ensuring that the clinical benchmark of the 30 minute mark is achieved. So, every new technology becomes my new performance measure. So, if we don't hit that performance measure for the person last month, I've got another measure that I need to actually manage in my day-to-day, and they just grow and grow.” (FGD4-P7).

Discussions about the increasing responsibilities for digital decision making centred around the need to support data-led, real-time business and clinical decision making using digital tools, with data of known provenance, available in the required context. Understanding of the additional digital decision-support responsibilities was enumerated by the participants, including the need to support the executives with decision making about digital technologies and associated workplace implications. As was detailed by one participant when explaining the implications of digital decision making:

“We're going to make a decision around the digital technology, so you need to frame that for them and give them some really clear information about the implications of those decisions.” (FGD2-P4).

A number of participants also discussed the additional responsibility now being felt in guiding upper management with decision making using system-generated information, identifying the associated risks, benefits and alternative options, as explained by one manager:

“But I actually put my hand up to talk to the point of the skills where you have to guide upper management on their decision, being able to present an ISBAR-type (a structured communication tool in healthcare: Identification, Situation, Background, Assessment, and Recommendation) approach on what is the issue, what’s led to it, to concisely state what are the risks associated with that, and to provide them with alternate options and the risks and benefits of each of those options. But to do it in almost a one-pager, because if it’s not small, they’re not going to read it. So being well informed about the implications of that but being able to present it as well.” (FGD2-P4).

6.3.2.1.4 Staff training

Increasing responsibilities for staff training were explained by the focus group participants, including supporting knowledge and skill acquisition for different end users in the local context, in being able to use the available digital tools, in real-time. These participants also described the need for a digital framework, underpinned by a common language to facilitate cross-team communication and collaboration. In describing the extra capability development and digital mentoring responsibilities being seen in practice, one of the participants observed:

“I think in building on what you said earlier around the title of this project, improving the digital health competencies for managers. I think that there’s a role for, a real need for a framework, or the ability for people to be speaking the same language, but also to enable people to help them feel competent. That notion of – I have worked through this module; I don’t need to be scared of this anymore.” (FGD3-P4).

Some of the participants also discussed how they are now experiencing an increased responsibility for educating staff about proper governance arrangements for all digital assets used, as well as feeling an obligation to mentor executive management about digital health capabilities. This is in addition to the increased need for managers to train staff in real-time reporting and developing digital dashboards for executive reports. As was illuminated by one participant:

“I think the additional responsibility of ensuring that the staff trainings are up to date, that they have access to the right information, and because as a performance unit we provide information, the reporting information that we work on those reports that go through to the ministry as well. It’s to ensure that we build the right dashboards that will allow the network to access this information in a way that’s helpful to them.” (FGD4-P5).

6.3.3 Changes in the skills and knowledge required to perform health service management work in a digital health context

Focus group participants were then asked to consider managing in the digital context and identify the management skills and knowledge they had seen emerge as a result. Eight main characteristics were discussed when focus group discussion participants were questioned about the changes in the skills and knowledge required to perform their

healthcare management work in adopting digital technologies. These were (1) change management, (2) data management, (3) educating staff, (4) governance, (5) negotiating, (6) security, (7) system knowledge, and (8) vendor management.

These initial themes were further aggregated into six major themes: (1) applying digital system knowledge, (2) data management, (3) change management, (4) supporting digital development, (5) vendor management and negotiating, and (6) governance and security. Under each of the six major themes, changing skills and knowledge characteristics were elaborated through iterative coding.

6.3.3.1 Elaboration on the six key themes

6.3.3.1.1 Applying digital system knowledge

As a result of adopting digital technologies, knowledge of different healthcare professionals' digital literacy, data, and technology requirements was highlighted as an additional skill that is increasingly required by many of the participants. As the participants explained, they are often the 'go to' person to support the various healthcare professionals in their workplace in being able to access, use, and manage the digital tools available. This was reflected by one of the participants who explained that:

"Keeping up to date with the technology itself and being able to interpret that on the ground level. So, I've become a resource person for everything and have to be more up to date or more technical because as they encounter some sort of question you interpret, and you help them navigate that kind of technology. So, I find myself being one foot forward and ahead of my staff in order to be able to respond to that in a timely manner because, we can say, go to digital health and ask for this help in all of that, and they don't have to wait then for several hours on the phone waiting for an answer. There is an expectation that you also know technically you are ahead of the game as well." (FGD2-P5).

A few of the participants acknowledged that the digital governance of these systems is not always clearly delineated, particularly when required for the business and clinical decisions needed in the fast-paced, dynamic healthcare environment. This finding is illustrated by one participant's comments, in which they highlight:

"One of the things that I find we are required to do more is actually navigate systems where clinicians or middle managers are having trouble navigating, how or when or where to use an information system, the questions rise to you, so you've got to be across the developments in the IT space, when your priorities in that doesn't appear in anyone's position description. I'm sure when your priorities are completely different, you still find yourself being the person who was the top of the tree, who has to navigate this problem for your clinical and management teams." (FGD4-P7).

Further, a few participants discussed the need to align corporate, clinical and digital governance, which assists in providing assurance that executive reporting is reliable, valid and timely. This was emphasised by one participant when explaining the number of digital systems to be accessed, including:

“A minimum of six programs that I have to enter every day, virtually, to make sure everything keeps moving because I have five different areas underneath me, and it's just about maintaining the separation. They don't all talk to each other, and some of them shouldn't talk to each other, but others it just seems like we've created it when someone had a bright idea, and they've created a separate system rather than thinking about – well, wait a minute, how can we incorporate that into other? ... So, you've got two systems holding that same information now. So, which one becomes the truth and then which one is up to date? And that all depends on who the user is.” (FGD6-P3).

6.3.3.1.2 Data management

As a result of adopting digital technologies, data management was highlighted as an enhanced skill essential to lead and manage in the workplace by many focus group participants, including the need for a common language and understanding of multidisciplinary data requirements. Notably, these participants discussed the accuracy, provenance, and reliability of the data. The ability to contextualise the data to explain the meaning of the aggregated information made visible in performance indicators and dashboards was emphasised. In illustrating this view, one participant stated:

“So, as a manager, I think one of the things the challenge these days is that you often get put on the spot to explain a dashboard or a number that you've never seen before. Nobody's talked to you about it. You've got no idea. And all of a sudden, you're explaining why your HACC (Home and Community Care) numbers are through the roof for a particular incident, and you know nothing about it, and you're expected to actually know what they're talking about, know where the data is coming from. Understand it and explain it, and you've got a four-hour turn around because somebody wants a ministerial briefing written that afternoon, type stuff.” (FGD1-P3).

Several participants observed that data literacy is increasingly required to manage in the digital environment effectively. Further, evidence-informed decision making is now predicated on access to timely and accurate digital data. Some participants noted that managing healthcare performance also requires dealing with ambiguity and being digitally dexterous and innovative in times of digital transformation.

Typical of this discussion was one participant who said:

“The other challenge would be the ability to get things wrong a bit too; I think that the ability to become a bit comfortable in the grey zone, we're not quite sure where we're going with this kind of virtual care, but we think there could be an opportunity for data to help with the management of this patient

cohort. So, the ability to think really differently to the way you've perhaps been trained to think, to think really outside the box around how healthcare can be delivered rather than just more appointments or more, whatever it might be, to really actually that skill to be ... I don't know what that skill is called. I don't know what the ability to think outside the box or to be comfortable in the grey zone and in innovation, kind of skill I guess.” (FGD3-P4).

6.3.3.1.3 Change management

As a result of adopting digital technologies, some focus group participants highlighted change management as an extra skill requirement required to lead and manage in the workplace, including the need to support staff through the digital changes occurring. These participants also raised the ability to manage projects, including the importance of stakeholder relationships required in managing change and risk across digital projects. This sentiment was expressed by one participant:

“And I think if you can manage a project really well, you can probably learn to manage a digital project, but the risks are so very different. I think you need really strong connections with people that you really know are digital experts. You don't necessarily need to be one to design it, but you need to know who to lean on if you are rolling out something digitally.” (FGD1-P6).

In addition, there was discussion about being able to support others in digitally transitioning evidence into practice, for example, ensuring that the latest clinical guidelines and protocols were being incorporated into and used in the digital health systems. As one manager explained:

“I was thinking the same thing that acknowledgment of the skills and knowledge that other people have, you know, we're all a team and none of us can do our job without the other people that make up that team. But in terms of knowledge and skill, I also find that it's about the transition of evidence into practice. So, when there is an update to our clinical guidelines, what do we need to do in the system to be able to support our clinicians and then also to be able to evaluate that, with research down the track, did that make a difference?”. (FGD2-P4).

6.3.3.1.4 Supporting digital development

A few of the participants discussed how, as a result of adopting digital technologies in the health service management context, increased skills and knowledge are required to develop and educate staff. This included addressing the ever-changing role requirements of the various practitioners operating in the shifting sands of healthcare service delivery. These participants described the rapidly increasing data literacy requirements for differentiated business and clinical user needs, including a common digital vocabulary needed across the workforce. A sentiment echoed by one participant when advocating for a digital capability framework:

“But now it's how the workforce used to do everything, or HR used to do everything. HR is now part of everyone's role. So, I think one of the knowledge things that we need as a manager that's changed, is a whole new vocabulary, and that's where I guess that whole idea of a framework or a capability framework, would be one just getting comfortable with the sort of language that's different and ever-evolving, ever-changing, you know the language in the digital space.” (FGD3-P4).

Further discussions from a few of the participants centred around the need to equip the workforce with skills in developing information-interpretation capability, in context, to also assist colleagues in realising their role-based digital benefits. As one manager explains:

“So, I guess that's where we're borrowing from other areas. Data is one thing, but how to use it is then what's critical because you'll have somebody say, well, we've got X number of outstanding, you know well, that's fine. But on its own, it means nothing. So, it's about teaching people how to even interpret and use data as well, but you've actually got to understand that yourself in the first place.” (FGD2-P2).

Some of the participants also discussed the ability to be able to contextualise the language of transformation and digital health technology disruption for colleagues, as a management competency required in the digital workplace. This was elucidated by one manager:

“I would like to elaborate on the previous point I also mentioned about the skills, the digital skills. So, I think there is also a need because we are moving towards a digital disruption world in healthcare, and in every sector, we have united technology incorporated. So, we need tools with an emphasis on the digital literacy. So how can we incorporate that to improve going forward?” (FGD6-P10).

6.3.3.1.5 Vendor management and negotiating

Discussions arose about the additional skills and knowledge required for vendor management and negotiating. A number of the focus group participants described the need for self-sufficiency in supporting local digital solutions to meet the information requirements for rapid, data-informed decision making. The importance of being able to negotiate with digital technology vendors, championing the local healthcare context and needs while acknowledging the need for a heightened awareness of contract management, was also expressed by the participants.

Reflecting on their experience, one participant explained:

“If you are responsible for the business unit that's running a particular system, it also leads you into more engagement with the vendors around the performance, which again compounds that need to understand more about the IT aspect of the system, and the things that influence it because you can't always call on ICT to come and help you out in those circumstances. And really, there's very few of the subject matter experts in your district that you can turn to for that.” (FGD4-P3).

6.3.3.1.6 Governance and security

Some of the focus group participants described the essential need for increased skills and knowledge in supporting digital governance and security. Cybersecurity threats and increasing media scrutiny were discussed as being at the forefront of their minds. One of the key issues described by the participants was the need for individuals to have heightened awareness of cyber-hygiene and that cybersecurity is everyone's business. Healthcare practitioner's need for and expectations of "anywhere, anytime" information availability was also emphasised as a digital governance concern by the participants. The need for digital business continuity was also highlighted by some of the participants and was illuminated by one participant in explaining that:

"When I think about it, the information security and risk management is a really big issue that sits in front of mind for me and business continuity planning for downtime...And the other one was cyber-hygiene. We need to ingrain cyber-hygiene training into the organisation, from top to bottom. The whole workforce. It needs to be something which is done a little better so that people can be really well aware. Cyber-hygiene refers to a set of routine practices that computer users follow to maintain and improve online security, to protect themselves from threats in the online environment." (FGD6-P8).

A number of the participants also articulated their need for further knowledge of data custodianship and digital stewardship of digital systems, and the ability to support digital capability for a range of organisational and external stakeholders. Data custodianship was seen as the senior data owner responsible for managing and approving the use of their domain data in the digital environment, recognising the legislative and privacy obligations. Participants saw digital stewardship as encompassing acquiring, managing, organising, protecting, and granting appropriate access to digital information. As one participant emphasised:

"Data is a big part of my life, and it is interesting that the XXXX (a State Department's) Health model, with data custodianship where it is very application focused. When I went to XXXX (a regional health location within the state), we decided to do a very different approach with our data custodianship, and ours is information domain focused. So, one of our domains will be pharmacy. So, it doesn't matter what application they're using; that is their information domain, and there will be a data custodian around that, then that person is supposed to be able to validate the origins of that data so that when it gets used by a user, the user understands what they're getting and how they're going to use that information?" (FGD5-P2).

6.3.4 Contextual skills and knowledge required to perform health service management work

When focus group participants were asked about the skills and knowledge they needed to perform their healthcare management work in the digital health context, the participants described 23 key skills and knowledge characteristics required. Nine initial codes emerged from the focus group participants' responses, which were identified iteratively via inductive coding. These were (1) agility, (2) change management, (3) common language, (4) data management, (5) decision making, (6) governance, (7) project management, (8) risk management, and (9) system capability.

The initial themes were compared and contrasted with the two co-investigators to search for coherence of the themes in addressing the research questions. These initial themes were then able to be aggregated into five major themes: (1) change, project and risk management, (2) contextualising system capability, (3) data management, (4) governance and decision making, and (5) digital agility and shared digital language. Under each of the five major themes, key skills and knowledge characteristics were detailed through iterative coding.

6.3.4.1 Elaboration on the five key themes

6.3.4.1.1 Change, project and risk management

Change, project and risk management were highlighted as a significant requirement by some of the focus group participants. They discussed the need for applied knowledge of related capability frameworks and maturity models required to manage in the workplace. Clarity was provided regarding the combination and complexity of complementary roles that were essential, as contextualised by one participant:

“So, to answer your question around what sort of skills you would need as a manager, I suppose there's quite a few. There's the change management side and introducing the system. There's also some project management around actually identifying who needs to be trained, when, how, and all the rostering.” (FGD6-P1).

Knowledge of organisational data provenance emerged as a baseline risk management requirement to lead and manage in today's healthcare environment. Data provenance refers to all the components of the data, its constructs and connections, which contribute to the certainty of healthcare data (Sembay et al., 2023). This includes the attributes about the origin of the data when it was initially captured, and traces the usage and transformation of the health data to information over its life span (Ahmed et al., 2023). These participants underscored this provenance requirement when describing the need to have sound knowledge

in the application of digital governance, to manage business and clinical risk, supported by foundational digital knowledge. The discussion about managing digital risk was amplified by one manager highlighting concerns about operational staff's digital awareness:

"I'm looking after the operational staff and we have HR online. We have so many things online, but these guys may or may not have an e-mail contact at work. There's one computer or two computers available to them freely but we're expecting them also to be digitally aware ... So, we're actually creating big separations with available information, because we're putting everything into an electronic format, but we're not necessarily taking all the staff along." (FGD6-P3).

6.3.4.1.2 Contextualising system capability

Contextualising system capability was highlighted by most of the focus group participants as an essential competency that is increasingly required to manage in the workplace. This was encapsulated by one participant when explaining the breadth of knowledge needed across various organisational roles:

"I often find my role in optimisation and in enhancing and improving the system that we use but largely in terms of understanding a system, having some knowledge about structure and how you build this thing in the background. But interpreting that with the clinicians' needs, what are the limitations that issues, what might that solution look like? And I think you need that clinical knowledge, and then combining that with a systems knowledge to be able to present a solution." (FGD2-P4).

Many of the participants reinforced the business and technical knowledge required, including a necessary understanding of the link between decision support and digital knowledge:

"I'm working at the moment on one of my projects about supporting clinicians with a really easy tool to make clinical decisions about where a patient might be able to be referred to or discharged, to get them out of hospital because a lot of the barriers are we don't know how to refer to XYZ XXXX and so we can develop a digital tool that will help them with that information. But unless it is super easy for them to access cues and it's not a laborious approach. So, we need to be able to understand system design as well and you know digital design, from the user's perspective." (FGD1-P6).

6.3.4.1.3 Data management

Most of the focus group participants highlighted the skills and knowledge needed for data management as a priority, which is increasingly required to lead and manage in the workplace. Discussions with the participants explored the complementary roles necessary to manage a discipline-based workforce, supported by a broad ability required to position data in context. These participants emphasised this discussion by describing the data definitions needed to ensure

data quality that can support decision making, further illuminating the importance of data literacy skills. In ensuring the consistency and accuracy of data used to inform contextual decision making, some of the participants again observed that foundational knowledge of data provenance is essential, not only from a risk management perspective (as mentioned in 3.2.2) but also for system-generated decision support surety, increasing information quality for improved patient and operational safety (Fadahunsi et al., 2021). As one participant recounted:

“Hang on, if the stuff that’s captured in the EMR about the Tier 2 (Non-Admitted Services Classification, which categorises non-admitted care services for funding purposes) is wrong, then what’s in in-patient costings is wrong, so I think we have to be able to have those and start those conversations about well, yes, this is your data, but where does your data come from and how well do you trust the data that’s being told to you? So, it’s that big picture thought processes and not just relying on what’s handed to us.” (FGD1-P3).

Importantly, a few of the participants concluded that digital dexterity was a responsive requirement, underpinned by an eclectic, essential digital knowledge base. As described by one participant:

“So, I think that’s a key aspect, what kind of manager training do we have? And then maybe these things we’re talking about, what does validated data look like ... and how we can utilise the very expensive resource better.” (FGD1-P5).

6.3.4.1.4 Governance and decision making

Accountabilities required in the current health service management context necessitate a heightened awareness of governance and decision making, particularly when it comes to improving the safety and surety of digital decision making in the workplace. There was also the expressed need to bridge the divide between business, clinical, and technical domains with digital knowledge and technical dexterity to support real-time decision making. For clarity, data governance is differentiated from digital governance by the level of organisational assurance required and the value delivered (Aninha et al., 2024, World Health Organization, 2023a). The World Bank (World Bank, 2023) defines data governance as the assurance of quality, timely, useful, secure and contextual data of known provenance. This is congruent with the current digital health discourse, where digital governance is seen at the system or jurisdictional level as a structural enabler for the creation of transformative value for patients, practitioners, providers, and funders (Saheb and Saheb, 2024, Kulkov et al., 2023, D’Anza and Pronovost, 2022). Recent literature now highlights the significant role that federal digital health governance provides in the digital transformation of health systems

(Aninha et al., 2024). Some of the participants discussed digital governance as an essential competency in the healthcare manager's toolkit. The digital knowledge required was explicated by one participant:

“Also, I need to understand digital governance, not just data governance, data governance is absolutely one aspect, but also how do we have governance over our digital systems? As I mentioned, I'm having a site issue where someone has accessed something that they should not access, you know. So, what are our digital systems in place that governs how we manage our data and our information sharing and how to make sure it's shared to the right people and in the appropriate way.” (FGD1-P6).

6.3.4.1.5 Digital agility and shared digital language

Some of the focus group participants emphasised a manager's adaptive ability and digital agility as a required competency and a responsive requirement to manage in the digital workplace. As noted by Duvivier and Gupta (2023) “In today's digital era, organizations are facing unprecedented challenges due to the rapid pace of technological advancements. The emergence of digital technologies has disrupted traditional business models, forcing companies to adopt agile responses to remain competitive. Digital agility, the ability to quickly adapt to digital disruptions and opportunities, has become a crucial factor in organizational success” (Duvivier and Gupta, 2023, p.1). These participants discussed the strategic link between data quality to support business and clinical decision making, and using the proper digital tools to provide accurate management information. The ability to use a variety of digital technologies to interpret and present valid information was highlighted by one participant:

“You mentioned what would the skills we need on a day-to-day basis as a manager. I think the key thing now is the ability to be able to find the data that you need or know of the reports that are available. You need to interpret that data, be able to put a quick reality-lens on that data and check whether or not you think it's correct and then finding out if that data point actually reflects what I think it reflects, because it pulls from all sorts of different systems.” (FGD3-P4).

A few of the participants explained that leadership, influence and agility are all needed to support data integration and governance across multiple digital systems and technologies. This was underscored by one participant when recounting their experience:

“You don't actually get formal training as to what strategy is and how organisational planning works. You just get thrown into it from being a frontline clinician and we don't have any of that embedded in any of our tertiary degrees. So, it becomes a learning on-the-job aspect and that's the other thing that we also need to have as leaders now as well as managing is the agile component, the ability to be able to actually move quickly with

the times and actually be able to set something down, reprioritise, take something else up, saying no, that's actually not going to be a good idea now. So, agile is really, really important.” (FGD5-P5).

These participants also discussed the need for an increasing awareness of a shared digital language. Acknowledging the strength in diversity of multi-disciplinary teams, participants recognised the importance of having an operational understanding of various healthcare roles across the organisation, including data definitions and data provenance as elaborated in one participant’s reflections:

“I think it's really important that you understand how data definitions are built and you know really understand when you get a piece of data, you know ... what is the source? But I'll say, what are the calculation points and are they the right calculation points for us to be considering, particularly if they're really important ones that you need to take action on? Are we taking action on the right points, you know, and there's lots of lots of questions about data definitions at a statewide level that needs to be expanded and understood.” (FGD1-P6).

6.4 Existing and enhanced competencies for health service managers to effectively work with and manage in the digital health context

The published scoping review conducted in 2022 explored international literature on the competencies that health service managers needed to acquire to effectively work with and manage in the digital health context, as well as describing the key factors that enable and inhibit health service managers in demonstrating digital health competence in the workplace (Brommeyer et al., 2023b). As detailed in Table 2 below, five broad competencies were previously confirmed as necessary for health service managers working in the digital health context, including additional skills and knowledge in the following domains: (1) leading in a digital environment, (2) operational and resource management for a digital workforce, (3) adaptive personal, interpersonal and professional qualities, (4) understanding the digital health industry and environment, and (5) information and data management.

As a result of the focus group discussion findings in this study the competencies have been enhanced to address the eight contemporary competencies required for health service managers working in the digital context (Brommeyer et al., 2025), as described in Table 2.

Table 2: Contemporary competencies for health service managers working in the digital health context

Existing competencies (Brommeyer et al., 2023b)	Enhanced competencies (Brommeyer et al., 2025)
1. Leadership	1. Applying digital system knowledge

• Critical and analytical thinking • Systems thinking • Demonstrated strong interests in technology • Commitment to innovation and change.	1. Ability to support various healthcare professionals in their workplace to access, use and manage digital tools available 2. Understanding of different healthcare professionals' digital literacy, data and technology requirements 3. Supporting executive reporting, with the surety, analysis and interpretation of organisational data 4. Capability in aligning corporate, clinical and digital governance, in context.
2. Operational and resource Management • Financial management • Resource allocation to enable innovation • Organizational assessment • Ability to drive performance/results • Ability to facilitate/enable development of workforce preparation strategy and educational program for digital health readiness.	2. Data management 1. Understanding the accuracy, provenance, surety and reliability of digital health data, in context 2. Ability to digitally turn data into information for business and clinical insights 3. Applying a common language to support the multidisciplinary workforce's digital health data needs 4. Supporting the healthcare workforce with data literacy to enhance the value of data-informed insights.
3. Personal, interpersonal and professional qualities • Cultural competence • Emotional intelligence • Ability in managing nurse/physician relationship management • Ability in leading diverse teams • Flexibility/adaptation/improvisation • Ability in accessing and using data to support decision making.	3. Change, project and risk management • Skills in leading digital health change with integrated project, change, stakeholder and risk management for digital transformation across multiple digital projects • Proficiency in supporting the digital transition of evidence into healthcare practice • Ability to apply digital governance in managing business and clinical risk

	• Capability to manage digital health data breaches and litigation risk challenges.
4. Understanding the industry and environment • Ability to actively and accurately represent service needs in design and deployment as well as procurement and customization • Political savvy • Expertise in regulatory affairs • Understanding the legal system for information management.	4. Supporting digital development • Applying a digital capability framework to manage the application of digital health in the workplace • Supporting the workforce to safely access, use and manage digital health tools in the workplace • Capability to contextualise the language of transformation and digital health technology disruption for the workforce • Supporting the workforce in assessing the validity, integrity, and relevance of digital health data in relation to their work
5. Information and data Management • Understanding of data governance, access and translation • The ability to develop the right system for data management • Systematic awareness of informatics and technologies • Fundamental understanding of core informatics concepts and their utility to patient care and professional collaboration • Understanding how digital health information ecosystems either support or disrupt clinical workflows and the implications of any such changes • Understanding of privacy and release-of-information activities • The ability to analyse, evaluate and maintain the information system.	5. Vendor management and negotiating • Understanding of technical self-sufficiency in supporting local digital solutions and understanding own limitations • Capabilities in stakeholder management to support digital data-informed healthcare decision-making • Enhanced skills in digital health technology lifecycle contract management • Ability to represent local healthcare context and needs when negotiating with digital technology vendors.

	6. Governance, security and decision making • Applying cyber-hygiene practices and organisational cybersecurity measures in the healthcare setting • Addressing healthcare data security and digital privacy requirements • Contemporary knowledge of data custodianship and digital stewardship, for governance of digital health systems • Supporting appropriate digital access for clinical, business and secondary uses, including managing digital downtime and business continuity planning.
	7. Contextualising digital system functionality • Employs appropriate digital technologies and methodologies to make data-driven decisions and solve problems • Ability to integrate digital health tools to improve the effectiveness and efficiency of own work • Knowledge needed to apply healthcare business and clinical decision support • Maintaining contemporary knowledge in applying new tools, latest technologies, and best practices in the digital health environment.
	8. Digital agility and shared digital language • Understanding of the strategic link between digital health technology and management information • Ability to link data provenance and data quality, in support of business and

	clinical decision making using a shared digital language • Enhanced capabilities in leadership, agility and influence to link healthcare organisational governance and digital integration.
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6.4.1 Changing health service management competency requirements

This research indicates two main priorities of management competency enhancement needed. First, competence in digital data management and security, and second, the management of digital technologies in practice.

In this study, digital data management and data security have been found to be central to effectively manage in the digital health context. Managing information in healthcare is essential to support the workforce in achieving the required clinical and business outcomes. Personal health information, an indispensable asset that needs appropriate security and sensitivity to ensure accurate, timely, accessible and contiguous availability that follows the consumer journey, underpins clinical decision making. Further, data-led decision making is important in health service management and foundational for the provision of safe, quality care. As this study confirmed, decision making in the digital environment is transfigured by the provenance and degree of digital data used, along with the surety required to ensure data quality. This is grounded in health service manager's digital health literacy and the need to maintain knowledge of developments in the digital health technology sphere.

This study also highlighted the manager's aptitude and agility needed in promoting digital integration and governance when using various digital systems and technologies, and ensuring that digital governance principles are supported and utilised locally. In addition, current understanding of data custodianship and digital stewardship, including advocating for apt digital access for secondary uses of data, supported by skills in managing digital downtime and business continuity planning, were enhanced competencies identified in this research. Enhanced understanding of data security and awareness of how to manage digital health data breaches and potential litigation risk challenges, were also iterated in this research.

The management of digital technologies in practice encompassed research findings across an array of enhanced competencies that were surfaced during this study. They included the need for health service managers to recognise various digital literacy levels of a

diverse healthcare workforce, and enhance understanding of the value of data-informed insights. During digital transformation, the need for leading digital health change with integrated project, change, stakeholder and risk management across numerous projects was enunciated in this research. In addition, being able to contextualise the vocabulary of transformation and digital disruption to the workforce was also required, as well as the ability to support the transition of digital evidence into healthcare processes, for managers in this study.

In addition to clinical and corporate governance necessities in healthcare, the skills required in aligning digital governance to manage business and clinical risk in practice was also seen as an enhanced requirement. Further, it was found that increased knowledge to manage healthcare business and clinical decision support in the digital environment was needed. This study also highlighted the increased understanding managers required for technical self-sufficiency in managing local digital solutions, while understanding their own technical limitations. Additional skills in digital health technology lifecycle contract management, and the ability to represent local healthcare context and needs when negotiating with digital technology vendors, were also illuminated in this research.

6.4.2 *Implications for healthcare systems*

Implications include supporting workplace change for practitioner and consumer access to personal digital health records and online communication, driving integration and usage of evidence-informed clinical guidelines and protocols in the workplace to deliver quality, safe care using digital health systems. Professional bodies, organisations and educational institutions play an important role in inculcating health service managers' prowess in digitally-enabled problem solving, with the subsequent demonstration of this performance in practice. At an organisational level, there needs to be alignment between corporate, clinical and information governance to ensure that digital health investment reinforces the strategic value being sought, as well as being able to provide public assurance of effective governance for sustainable healthcare management in the digital environment. In addition, empowering the healthcare workforce with skills and knowledge of business continuity planning and management of digital-downtime in practice is required. Furthermore, investments are required to enhance knowledge in collaborative digital innovation and shared value, negotiating skills and the ability to realise contract accountability across the digital health technology lifecycle (Brommeyer et al., 2025).

6.4.3 *Potential impacts of AI on managing health services*

Literature from the desktop review exploring developments in the transformation of Artificial Intelligence (AI) in healthcare, and potential impacts of AI on managing health

services, on managing the workforce, and on managers, noted the increased use of AI in hospital command centre dashboards to predict patient flow improvements using real-time information and decision support was highlighted (Johnson et al., 2024), as well as for advanced analytics in support of clinical decision making (Staunton et al., 2024, Barbieri et al., 2023). Further, literature also highlighted the need for professional guidance and regulations to support practitioners use of AI clinical decision support systems is recommended, to better manage clinical, professional and reputational risks in use of these tools (Smith et al., 2024). This has also been reflected in recent literature addressing challenges for implementing AI that include technological, regulatory and workforce considerations as well as the need to build public trust (Roberts et al., 2025). In exploring barriers and facilitators to the adoption of AI, a recent study further highlighted that trust is a substantial stimulus of adoption as well as transparency and algorithmic explainability for practitioners and patients alike, with the need for governance models to support the delivery of quality, safe healthcare (Hassan et al., 2024). Current literature confirms that for management use of AI, tailoring of competency development is required for healthcare executives and operational managers in implementing strategic, operational and tactical skills that are unique to local systems (Reddy, 2025). These findings are also aligned with the digital competencies required by health service managers, as evidenced in this research study.

6.5 Chapter Summary

Chapter 6 examined the changing digital health context, roles, responsibilities, and competencies that health service managers perceived that they need to demonstrate in current practice. The findings from the focus groups identified that the digital competencies health service managers need require demonstration of much broader competence across eight major themes: (1) applying digital system knowledge, (2) data management, (3) change, project and risk management, (4) supporting digital development, (5) vendor management and negotiating, (6) governance, security and decision making, (7) contextualising digital system functionality, and (8) digital agility and shared digital language.

Importantly, these findings yield insights into the changing context, roles, responsibilities, and competencies health service managers need to demonstrate in practice in a digitally transforming health context. As competency is context sensitive, demonstrating how existing and new digital competencies are applied in practice has also been presented, with this study providing more in-depth understanding of the nuances of the digital competencies required for health service managers. Recognising organisational capacity, health service workforce capability, and individual health service manager digital health competencies as synergistic necessities was established. To ensure the digital competencies

for health service managers can be demonstrated in practice, requires systemic support and changes across the broader health system that can be contextualised using the WHO (2007) six building blocks of a health system, which is further explored in the next and final chapter. This will assist in achieving the objective of incorporation of digital health in reaping the health system gains of efficacy, value, safety and effectiveness.

This research contributes to the literature and health service management prevailing practice environment by elucidating the competencies required to effectively manage in the Australian digital health context, which can guide professional credentialling, industry certification and competency framework validation activities.

Chapter Seven – Summative discussion and conclusion

“Digital health is not about applications, platforms, or devices. It’s about transforming how health systems serve people—more equitably, more effectively, and with greater attention to individual needs” (World Health Organization, 2025b).

— WHO Director-General, Dr Tedros Adhanom Ghebreyesus

7.1 Chapter Introduction

The purpose of this final chapter of the thesis is to provide a summary of the main study findings, synthesised from each empirical chapter, in the context of digital health transformation. This includes developing further understanding as to how the framework for developing health service management workforce capacity should apply in the digital healthcare environment. Also, the impact of digital health in supporting improved healthcare outcomes is framed against the World Health Organization’s six building blocks of a health system (World Health Organization, 2007). Further, the innovation potential that can be generated across the healthcare workforce and system (Abi Saad et al., 2024) is also detailed. The chapter concludes with the potential implications of this study for future practice, policy, and research in the Australian healthcare context.

Figure 7 situates this chapter in the conceptual map of the broader thesis structure:

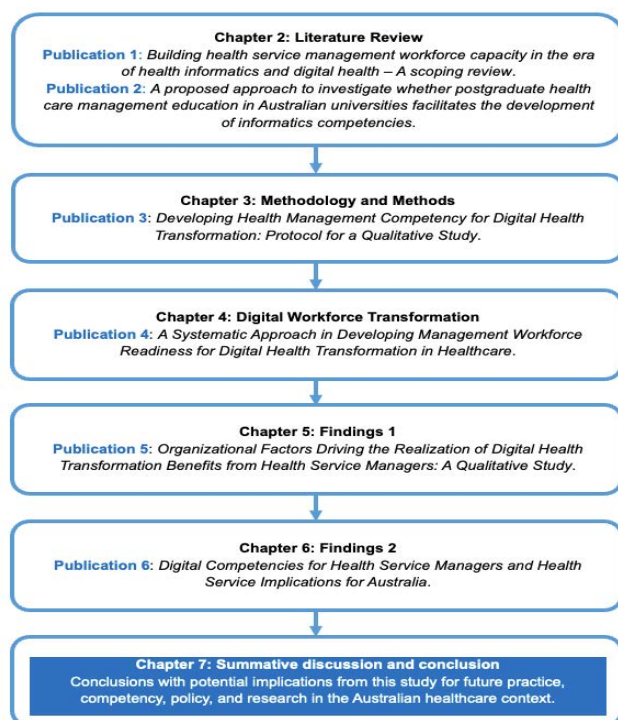


Figure 7: Thesis structure map Chapter 7

This final chapter summarises the evidence developed from the PhD research study, which examined the changes in health service manager competencies required to work effectively in supporting the organisation's vision, mission and strategic goals in the digitally transforming environment. These include the digital competencies health service managers need that require demonstration of much broader competence across eight major themes. This advances understanding by contextualising the key success factors and barriers for health service managers to demonstrate digital health competence in their workplace and discusses the broader health system changes required, utilising the World Health Organization's six building blocks of a health system (World Health Organization, 2007). The findings also underscore the systemic need to adapt across all six building blocks, to accommodate the impact of digital health throughout every aspect of the healthcare system, with the changes evidenced being required at the macro-system level, meso-enterprise structure and process level, and the micro-human factors level. These insights provide a broader policy, practice and research agenda required to ensure that health service managers are best equipped for digital health to realise its potential in assisting to achieve the health system gains of efficacy, value, safety and effectiveness.

7.2 Key findings

This study, conducted in three steps, provided answers to the three research questions:

1. To what extent can the existing health service management and digital health competency frameworks guide development of competence for health service managers in understanding and managing in the digital health space?
2. What are the competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context?
3. What are the key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace?

Step 1 provided understanding of the health service management competencies that have been used to guide curricula and the teaching focus of formal and informal health management training. Competency mapping of the existing frameworks guiding health service management accreditation, professional development, and postgraduate studies was completed in 2021. The findings from which identified that of the 21 Australian master's-level health service management programs mapped, only 10% of the AHICF competencies were fully addressed, 12% of the AHICF competencies were mostly addressed, 28% were partially addressed, and 50% of the AHICF competencies were not addressed at all.

Step 2 identified international evidence on competencies health service managers needed to effectively demonstrate digital health competence in the workplace, along with the system and organisation capacity factors that were critical to building the management workforce capacity in the digital health environment. A scoping review was undertaken in 2022; three findings included: firstly, the additional competency of 'information and data management' must be included as a core competency for health service managers. Secondly, enhanced elements for four core management competencies are important to health service managers working in the digital health context, being (1) leadership; (2) operational and resource management; (3) personal, interpersonal and professional qualities; and (4) understanding the industry and environment. Thirdly, factors critical to developing system and organisational capacity in the use of health informatics and digital health technology, and leading and managing the adoption in the healthcare organisations, were identified in three categories: (1) policy/system; (2) organisational structure and processes; and (3) people factors.

Step 3 utilised focus group discussions to collect primary data that were conducted between February and March 2023. The findings demonstrated the competencies that health service managers need to attain to effectively work with and manage in the digital health context, as well as identifying the key factors that enable and inhibit attainment of these competencies. These findings have led to development of the recommendations at the healthcare system, policy, organisational, and local levels, which have advanced understanding based on the World Health Organization's (2007) six building blocks of a health system, as detailed below.

7.3 Capability building, contextualisation and competency

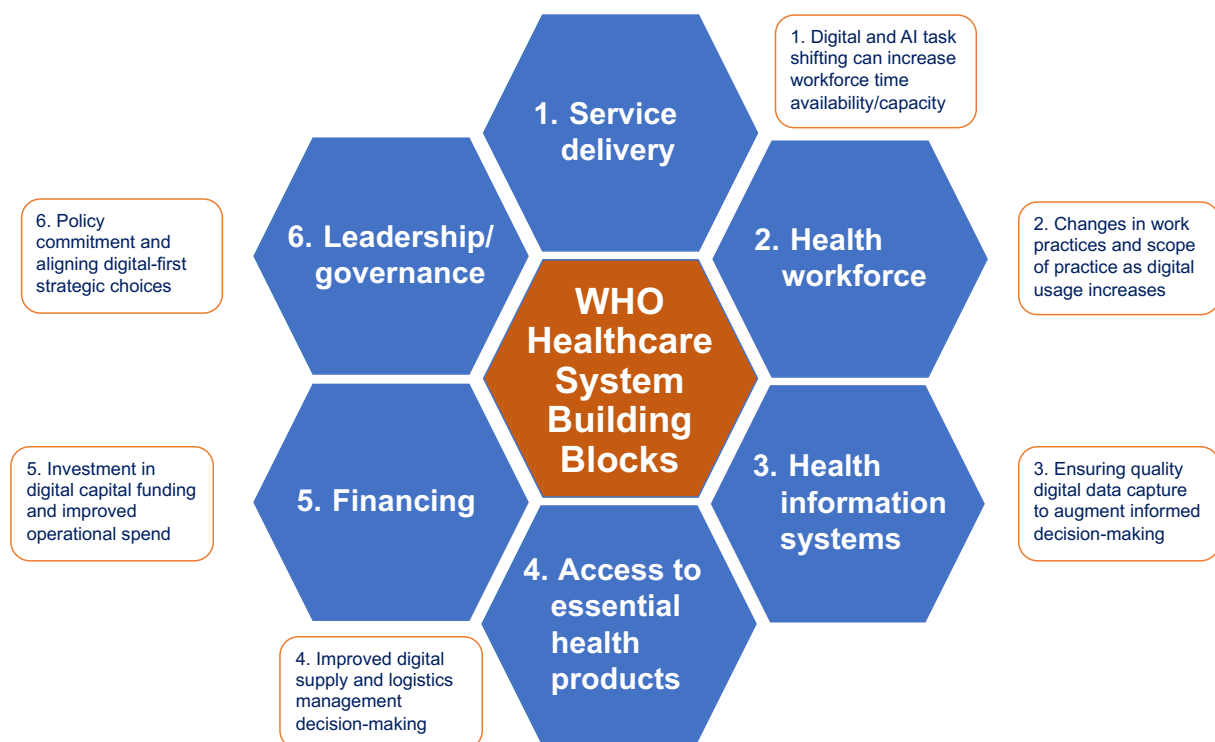
Building capability for health service managers to effectively work with and manage in the digital context requires both the demonstration of competence in practice, and the systemic supports required across healthcare services and environments. In the global digital society, impacts of digital technologies in health are profound and pervasive (Ramachander and Gowri, 2025), the impacts of which are associated with a country's level of digital maturity (Campmann et al., 2025). The resultant competencies required by health service managers will be dynamic and responsive to the healthcare system and setting in which they practice (World Health Organization, 2023b). As work practices change and digital health transforms workforce roles and functions, existing tasks and responsibilities change and the focus of required competencies shift in response to the changing healthcare environment (Gutiérrez et al., 2025).

Health systems globally vary in funding, structure, scope and scale of services provided, thus, consideration of the required capacity in the relevant context to support demonstration of competence can be conceptualised using the World Health Organization's (2007) six building blocks of a health system, to align this study's findings with recommendations, for digital health to realise its potential in assisting to achieve the health system gains of efficacy, value, safety and effectiveness.

7.4 Recommendations for healthcare system, policy, organisational, and local factors supporting health service managers in enabling digital transformation

Necessary changes required across health systems can be envisioned utilising the World Health Organization's (WHO) six building blocks of a health system (Borghi and Brown, 2022), which are interdependent and need to function effectively together to achieve the goals of a well-functioning health system (World Health Organization, 2007). The system impacts and key changes required, aligned to each of the WHO six building blocks, are presented as exemplars in Figure 8, below.

Figure 8: WHO six building blocks and digital impact exemplars



The following section details the resultant system changes necessary to support health service managers advancing the health system outcomes arising from digital transformation in the public hospital context, with the changes evidenced being required at the macro-system level, meso-enterprise structure and process level, and the micro-human factors level. The systemic, organisational and individual changes required for health service

managers to effectively manage in the digital context are interrelated and have outcomes and impact in improving how digital health inputs and processes, including health workforce and health information systems, are reflected in outputs, including digitally-enabled decision-making and evidence-informed healthcare services. The outcomes generated include access to timely, efficient, quality, safe care, which impacts improved citizen health coverage, the balance between organisational and clinical risk, and enhanced management of healthcare services in the digital environment (World Health Organization, 2010).

7.5 Implications for practice, policy and research

Findings from this PhD research study identified necessary changes required across health systems, as envisioned using the World Health Organization's (World Health Organization, 2007) six building blocks of a health system, which considered the practice, policy and research implications. These resultant system changes are necessary to support health service managers advancing the health system outcomes arising from digital transformation in the public hospital context, with the changes evidenced being required at the macro-system level, meso-enterprise structure and process level, and the micro-human factors level.

7.5.1 Service delivery

During digital transformation, it is important that managers support workplace change for both practitioner and consumer access to personal digital health records, which requires appropriate and secure access being provided to patients and consumers of healthcare (Alomar et al., 2024, Hendl and Shukla, 2024, Topp et al., 2023). Further, the integration and use of evidence-informed digital clinical guidelines and protocols in the workplace must be supported for digitally-enabled clinical and business decision-making, by providing assistance to others in digitally transitioning evidence into practice (Campione et al., 2025, Khatri et al., 2025, Knight, 2025). To ensure that quality digital data of known provenance is available to the healthcare user when and where needed, policies should incorporate data provenance frameworks for system-generated decision support surety, increasing information quality for improved patient and operational safety (Ahmed et al., 2023, Sembay et al., 2023, Fadahunsi et al., 2021).

These changes are framed in Table 3 at both the macro, meso and micro levels for the digital health context, as well as more broadly across the health system context.

Table 3: Service delivery changes required in the health system

WHO Building blocks of a health system	Changes required in the health system to support health service managers advancing the health system outcomes arising from digital transformation		
	Macro level	Meso level	Micro level
1. Service delivery			
a) Digital health context	• Digital governance alignment between corporate and clinical governance • Data provenance frameworks for system-generated decision support surety, increasing information quality for improved patient and operational safety.	• Consumer access to personal digital health records • Integration and usage of evidence-informed digital clinical guidelines and protocols in the workplace.	• Competence in digitally-enabled clinical and business decision making.
b) Broader system context	• Improve coordination and collaboration across healthcare organisations to support harmonisation and optimisation of digital data. • Plan and evaluate change management strategies for each digital health process introduced. • Ensure digital policies incorporate data provenance frameworks that support transitioning evidence into practice in a digitally transforming context.		

7.5.2 Health workforce

Health service managers require skills and knowledge in applying whole-of-life digital systems investment capability, which includes training in vendor management and negotiation to improve return on investment metrics (Martikainen et al., 2025, Avinash and Joseph, 2024, Smith et al., 2024b). The increasing need for data analytics capability to digitally apply and manage organisational knowledge is also evident (Kehinde, 2025,

Housawi and Lytras, 2025, Olaniyan et al., 2024). Managers need to be able to employ integrated digital change, project and risk management capability frameworks and maturity models across the organisation, in support of enterprise digital transformation capability. Having the competence to strategically influence corporate digital decision making is also a management necessity (Gutiérrez et al., 2025, Atobishi et al., 2024). Managers can also champion digital literacy training programs, as well as use of a commonly understood, shared digital language for the healthcare workforce (Madsen et al., 2025, Mannevaara et al., 2024). This study found that there are policy implications for allocating appropriate resources for managers and the workforce in support of digital literacy and role-based training. Also, accreditation and policy requirements for digital health competencies being further incorporated into postgraduate health service management curricula, as well as digital competencies being integrated into and measured against industry certification frameworks. National collaboration is required for a more coherent, consistent and coordinated set of policy parameters to advance digital health and workforce development. Additionally, health service management workforce development requires policy, structure and processes to successfully implement the adoption of innovation for digital improvements and outcomes.

Resultant changes are framed in Table 4 at both the macro, meso and micro levels for the digital health context, as well as more broadly across the health system context.

Table 4: Health workforce changes required in the health system

WHO Building blocks of a health system	Changes required in the health system to support health service managers advancing the health system outcomes arising from digital transformation		
	Macro level	Meso level	Micro level
2. Health workforce			
a) Digital health context	• Resourcing for digital literacy • Digital health role-based training • Digital health competencies incorporated into postgraduate health service management curricula	• Managers with whole-of-life digital systems investment capability • Data analytics capability to digitally apply organisational knowledge	• Digital transformation capabilities • Competence in strategically influencing corporate digital decision making • Championing a commonly

	• Digital health management competencies integrated into industry certification frameworks.	• Employing digital change, project and risk management capability frameworks and maturity models • Training in vendor management and negotiation for managers.	understood, shared digital language.
b) Broader system context	• Review roles and positions across healthcare organisations to shift the burden of on-call responsibilities to support continuity and interpretation of digital information. • Increase clinical workforce training for digital data visualisation and interpretation, including using real-time dashboards. • Review workload implications across the clinical workforce to ensure appropriate resourcing and work-life balance. • Incorporate accreditation and policy requirements for digital health competencies into postgraduate health service management curricula. • Integrate digital competencies into, and measure performance against, industry certification frameworks.		

7.5.3 Health information systems

Managers role in reducing organisational digital vulnerabilities and the protection of personal health information is increasingly required in the digital environment, including improving cyber-hygiene practices as well as the ability to manage digital-downtime to ensure business continuity (Jawad, 2024, Salama et al., 2024, Argyridou et al., 2023). In addition, competence in digital stewardship to safely acquire, manage, protect, and grant appropriate access to digital information is required, along with clear data custodianship responsibilities for managing and approving the use of data in the digital environment (Bartlett, 2025, Kolawole et al., 2025). The ability to support organisational technology integration strategies, as well as additional skills and knowledge in linking strategic, operational and tactical use of digital data for decision support and organisational knowledge also requires attention. Digital health technologies need to be implemented and integrated in

a safe and secure environment, supported by national policies for digital innovation, digital safety and digital security (Wani et al., 2025, Zhang et al., 2025, Jawad, 2024).

Required changes are framed in Table 5 at both the macro, meso and micro levels for the digital health context, as well as more broadly across the health system context.

Table 5: Health information systems changes required in the health system

WHO Building blocks of a health system	Changes required in the health system to support health service managers advancing the health system outcomes arising from digital transformation		
	Macro level	Meso level	Micro level
3. Health information systems			
a) Digital health context	• National policies for digital innovation • Enhancing digital health security • Standards for organisational technology integration strategies.	• Reducing organisational and user digital vulnerabilities • Managing digital-downtime and ensuring business continuity • Clear data custodianship responsibilities for managing and approving the use of data in the digital health environment.	• Routinised cyber-hygiene practices • Enhanced competence in aligning digital data, technology and strategy • Applied knowledge of the link between decision support and digital knowledge • Competence in digital stewardship to safely acquire, manage, protect, and grant appropriate

			access to digital information.
b) Broader system context	• Increase role of health information technology workforce for management of digitally linked resources and risk management. • Increase workforce capacity to provide real-time support to the healthcare workforce for problem solving digital health issues. • Develop and test business continuity plans for organisational digital technology downtime contingencies.		

7.5.4 Access to the essential health related commodities and products

Managers have a responsibility to procure healthcare products and services effectively and efficiently, which also includes the procurement of digital tools to enhance safe clinical and business decision making for the organisation (Stek et al., 2025, Smith et al., 2024b). Having the ability to manage digital technology contracts and effectively negotiate with technology vendors is increasingly being required. This must be underpinned by establishing and using contemporary digital health procurement guidelines. There is systemic policy settings needed, including digital health regulations and technology standards to guide technology procurement, contract and vendor management capabilities, to support health service managers working in the digital context (Martikainen et al., 2025, Callens and Hans Klijn, 2024).

Necessary changes are framed in Table 6 at both the macro, meso and micro levels for the digital health context, as well as more broadly across the health system context.

Table 6: Access to essential health related products changes required in the health system

WHO Building blocks of a health system	Changes required in the health system to support health service managers advancing the health system outcomes arising from digital transformation		
	Macro level	Meso level	Micro level
4. Access to essential health related commodities and products			
a) Digital health context	• Contemporary digital health regulations and technology standards to guide procurement,	• Standardised digital health procurement guidelines	• Enhanced capability in managing digital technology

	contract and vendor management.	established and utilised • Procuring digital tools to enhance safe clinical and business decision making.	contracts and negotiating with technology vendors.
b) Broader system context	• Ensure appropriate procurement and supply chain management for digital assets and removal of redundant assets. • Support health service managers with skills in developing specifications for digital asset procurement. • Improve access to digital health technologies with demonstrated quality, safety, efficacy and cost-effective usages.		

7.5.5 Financing

In the digital environment, investment is increasingly required in digital safety of the organisational assets, which necessitates a prioritisation of funding for managers' digital health safety and security education and training (Rees et al., 2025, World Health Organization, 2025a). Appropriate financing must also be available to purchase, incorporate and maintain digital systems, that is both capital and recurrent budget allocations are provided and protected (Binsar et al., 2025, Popescu and Abdelmagid, 2025). An important finding in this study was the need to provide policy support for digital health innovation and investment frameworks, along with appropriate digital literacy resourcing policies for health service managers and the healthcare workforce.

Requisite changes are framed in Table 7 at both the macro, meso and micro levels for the digital health context, as well as more broadly across the health system context.

Table 7: Financing changes required in the health system

WHO Building blocks of a health system	Changes required in the health system to support health service managers advancing the health system outcomes arising from digital transformation		
	Macro level	Meso level	Micro level
5. Financing			

a) Digital health context	• Digital innovation and investment frameworks • Resourcing for digital health literacy • Financing framework to incorporate and sustain digital health systems.	• Investment in digital safety for providers and users • Investment in managers' digital health education and training.	• Prioritising workplace competency development for managing in the digital age.
b) Broader system context	• Ensure organisational budgets have necessary allocations to support the entire digital technology investment lifecycle. • Increase organisational capacity for contract management, including for digital assets. • Strategically align digital health investment and innovation agendas.		

7.5.6 Governance and leadership

Aligning corporate, clinical and digital governance across the healthcare organisation is essential, this supports the local application of digital governance to manage business and clinical risk (Coiera et al., 2025, Patel et al., 2025). Furthermore, the technical and business integration of clinical decision support systems, data information exchanges, and analytics tools are needed to enable data-informed decision-making. This can assist health service managers in leading the adoption and implementation of digital health technologies to accelerate the digital transformation outcomes for patients, practitioners, organisations and the healthcare system (Newton et al., 2025, Cantilina, 2025). Overarchingly, the need for digital health governance frameworks became apparent, with policy guidance, a supportive organisational structure, and strong leadership to support the management workforce in leading and managing the changing healthcare landscape.

Changes identified are framed in Table 8 at both the macro, meso and micro levels for the digital health context, as well as more broadly across the health system context.

Table 8: Governance and leadership changes required in the health system

WHO Building blocks of a health system	Changes required in the health system to support health service managers advancing the health system outcomes arising from digital transformation
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	Macro level	Meso level	Micro level
6. Governance and leadership			
a) Digital health context	• Digital health governance frameworks • Integrating clinical decision support systems, data information exchanges, and analytics tools to enable data-informed decision-making.	• Aligning corporate, clinical and digital governance • Applying digital governance to manage business and clinical risk.	• Contextualised authority-certainty for decision-ownership.
b) Broader system context	• Review lines of accountability for all healthcare data usage, including digital and related performance metrics. • Ensure executive and governing board members have strategic knowledge of digital health implications on corporate and clinical governance, ensuring alignment with organisational goals. • Increase capacity of clinical governance committees to include oversight of digital health safety, quality and risk management. • Employ detailed and defined governing board reporting, with proven delegation hierarchies for cybersecurity resilience.		

7.5.7 Contextual checklist for health service managers managing in the digital environment

From the research findings, key questions an organisation could ask when a digital health innovation is being implemented have been designed as a contextual checklist, and included in Appendix C.

7.6 Strengths and limitations of the research

Research strengths identified in this study include:

The research methodology was guided by the empirically validated management competency identification and development process conducted in the Australian health system (Liang et al., 2018b). Qualitative methods provided a very robust and responsive approach for addressing health service management research.

There are some limitations associated with this research that are worth noting:

7.6.1 Contextual limitation

The study focused on Australian public hospital organisations, so findings should not be generalised without considering local contexts and priorities. Although the empirically validated research methodology was applied to mid-level public hospital managers, considerations about validity and applicability to other healthcare sectors and domains would necessitate alignment with local factors, which could include primary, community and aged care, as well as the private sector.

7.6.2 Sample limitation

Focus group participants may have possessed a specific motive to contribute particular insights into the study that could generate bias. Focus group discussions involved mid-level public hospital managers, so applicability to other healthcare sectors (primary care, community care, aged care, private sector) may require contextual adaptation.

7.6.3 Methodological limitation

Qualitative findings provide depth and rich insights from the managers lived experiences, rather than statistical generalisability. The study adopted a qualitative approach for developing a contemporary understanding of experiences and observations of the competencies needed, and the organisational barriers that health service managers confronted, in realising the benefits of a digitally transforming environment in the Australian context. The methods used in this study could be applied to other jurisdictions, although the results should not be generalised to other country jurisdictions without appreciating local conditions, contexts and prevailing research priorities.

It is recognised that the study's findings should be interpreted within these contextual and methodological limitations.

7.7 Future research

Future research has been conceptualised as a research translation phase to contextualise and advance the framework for developing the health service management workforce in the digital health context (Brommeyer and Liang, 2022). Key informant interviews will be undertaken to validate findings from the focus group discussions regarding health service manager competencies for managing in the digital health environment. In addition, issues that influence digital health policy and practice, including system-level support and organisational capacity factors, will be explored.

This research was conducted throughout and immediately following the COVID-19 pandemic, as such, future research could focus on the enduring effects of managing digital

health in the context of rapidly emerging technologies, how healthcare organisations are transforming and adapting to achieve the health system gains of efficacy, value, safety and effectiveness, as well as the evolving health service managers competencies necessary to adeptly navigate digital transformation in this dynamic and burgeoning environment, which could also include addressing the rapid uptake of various business and clinical artificial intelligence tools. Additionally, it could be purposeful to expand this research into other sectors of the healthcare system, including primary, aged and community care. Future research could also explore competencies required in private healthcare settings, as well as in the digital health technology industry and vendor sector.

7.8 Conclusion

In conclusion, this PhD study provides important insights in three key areas, namely (1) the extent to which existing health service management and digital health competency frameworks guide development of competence for health service managers in understanding and managing in the digital health space, (2) competencies that are necessary for health service managers to acquire in order to effectively work with and manage in the digital health context, and (3) key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace.

Firstly, this research revealed a critical gap in existing health service management competency frameworks; nearly half of the competencies outlined in the Australasian Health Informatics Competency Framework (AHICF) were absent from the frameworks guiding health management education and training. Addressing this gap was essential to ensure health service managers are equipped to lead and manage in a digital health environment. The study's findings directly informed national competency framework revisions, shaping the future of workforce capability development. Specifically, the evidence contributed to the second edition of the AHICF, which now includes eleven leadership and management competencies (Australasian Institute of Digital Health, 2022), and influenced the Master Health Service Management Competency Framework to incorporate six digital management competencies (Australasian College of Health Service Management, 2022). These changes represent a significant advancement in aligning health management education with the demands of digital transformation, ensuring that future leaders possess the skills required to navigate and lead in technology-enabled health systems.

Secondly, this study has uniquely identified the lived experiences of health service managers as organisations in Australia introduce and scale up digital health. Their insights have distinguished and categorised changes in competencies required, some needing both strengthening and enhancing, for health service managers to undertake this work effectively

in supporting the organisation's vision, mission and strategic goals (Brommeyer et al., 2025). Thirdly, key factors that enable and inhibit health service managers to develop and demonstrate digital health competence in the workplace were published, with barriers including the human and technical challenges faced with digital health adoption, as well as the governance required for data-driven decision-making in a transforming environment. The enabling factors were illuminated in three key areas of the healthcare enterprise: (1) policy and system, (2) organisational structure and processes, and human resource management, and (3) people factors (Brommeyer et al., 2024b).

The research has identified broader health system changes required in an organisation, utilising the World Health Organization's six building blocks of a health system (World Health Organization, 2007) to support the health service managers in performing their role in context. This also includes the organisation's need to adapt across all six building blocks, to accommodate the impact of digital health throughout every aspect of the organisation. Without these enablers, health service managers cannot work effectively, nor can the organisation optimise the benefits from digital health. These insights have provided a broader policy, practice and research agenda required to ensure that health service managers are best equipped for digital health to realise its potential in assisting to achieve the health system gains of efficacy, value, safety and effectiveness.

The contributions to developing the contemporary digital health competencies for health service management education and training also include the PhD researcher's academic role as a teaching specialist, in leading the co-design and delivery of a new Flinders University Graduate Certificate in Digital Health Management, which commenced in 2024.

Future research might focus on the longer term influences of managing digital health in the contemporary milieu of rapidly emerging technologies, including addressing the rapid uptake of various artificial intelligence tools, to equitably manage the safe and effective use of artificial intelligence in healthcare. This must consider the changing health service managers competencies required to successfully steer digital transformation in this fast-changing environment.

Appendix A

Focus Group Discussion Guide

Focus Group Discussion Guide

Project Title: Digital Health Competencies for Health Service Managers

FGD Number:	Date:	Start Time:	End Time:

Run Sheet for Focus Group Discussion data collection

The focus group discussions will be conducted for approximately ninety (90) minutes each, following the below format and facilitated by the PhD candidate:

Stage	Activity	Question/Wording
Opening	Setting the scene 00:00 – 00:10	- Welcome and thank you all for participating. - To help set-the-scene: - The purpose of this study is to explore the changing <i>management requirements</i>, including the <i>skills</i> and <i>knowledge</i>, for health service managers to lead and manage in the Digital Health context, and to identify <i>key factors</i> that enable and inhibit your ability to be successful in your role. - Does anyone have any questions about the research, or is there any detail provided in the Participation Information Sheet, that anyone would like clarified please? - Explain focus group process, and questions: - I will pose a series of questions to stimulate discussion, as I am keen to hear your experiences, and what it means to manage in a digital health environment. - Some ground rules to start with, if I may: - Could you please leave your video cameras on during the session, so I can see you, and respond to any non-verbal cues, as we would if we were face-to-face in the same room. - You have the right to <i>not answer</i> any question, if you feel uncomfortable or concerned about confidentiality. - I would ask that you maintain each <i>other's confidentiality</i> in participation in this focus group and the discussions we have today. - There are no right or wrong answers, everyone's experiences and inputs are equally important and valid. - I would like to assure you that everything that is said in the focus group will be anonymised. The findings will contribute to my PhD research and will be reported in general, and your personal anonymity will be preserved.

		6. The focus group will be recorded, and the transcription function will be turned on – does anyone have an objection? (PAUSE – then turn ON recording + transcription).]
Benefits questions	Introductions/ Ice breaker Exploration Questions 00:10 – 00:20 00:20 – 00:30	It is useful to understand who we all are, as we undertake these discussions, so could you each please <i>briefly</i> introduce yourself by: i) name; ii) your current position; and iii) the organisation you work for (I'll start – I'm Mark Brommeyer, PhD candidate at James Cook Uni + Senior Lecturer in Health Care Management at Flinders Uni). Who would like to go next? Focus on: benefits Digital health, as defined by the Australian Institute of Health and Welfare (AIHW) is “an umbrella term referring to a range of technologies that can be used to treat patients and collect and share a person’s health information” and is used by patients, practitioners, managers and healthcare organisations, amongst others. 1. We know that adopting digital health can create many benefits – please take a minute to identify <i>two (2) benefits</i> that you have experienced in your workplace (allow each participant to respond) Probe → any examples of the sorts of benefits you have seen in your hospital/organisation?
Influencing factors questions	Tasks and key factors discussion 00:30 – 00:45	Focus on: factors and difficulties (content and context) 2. Have you experienced any <i>difficulties</i> in realising the benefits of introducing digital health in your organisation? Probe → any examples of the sort of difficulties you have experienced in practice? Probe → can you tell me more about...? Note → look for positives and negatives (any <i>system, organisational or local level</i> support to help you do your work) Probe → are there any factors that you feel are <i>state (SA, VIC, QLD, NSW...)</i> or <i>hospital (organisation)</i> based?

Required competencies questions	Competencies discussion 00:45 – 00:55 00:55 – 01:10	Focus on: competencies 3. As a manager, what skills and knowledge do you feel you need to have, to perform your management work? Probe → any examples of these skills or knowledge, in practice/needed on a day-to-day basis? Probe → does anyone have a similar experience? 4. As a result of adopting digital technologies, have you noticed any <i>changes</i> in the skills and knowledge you require as a manager – what are they? Probe → how has your EMR/digital health implementation changed your required skills/knowledge?
Additional responsibilities questions	Changing roles discussion 01:10 – 01:20	Focus on: additional responsibilities 5. In the last five years, as a result of introducing digital health into your organisation, have your <i>responsibilities increased</i>, as a manager? Probe → any examples of the added responsibilities you now have? Note → any expected responses (including COVID related vs. focussing on <i>digital specific changes</i>) Probe → any examples of the changes you have noticed?
	Final discussion 01:20 – 01:25	Are there any other ideas, inputs or comments you feel need to be considered, that we haven't already discussed?
Closing	Summary and thanks 01:25 – 01:30	1. Thank you very much for your time and so graciously sharing your experiences, insights and considerations, it is greatly appreciated. 2. I will email each of you a copy of the cleaned-up meeting transcript, for you to amend or delete any of your comments, should you wish to – you can also add any <i>additional</i> comments or information that you may have subsequently thought of, that you feel might be useful.

		3. The written and recorded data will then be analysed to aggregate the key competencies, skills, knowledge, and factors discussed. 4. (Turn OFF recording + download/save).
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Notes

1. If there are technical difficulties with any participant connecting/joining the MS Teams FGD call, they will be emailed and offered the opportunity to join a later FGD session, or to have a follow-up conversation/semi-structured interview to provide their inputs.
2. If the MS Teams call fails completely, all participants will be emailed to negotiate/plan a replacement/second-attempt FGD session.

Appendix B***Informed Consent***

All participants were sent an email invitation confirming participation and consent to participate in a Focus Group Discussion via MS Teams, as per below:

This administrative form
has been removed

Appendix C

Contextual checklist for managing in the digital health environment

From the research findings, **key questions to ask** when a digital health innovation is being implemented include (**part a.** of each question targets the *health service manager (HSM)*; and **part b.** of the question addresses the broader *healthcare system*):

Key questions to ask when a digital health innovation is being implemented	
1.	a. What are the adaptive competencies HSMs need to demonstrate in digital practice?
	b. How is the healthcare workforce trained to deal with ambiguity?
2.	a. What environmental factors will help or hinder HSM's capability to adapt to the transforming digital health context?
	b. What are the organisational constructs required to support HSMs to manage and lead in a digitally transforming context?
3.	a. How is competency applied and demonstrated in the digitally transforming environment for HSMs to be adaptive and agile?
	b. What are the strategic and systemic resources needed to support HSM's digital capacity to assist in achieving the health system gains of efficacy, value, safety and effectiveness?
4.	a. What skills and knowledge do HSMs need to strategically influence corporate digital decision-making?
	b. Organisationally, is digital governance aligned with clinical and corporate governance?
5.	a. How best can HSMs champion a commonly understood, shared digital language across the organisation?
	b. What data provenance frameworks are in place for system-generated decision support surety?
6.	a. What digital stewardship knowledge and skills do HSMs need to safely acquire, manage, protect, and grant appropriate access to digital information?
	b. Are there clear organisational data custodianship responsibilities evidenced for managing and approving the use of data in the digital environment?
7.	a. What capabilities do HSMs need to support whole-of-life digital systems investment decisions?
	b. How are organisational innovation and investment frameworks applied to decision making for digital health safety?
8.	a. What knowledge and skills do HSMs need to effectively and efficiently manage technology contracts and negotiate with digital technology vendors?
	b. What digital health regulations and technology standards are available to guide procurement, contract and vendor management?
9.	a. How can HSMs effectively employ integrated digital change, project and risk management capability frameworks and maturity models during times of transformation?

	b. Which organisational maturity models for digital health are endorsed and supported by the healthcare jurisdiction?
10.	a. How is digital governance employed to manage business and clinical risk in the workplace?
	b. Are clear roles, responsibilities and reporting mechanisms in place for maintaining robust organisational cybersecurity?
11.	a. How is contextualised authority-certainty for decision-ownership clarified in the digital health environment?
	b. Are organisational decision making authority, responsibility and delegations clearly understood?
12.	a. How do HSMs prioritise and access own competency development for managing in the digital age?
	b. How are resources allocated to increase digital literacy for the workforce?

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