Review

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

Mark Brommeyer [1, 2, *] and Zhanming Liang [2]

[1] College of Business, Government and Law, Flinders University, Adelaide, Australia; mark.brommeyer@flinders.edu.au
[2] College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Queensland, Australia; zhanming.liang@jcu.edu.au
* Correspondence: mark.brommeyer@flinders.edu.au

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 maximise 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 will guide the formulation of strategies in developing a digitally enabled health management workforce in the digital health era. Conclusions: With the ever-changing landscape of digital health, being able to lead and manage in times of system transformation requires a holistic approach to develop the necessary health management workforce capabilities and system-wide capacity. The evidence would support that this can be achieved with the required system, policy, educational and professional organizational enablers, which 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 organisations 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

 doi:10.20944/preprints202209.0300.v1

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', including 'right-sizing' of regulation, 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 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

The success in healthcare innovation and transformation necessitates a health workforce with the required understanding and new skillsets, 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 indicate 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 of difficulties in access, and the perceived lack of effectives 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 [16-18]. 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

The overall health workforce development should be fundamentally driven and supported by workforce policy with allocated funding and resources [19]. 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* [20]. 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.

 doi:10.20944/preprints202209.0300.v1

International studies [21-26] have highlighted that policy and system level factors are also crucial for the 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, support and investment in socio-economic and regulatory impact assessments of digital technologies is provided, and the privacy and integrity of digital data is 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 organisations in workforce development

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), and professional institutions: the Australasian College of Health Service Management (https://www.achsm.org.au) and Royal Australasian College of Medical Administrators (https://racma.edu.au). Other member-based professional institutions, such as the Australian College of Nursing (https://www.acn.edu.au), Australian College of Rural and Remote Medicine (https://www.acrrm.org.au) and Australasian Institute of Digital Health https://digitalhealth.org.au), 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 [27]. The 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

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.

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.

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 from national expert digital health

 doi:10.20944/preprints202209.0300.v1

working groups, led by the Australian Digital Health Agency, through undertaking environmental digital health policy, capability and competency framework scans.

The twelve identified digital health government, educational and workforce registration credentialling policy frameworks, were analyzed for digital health capability statements and key words, 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 fifty 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 [28]. Both authors then independently analyzed the current 17 master's degree programs, 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 (NWCPHP), as this has demonstrated a high level of confidence in the accuracy of the process for mapping competencies to its courses [29].

2.3. Scoping review

A scoping review of 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 [30] 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 key words: 'health informatics', 'digital health', 'electronic health', 'competencies', 'capability', 'proficiency', 'qualification', 'certification', 'health manager', 'health executive', 'health administrator', 'training', 'education', and 'professional development'. A PRISMA approach [31] was used for eligibility screening. The review searched for empirical articles published in the English language since 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 organisations, 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 [32]. The contextualized roles, e.g., HSM, require discipline-specific competencies to be demonstrated for increased proficiency across healthcare settings.

 doi:10.20944/preprints202209.0300.v1

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 needs 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), along with eleven Graduate Certificates in Health Informatics and Digital Health offerings. The master's degree focusses 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 1,679 publications, and after duplicates were removed, 1,344 + 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 in developing HSM workforce to be included in 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 [30].

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 September 2022 doi:10.20944/preprints202209.0300.v1

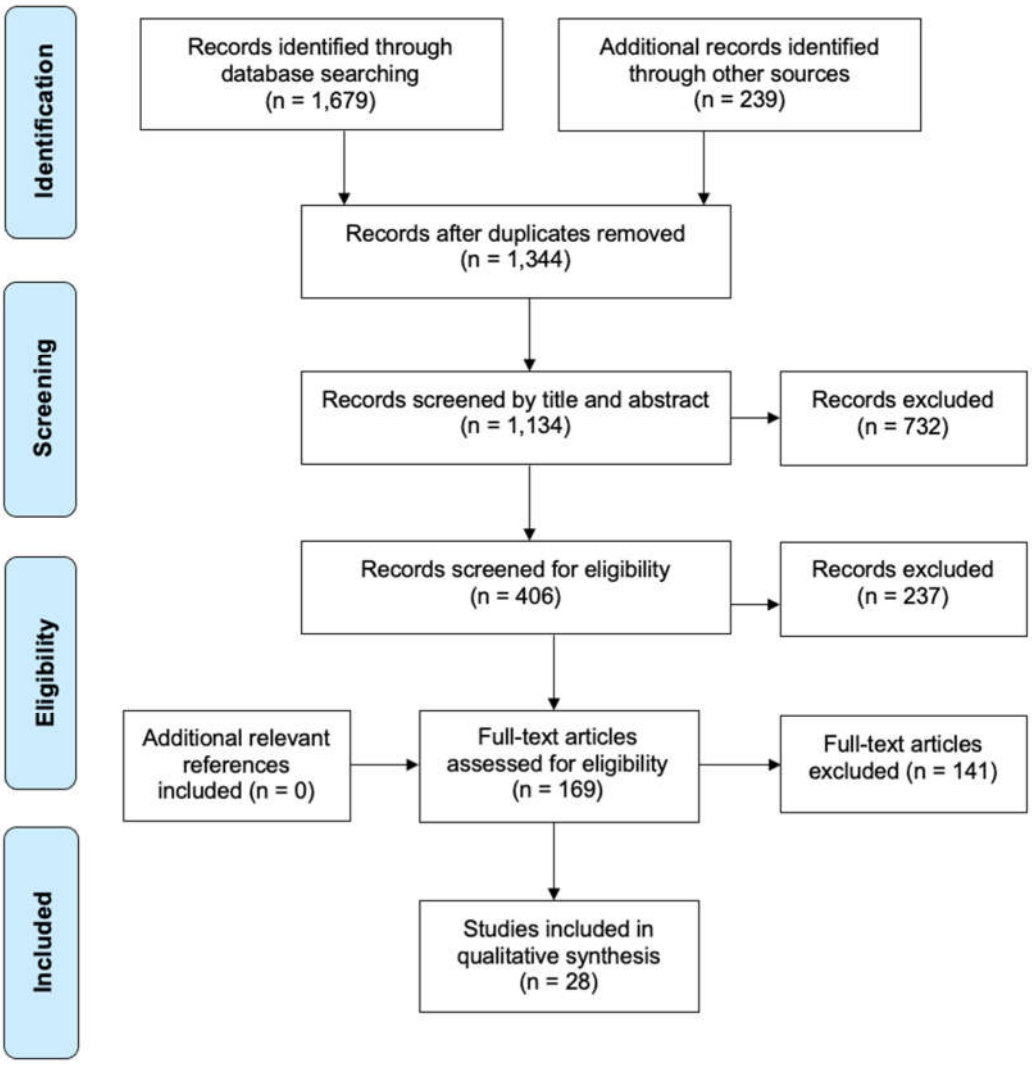

Figure 1. PRIMA Flow Diagram.

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 on various leadership and management trainings to different professional groups, including clinicians, nursing staff, and different types of management positions. The analysis confirmed that training programs targeting specific competency areas could develop managers' competency and management capacity, and institute positive change [33-44]. Leadership and management training has been proven a key ingredient in health system strengthening [38].

The analysis identified five key strategies and seven enabling factors that encourage competency and management capacity development, which are detailed in Table 1 and Table 2.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 September 2022 doi:10.20944/preprints202209.0300.v1

Table 1. Five key strategies for health management workforce development.

Strategy	Details
One [44-46]	Embedding competency assessment into management competency development processes.
Two [45,47]	Developing a competency model to guide developing competent HSM.
Three [49-50]	Providing formal and comprehensive HSM development opportunities to managers with three considerations*.
Four [34-38,51]	Providing short-term training programs targeting specific competency areas with seven considerations as management competency is context sensitive**.
Five [36,47,51-53]	Adopting a work-based learning and capacity building approach in providing training and support within the organization.

*The analysis of literature identified three key considerations for providing formal and comprehensive HSM development opportunities to managers:

1) Incorporating digital health competencies into 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 level within the organization
2) Taking the size of the hospitals into consideration as additional support maybe required for small hospitals
3) Leadership and management training and development needs to reflect local culture, hence work-based and action learning approach should be adopted
4) Recognising management competency development is an iterative, dynamic and complex process
5) Keeping capacity building approach in mind when developing training programs
6) Recognising complex leadership challenges can be a source of significant experiential learning for individual and groups, hence, articulating and reflecting on experiential learning can elucidates the skill, knowledge and judgments embedded in management practice
7) A progressive and staged learning process contributes to skill consolidation.

The analysis of the literature also confirmed seven key factors that can encourage the overall management workforce development as detailed in Table 2.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 September 2022 doi:10.20944/preprints202209.0300.v1

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

Factors	Details
One [37,43]	Acknowledement and recognition: • 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.
Two [43]	Organization's capacity in adopting innovation and support that assists HSM in adopting innovation.
Three [54]	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.
Four [38,55]	Provide high level support and political will in developing leadership and management across sectors and organizations.
Five [56]	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.
Six [50,57-59]	Investment in developing the health informatics and digital health workforce is critical. Managers can not lead a workforce that are not yet ready.
Seven [50]	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 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, postgraduate curricula and industry certifications [27]. 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 capacity of the organisation in supportive digital health adoption [38,43,54,55].

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 healthcare 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 [45,47], as well as embedding competency assessment into management competency development processes [44-46]. The need to include management and leadership competencies that focus on enabling system-wide transformation in the current digital context, was also evidenced [27].

 doi:10.20944/preprints202209.0300.v1

4.2. Efforts in developing a digitized HSM workforce

Efforts in developing a digitized HSM workforce are evident in multiple levels. Digital health and workforce policies have been developed [19]; 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 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 [27].

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 allows immediate translation into practice [34-38,51]. This is particularly true when evidence indicates that specific competencies relevant to leading and managing digital health transformation are required to be developed amongst health service managers [60]. Short-term training targeting identified competencies gaps is more appealing and relevant to health service managers for a number of reasons: workload, time availability and level of required commitment.

Literature has confirmed that management and management competency are context sensitive and influenced by the different nature of management positions and management levels [45,46]. A number of papers discussing evaluation results of training programs, reinforced the importance of taking organizational culture into consideration when designing training programs [43,53], hence, a work-based and action-learning approach were suggested [36,51]. This is certainly much easier to be adopted by short-term training 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 [45,46], hence, short-term programs, without fulfilling another degree requirements, may be more attractive to senior management levels. On the other hand, entry and middle level manager 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 [33]. Professional institutions, such as ACHSM in Australia, have the responsibility to support and ensure the accredited formal education programs for health service managers, are responsive to the changing workforce development needs [61].

4.3. 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 of 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 [62], developing the right systems for data management [63], and having an organization-wide awareness of required digital tools and technologies [64]. Furthermore, a sound understanding of how digital health systems promote quality care [65], as well as personal health information privacy and security principles, are key attributes required of successful health service managers [63,66]. 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

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 September 2022 doi:10.20944/preprints202209.0300.v1

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 [50]. 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 [67].

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.

4.4. A holistic approach toward HSM workforce development to enable digital heath 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 [59].

Competency assessment can identify individual's competency gaps and training needs via various processes such as self-assessment and 360-degree assessment [45,46]. 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.

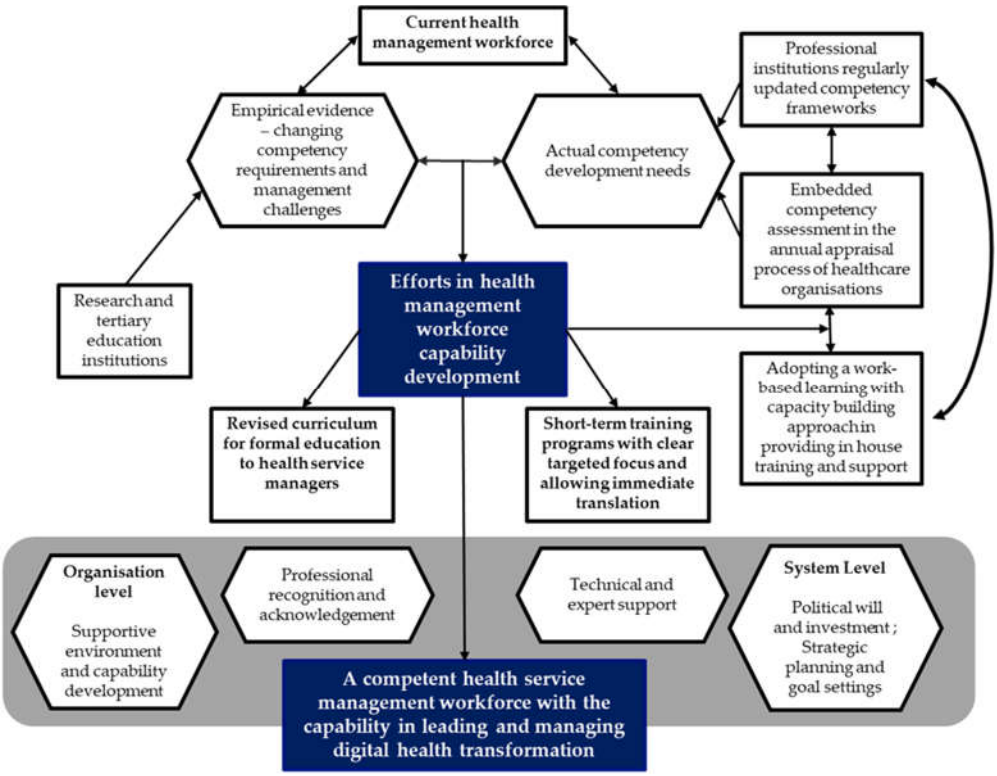

Figure 2. Framework for developing the HSM workforce in the digital health context .

 doi:10.20944/preprints202209.0300.v1

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 guidance on digital education for building health workforce capacity [71].

In the rapidly changing healthcare environment, professional development needs of the HSM workforce can't 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 [49,50,55,57-59], 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. A holistic approach to developing the requisite HSM capabilities and system-wide capacity 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 to the ongoing development of required digital health competencies and capabilities.

Author Contributions: MB and ZL are co-first authors of the paper and shared responsibilities in completing all research steps and developing and finalizing the article. MB was primarily responsible for policy analysis and competency mapping. ZL was primarily responsible for data extraction and analysis for the scoping review and developing the HSM workforce development conceptual framework.

Funding: With grateful acknowledgment to the Australian Government Research Training Program (RTP) fee offset scholarship.

Acknowledgments: We would like to acknowledge the contribution and support from Professor Mark Mackay, Professor Peter Balan, Dr Louise Schaper and Professor Maxine Whittaker in the access to required policies and competency mapping.

Conflicts of Interest: The authors declare no conflict of interest.

 doi:10.20944/preprints202209.0300.v1

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 seventeen 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
2) Curtin University – Master of Health Administration: https://handbook.curtin.edu.au/courses/course-pg-master-of-health-administration--mc-hladmnv1
3) Deakin University – Master of Business Administration (Healthcare Management): https://www.deakin.edu.au/course/master-business-administration-healthcare-management
4) Deakin University – Master of Health and Human Services Management: https://www.deakin.edu.au/course/master-health-and-human-services-management
5) Flinders University – Master of Health Administration: https://www.flinders.edu.au/study/courses/postgraduate-health-administration
6) Flinders University – Master of Business Administration (Healthcare Management): https://www.flinders.edu.au/study/courses/postgraduate-business-administration-health-management
7) Griffith University – Master of Health Services Management: https://www.griffith.edu.au/study/degrees/master-of-health-services-management-5586
8) Latrobe University – Master of Health Administration: https://www.latrobe.edu.au/courses/master-of-health-administration
9) Monash University – Master of Health Administration: https://online.monash.edu/online-courses/health-courses/online-master-health-administration
10) Murdoch University – Master of Health Care Management: https://www.murdoch.edu.au/course/Postgraduate/M1217

11) Queensland University of Technology – Master of Health Management: https://online.qut.edu.au/online-courses/health/master-of-health-management/
12) University of Adelaide – Master of Business Administration Health Management: https://online.adelaide.edu.au/campaign-lp-master-of-business-administration-health-management
13) University of New England – Master of Health Management: https://handbook.une.edu.au/courses/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
15) University of Tasmania – Master of Health Service Management: https://www.utas.edu.au/courses/bus/courses/c7o-master-of-health-service-management
16) University of Technology Sydney – Master of Health Services Management: https://studyonline.uts.edu.au/online-courses/master-health-services-management
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

References

1. Ingebrigtsen, T.; Georgiou, A.; Clay-Williams, R.; Magrabi, F.; Hordern, A.; Prgomet, M.; Li, J.; Westbrook, J.; Braithwaite, J. The impact of clinical leadership on health information technology adoption: systematic review. *Int. J. Med. Inform.* **2014**, *83*(6), 393-405. https://doi.10.1016/j.ijmedinf.2014.02.005.
2. Strudwick, G.; Nagle, L.M.; Morgan, A.; Kennedy, M.A.; Currie, L.M.; Lo, B.; White, P. Adapting and validating informatics competencies for senior nurse leaders in the Canadian context: results of a Delphi study. *Int. J. Med. Inform.* **2019**, *129*, 211-218. https://doi.10.1016/j.ijmedinf.2019.06.012.
3. Grain, H.; Hovenga, E. Health informatics competencies–underpinning e-health. In *Health Informatics: The Transformative Power of Innovation.* IOS Press. **2011**, 73-81. https://doi.10.1016/j.ijmedinf.2019.06.012.
4. Strudwick, G.; Nagle, L.; Kassam, I.; Pahwa, M.; Sequeira, L. Informatics competencies for nurse leaders: a scoping review. *J. Nurs. Adm.* **2019**, *49*(6), 323-330. https://doi.10.1097/NNA.0000000000000760.
5. Sheridan, P.T.; Watzlaf, V.; Fox, L.A. Health information management leaders and the practice of leadership through the lens of Bowen theory. *Perspect. health inf. manag.* **2016**, *13*(Spring).
6. Peek, N.; Sujan, M.; Scott, P. Digital health and care in pandemic times: impact of COVID-19. *BMJ Health Care Inform.* **2020**, *27*(1), e100166. https://doi:10.1136/bmjhci-2020-100166.
7. Pérez Sust, P.; Solans, O.; Fajardo, J.C.; Medina Peralta, M.; et al. Turning the Crisis Into an Opportunity: Digital Health Strategies Deployed During the COVID-19 Outbreak. *JMIR Public Health Surveill.* **2020**, *6*(2), e19106. https://doi:10.2196/19106.
8. Wong, B.L.H.; Maaß, L.; Vodden, A.; van Kessel, R.; Sorbello, S.; Buttigieg, S.; Odone, A.; Section, D.H.; European Public Health Association. The dawn of digital public health in Europe: Implications for public health policy and practice. *Lancet Reg. Health-Eur*. **2022**, *14*, p.100316. https://doi:10.1016/j.lanepe.2022.100316.
9. Williams, G.A.; Fahy, N.; Aissat, D.; Lenormand, M.C.; Stüwe, L.; Zablit-Schmidt, I.; Delafuys, S.; Le Douarin, Y.M.; Muscat, N.A. COVID-19 and the use of digital health tools: opportunity amid crisis that could transform health care delivery. *Eurohealth* **2022**, *28*(1).
10. Lee, P.; Abernethy, A.; Shaywitz, D.; Gundlapalli, A.V.; Weinstein, J. Doraiswamy, P.M.; Schulman, K.; Madhavan, S. Digital Health COVID-19 Impact Assessment: Lessons Learned and Compelling Needs. *NAM perspectives*, **2022**. https://doi:10.31478/202201c.
11. Sturgiss, E.; Desborough, J.; Dykgraaf, S.H.; Matenge, S.; Dut, G.; Davis, S.; de Toca, L.; Kelly, P.; Kidd, M. Digital health to support primary care provision during a global pandemic. *Aust. Health Rev*. **2022**, *46*(3), 269–272. https://doi.org/10.1071/AH21263.
12. Al Knawy, B.; McKillop, M.M.; Abduljawad, J.; Tarkoma, S.; Adil, M.; Schaper, L.; Chee, A.; Bates, D.W.; Klag, M.; Lee, U.; Kozlakidis, Z. Successfully implementing digital health to ensure future global health security during pandemics: a consensus statement. *JAMA Network Open*. **2022**, *5*(2), e220214. https://doi.org/10.1001/jamanetworkopen.2022.0214
13. Laukka, E.; Huhtakangas, M.; Heponiemi, T.; Kanste, O. Identifying the Roles of Healthcare Leaders in HIT Implementation: A Scoping Review of the Quantitative and Qualitative Evidence. *Int. J. Environ. Res. Public Health.* **2020**, *17*, 2865. https://doi.org/10.3390/ijerph17082865.
14. Jones, E.B. Factors Associated With Electronic Health Record Use Among Nurse Practitioners in the United States. *J Ambul Care Manage.* **2017**, *40*(1), 48-58. https://doi.10.1097/JAC.0000000000000169.

15. Sockolow, P.S.; Bowles, K.H.; Adelsberger, M.C.; Chittams, J.L.; Liao, C. Challenges and Facilitators to Adoption of a Point-of-Care Electronic Health Record in Home Care. *Home Health Care Serv. Q.* **2014**, *33*(1), 14-35. https://doi.10.1080/01621424.2013.870098.
16. Aarons, G.A.; Ehrhart, M.G.; Farahnak, L.R.; Sklar, M. Aligning Leadership Across Systems and Organizations to Develop a Strategic Climate for Evidence-Based Practice Implementation. *Annu. Rev. Public Health.* **2014**, *35*, 255–274. https://doi.10.1146/annurev-publhealth-032013-182447.
17. Ingebrigtsen, T.; Georgiou, A.; Clay-Williams, R.; Magrabi, F.; Hordern, A.; Prgomet, M.; Li, J.; Westbrook, J.; Braithwaite, J. The Impact of Clinical Leadership on Health Information Technology Adoption: Systematic Review. *Int. J. Med. Inform.* **2014**, *83*, 393–405. https://doi.10.1016/j.ijmedinf.2014.02.005.
18. Murphy, J. Leading from the future: leadership makes a difference during electronic health record implementation. *Front Health Serv Manage.* **2011**, *28*(1), 25-30. PMID: 21961382.
19. Socha-Dietrich K. 2020. Empowering the health workforce – Strategies to make the most of the digital revolution. OECD Directorate of Employment. Available online: https://www.oecd.org/health/health-systems/Empowering-Health-Workforce-Digital-Revolution.pdf (accessed on 11 September 2022).
20. Australian Digital Health Agency. *National digital health workforce and education roadmap*. Australian Government, Sydney, **2020a**.
21. Castillo, V.H.; Martínez-García, A.I.; Pulido, J.R.G. A knowledge-based taxonomy of critical factors for adopting electronic health record systems by physicians: a systematic literature review. *BMC Medical Inform. Decis. Mak.* **2010**, *10*(1), 1-17. https://doi.10.1186/1472-6947-10-60.
22. Beane, A.; De Silva, A.P.; Athapattu, P.L.; Jayasinghe, S.; Abayadeera, A.U.; Wijerathne, M.; Udayanga, I.; Rathnayake, S.; Dondorp, A.M.; Haniffa, R. Addressing the information deficit in global health: lessons from a digital acute care platform in Sri Lanka. *BMJ Glob. Health*. **2019**, 4(1). https://doi.10.1136/bmjgh-2018-001134.
23. Scott, P.J.; Dunscombe, R.; Evans, D.; Mukherjee, M; Wyatt, J.C. Learning health systems need to bridge the 'two cultures' of clinical informatics and data science. *J Innov Health Inform.* **2018**, *25*(2), 126-131. https://doi.10.14236/jhi.v25i2.1062.
24. Craig, S; Kodate, N. Understanding the state of health information in Ireland: A qualitative study using a socio-technical approach. *Int. J. Med. Inform.* **2018**, 114, 1-5. https://doi.10.1016/j.ijmedinf.2018.03.001.
25. Afnan, A.; Chandrasekaran, R. Factors Associated with EHR User Satisfaction in Small Clinic Settings. Thirty Sixth International Conference on Information Systems. **2015**, Fort Worth, USA, pp.1-10.
26. Stroetmann, K.A.; Artmann, J; Stroetmann, V. Developing national eHealth infrastructures–results and lessons from Europe. In AMIA Annual Symposium Proceedings. American Medical Informatics Association. **2011**, 1347-1354.
27. Ritchie, A., Siemensma, G., Fenton, S.H.; Butler-Henderson, K. Competencies, Education, and Accreditation of the Health Information Workforce. In: *Health Informatics*. **2021**, pp. 79–95. https://doi:10.1007/978-3-030-81850-0_5.
28. Brommeyer, M.; Mackay, M.; Liang, Z.; Schaper, L.; Balan, P. A proposed approach to investigate whether postgraduate health care management education in Australian universities facilitates the development of informatics competencies. *Stud Health Technol Inform*. **2021**, *284*, 93-97. https://doi.10.3233/SHTI210677.
29. Neiworth, L.L.; Allan, S.; D'Ambrosio, L.; Coplen-Abrahamson, M. Charting a course to competency: An approach to mapping public health core competencies to existing trainings. *Health Promot. Pract*. **2014**, *15*:1, 33S-38S. https://doi.10.1177/1524839913509274.
30. Arksey, H.; O'Malley, L. Scoping studies: towards a methodological framework. *Int. J. Soc. Res. Methodol.* **2005**, *8*(1), 19-32.
31. Liberati, A.; Altman, D.G.; Tetzlaff, J.; Mulrow, C.; Gøtzsche, P.C.; Ioannidis, J.P.; Clarke, M.; Devereaux, P.J.; Kleijnen, J.; Moher, D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J. Clin. Epidemiol.* **2009**, *62*(10), 1-34. https://doi.10.1371/journal.pmed.1000100.
32. Australian Digital Health Agency. *National nursing and midwifery digital health capability framework*. Australian Government, Sydney, **2020a**.
33. Ackerly, D.C.; Sangvai, D.G.; Udayakumar, K.; Shah, B.R.; Kalman, N.S.; Cho, A.H.; Schulman, K.A.; Fulkerson Jr, W.J.; Dzau, V.J. Training the next generation of physician–executives: an innovative residency pathway in management and leadership. *Acad Med.* **2011**, *86*(5), 575-579. https://doi.10.1097/ACM.0b013e318212e51b.
34. Agarwal, R.; Green, R.; Agarwal, N.; Randhawa, K. Management practices in Australian healthcare: can NSW public hospitals do better? *J Health Organ Manag*. **2016**. *30*(3), 331-53. https://doi:10.1108/JHOM-01-2015-0016.
35. Chapman, T.W.; Confessorre, S. The dominant influence of social context on CEO learning in health care: a challenge to traditional management continuing education and development. *J Health Adm Educ.* **2002**, *20*(2), 123-134.
36. Clarke, E.; Diers, D.; Kunisch, J.; Duffield, C.; Thoms, D.; Hawes, S.U.E.; Stasa, H.; Fry, M. Strengthening the nursing and midwifery unit manager role: an interim programme evaluation. *J. Nurs. Manag*. **2012**, *20*(1), 120-129. https://doi.10.1111/j.1365-2834.2011.01331.x.
37. Gumus, G.; Borkowski, N.; Deckard, G.J.; Martel, K.J. Healthcare Managers' perceptions of Professional Development and Organizational Support. *J Health Hum Serv Adm*. **2011**, *34*(1), 42-63.
38. Mutale, W.; Vardoy-Mutale, A.T.; Kachemba, A.; Mukendi, R.; Clarke, K.; Mulenga, D. Leadership and management training as a catalyst to health system strengthening in low-income settings: Evidence from implementation of the Zambia Management and Leadership course for district health managers in Zambia. *PLoS One*. **2017**, *12*(7), p.e0174536. https://doi.10.1371/journal.pone.0174536.
39. Omar, M.; Gerein, N.; Tarin, E.; Butcher, C.; Pearson, S.; Heidari, G. Training evaluation: a case study of training Iranian health managers. *Hum. Resour. Health.* **2009**, *7*(1), 1-14. https://doi.10.1186/1478-4491-7-20.

40. Penney, S.; Ryan, A. The effect of a leadership support programme on care home managers. *Nurs Older People.* **2018**, *34*(3), 35-40. https://doi:10.7748/nop.2018.e979.
41. Sucaldito, N.L.; Tayag, E.A.; Roces, M.C.R.; Malison, M.D.; Robie, B.D.; Howze, E.H. The Philippines Field Management Training Program (FMTP): strengthening management capacity in a decentralized public health system. *Int J Public Health.* **2014**, *59*(6), 97-903. https://doi:10.1007/s00038-014-0603-5.
42. Terzic-Supic, Z.; Bjegovic-Mikanovic, V.; Vukovic, D.; Santric-Milicevic, M.; Marinkovic, J.; Vasic, V.; Laaser, U. Training hospital managers for strategic planning and management: a prospective study. *BMC Med Educ.* **2015**, *5*(1), 25. https://doi:10.1186/s12909-015-0310-9.
43. Weatherford, B.; Bower, K.A.; Vitello-Cicciu, J. The CNO and leading innovation: Competencies for the future. *Nurs Adm Q.* **2018**, *42*(1), 76-82. https://doi:10.1097/NAQ.0000000000000263.
44. Heuston, M.M.; Leaver, C; Harne-Britner, S. Using Data from a 360° Leadership Assessment to Enhance Nurse Manager Transformational Leadership Skills. *J Nurs Adm.* **2021**, *51*(9), 448-454. https://doi.10.1097/NNA.0000000000001044
45. Liang, Z.; Howard, P.; Wang, J.; Xu, M; Zhao, M. Developing senior hospital managers: does 'one size fit all'? Evidence from the evolving Chinese health system. *BMC Health Serv. Res.* **2020**, *20*(1), 1-14. https://doi.10.1186/s12913-020-05116-6.
46. Liang, Z.; Howard P.F.; Leggat, S.; Bartram, T. Development and validation of health service management competencies. *J Health Organ Manag.* **2018**, *32*(2), 157-175. https://doi.10.1108/JHOM-06-2017-0120.
47. Tetui, M.; Coe, A.B.; Hurtig, A.K.; Bennett, S.; Kiwanuka, S.N.; George, A.; Kiracho, E.E. A participatory action research approach to strengthening health managers' capacity at district level in Eastern Uganda. *Health Res. Policy Syst.* **2017**, *15*(2), 39-53. https://doi.10.1186/s12961-017-0273-x.
48. Duarte, R.G.; Miura, I.K.; Sawada, N.O.; Alves, M.; Petrin, R. The development of transversal competence of health service managers. *Revista de saúde pública*. **2019**, *53*. https://doi.10.11606/s1518-8787.2019053001292.
49. Hersh, W.R.; Gorman, P.N.; Biagioli, F.E.; Mohan, V.; Gold, J.A.; Mejicano, G.C. Beyond information retrieval and electronic health record use: competencies in clinical informatics for medical education. *Adv Med Educ Pract*. **2014**, *5*, 205-212. https://doi.10.2147/AMEP.S63903.
50. Gray, K.; Dattakumar, A.; Maeder, A.; Butler-Henderson, K.; Chenery, H. *Advancing Ehealth Education for the Clinical Health Professions; Final Report*. Australian Government Department of Education Office for Learning and Teaching, Sydney, **2018**.
51. Edmonstone, J. Leadership development in health care in low and middle-income countries: is there another way? *Int J Health Plann Manage.* **2018**, *33*(4), e1193-e1199. https://doi:10.1002/hpm.2606.
52. Tetui, M.; Zulu, J.M.; Hurtig, A.K.; Ekirapa-Kiracho, E.; Kiwanuka, S.N.; Coe, A.B. Elements for harnessing participatory action research to strengthen health managers' capacity: a critical interpretative synthesis. *Health Res. Policy Syst.* **2018**, *16*(1), 1-14. https://doi.10.1186/s12961-018-0306-0.
53. Cathcart, E.B.; Greenspan, M.; Quin, M. The making of a nurse manager: the role of experiential learning in leadership development. *J. Nurs. Manag.* **2010**, *18*(4), 440-447. https://doi.10.1111/j.1365-2834.2010.01082.x.
54. Brooke-Sumner, C.; Petersen-Williams, P.; Kruger, J.; Mahomed, H.; Myers, B. 'Doing more with less': a qualitative investigation of perceptions of South African health service managers on implementation of health innovations. *Health Policy Plan.* **2019**, *34*(2), 132-140. https://doi.10.1093/heapol/czz017
55. Were, M.C.; Gong, W.; Balirwa, P.; Balugaba, B.E.; Yeung, A.; Pierce, L.; Ingles, D.; Kim, Y.; Shepherd, B.E. Coverage of IMIA-recommended competencies by masters in health informatics degree programs in East Africa. *Int. J. Med. Inform.* **2020**, *143*, p.104265. https://doi.10.1016/j.ijmedinf.2020.104265.
56. van Hulzen, G.; Martin, N.; Depaire, B.; Souverijns, G. Supporting capacity management decisions in healthcare using data-driven process simulation. *J. Biomed. Inform.* **2022**, *129*, p.104060. https://doi.10.1016/j.jbi.2022.104060.
57. Sapci, A.H.; Sapci, H.A. Teaching hands-on informatics skills to future health informaticians: a competency framework proposal and analysis of health care informatics curricula. *JMIR Med. Inform.* **2020**, *8*(1), p.e15748. https://doi.10.2196/15748.
58. Jidkov, L.; Alexander, M.; Bark, P.; Williams, J.G.; Kay, J.; Taylor, P.; Hemingway, H.; Banerjee, A. Health informatics competencies in postgraduate medical education and training in the UK: a mixed methods study. *BMJ open*. **2019**, *9*(3), p.e025460. https://doi.10.1136/bmjopen-2018-025460.
59. Butler-Henderson, K.; Gray, K.; Pearce, C.; Ritchie, A.; Brophy, J.; Schaper, L.K.; Bennett, V.; Ryan, A. Exploring the health informatics occupational group in the 2018 Australian health information workforce census. *Stud. Health Technol. Inform.* **2019**, *266*, 44-50. https://doi.10.3233/SHTI190771.
60. Leung, T.I.; Wang, K.H.; McCall, T; Merode, F.V. Leadership Roles in the Specialist Digital Health Workforce. In *The Health Information Workforce*. 2021, 171-184. Springer, Cham. https://doi.org/10.1007/978-3-030-81850-0_11.
61. Australasian College of Health Service Management. *Master health service management competency framework*. ACHSM, Sydney, **2016**.
62. Butler-Henderson, K.; Dalton, L.; Probst, Y.; Maunder, K.; Merolli, M. A meta-synthesis of competency standards suggest allied health are not preparing for a digital health future. *Int. J. Med. Inform.* **2020**, *144*, p.104296. https://doi.10.1016/j.ijmedinf.2020.104296.
63. Valenta, A.L.; Meagher, E.A.; Tachinardi, U.; Starren, J. Core informatics competencies for clinical and translational scientists: what do our customers and collaborators need to know? *J Am Med Inform Assoc.* **2016**, *23*(4), 835-839. https://doi.10.1093/jamia/ocw047.
64. Westra, B.L.; Delaney, C.W. Informatics competencies for nursing and healthcare leaders. In *AMIA Annual Symposium Proceedings*. American Medical Informatics Association. **2008**, 804-808.

65. Kennedy, M.A.; Moen, A. Nurse leadership and informatics competencies: shaping transformation of professional practice. *Stud Health Technol Inform.* **2017**, *232*, 197-206. https://doi.10.3233/978-1-61499-738-2-197.
66. Sheridan, P.T.; Watzlaf, V.; Fox, L.A. Health information management leaders and the practice of leadership through the lens of Bowen theory. *Perspect. health inf. manag.* **2016**, *13*.
67. Australian Digital Health Agency. *National digital health workforce and education roadmap*. Australian Government, Sydney, **2020b**.
68. Latham, G.; Almost, J.; Mann, S.; Moore, C. New developments in performance management. *Organ. Dyn.* **2005**. *34*, 77–87. https://doi.10.1016/j.orgdyn.2004.11.001.
69. Maurer, J.; Kimberly, A.; Haefner, J.; Stuart, A.; William, C. Beliefs about 'improvability' of career-relevant skills: Relevance to job/task analysis, competency modelling, and learning orientation. *J. Organ. Behav.* **2003**, *24*, 107–131. https://doi.10.1002/job.182.
70. World Health Organization. *WHO guideline: recommendations on digital interventions for health system strengthening*. World Health Organization, Geneva, 2019.
71. World Health Organization. *Digital education for building health workforce capacity*. World Health Organization, Geneva, 2020.