Disinvestment initiatives in healthcare

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Abstract

Background:

Health systems worldwide are increasingly adopting disinvestment initiatives to enhance care quality and maximize value by eliminating ineffective and obsolete interventions. However, removing low-value care (LVC) is challenging and complex, as many were adopted without rigorous evidence of clinical or cost-effectiveness, as well as resistance from healthcare stakeholders due to uncertainty in the outcomes of disinvestment. Inconsistent systems for identifying such technologies exacerbate this issue, along with unclear methodologies to assess these LVC. Existing disinvestment efforts have achieved mixed success, highlighting a critical need for structured, inclusive, and evidence-based approaches to address these gaps and enhance the implementation of the initiatives.

Methods:

This multi-method study included a scoping review of healthcare disinvestment initiatives, a mixed-method study integrating an online survey and key informant interviews with Malaysian healthcare stakeholders, and triangulation of findings to inform the development of a decision-making framework. Two case studies were conducted to assess LVC candidates, and the proposed framework was pilot-tested in a stakeholder workshop.

Results:

Stakeholder engagement emerged as pivotal for the success of disinvestment initiatives. Through stakeholder engagement, scoping review, and consultation with experts, this thesis introduces a novel decision-making framework based on the value of de-implementation concept, which incorporates five key domains: health impact, equity considerations, enablers for disinvestment, system readiness, and economic impact. Pilot-testing with Malaysian stakeholders demonstrated the framework's feasibility and acceptance, supporting its role in promoting a systematic, transparent, and inclusive approach to disinvestment.

Implications:

Implementing healthcare disinvestment as a policy-driven initiative requires a complex approach of stakeholder engagement and empowerment, as well as systematic and comprehensive methodology. This process is heavily dependent on reliable data and evidence to support the assessment and decision-making process, availability of guidance or framework for decision-making, as well as leadership commitment and resources to ensure the sustainability of the effort. Future work should aim to integrate public and patient perspectives into the decision-making process, with opportunities to refine, evaluate, and validate the proposed framework. Further research is needed in assessing the impact of disinvestment decisions and recommendations, especially in optimising value in health service delivery and transition to higher-value strategies as a result of de-implementing LVC.

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Publications and presentations

The following publications, conference presentations, and panel sessions have resulted from the research described in this thesis. My specific contribution to each component of the project is described in detail in Author's Declaration (page 16).

a) Publications

Kamaruzaman HF, Grieve E, Wu O. Disinvestment in healthcare: a scoping review of systematic reviews. International Journal of Technology Assessment in Health Care. 2022;38(1):e69. DOI: https://doi.org/10.1017/S0266462322000514
(Chapter 2, reproduced with permission from Cambridge University Press.)

Kamaruzaman HF, Grieve E, Ku Abd Rahim KN, Izzuna MMG, Lee SW, Romli EZ, Abdullah MH, Wu O. Stakeholders' perspectives on disinvestment of low-value healthcare interventions and practices in Malaysia: an online survey. International Journal of Technology Assessment in Health Care. 2024; 40(1):e57. DOI: https://doi.org/10.1017/S0266462324004665
(Chapter 4, reproduced with permission from Cambridge University Press.)

Kamaruzaman HF, Ku Abd Rahim KN, Izzuna MMG. Disinvestment initiatives in Malaysia: the journey from possibility to reality. GMS Health Innovation and Technologies. 2024;18:Doc03. DOI: https://dx.doi.org/10.3205/hta000140
(Discussed in Chapter 3, but not included as a chapter in this thesis.)

b) Conference presentations

Kamaruzaman HF, Grieve E, Wu O. (2022) Disinvestment initiatives in healthcare: a scoping review of systematic reviews. *Health Systems Research UK 15th Annual Conference*, Sheffield, United Kingdom, 5th-7th July 2022.

Kamaruzaman HF, Nik Adnan NA, Mohd Salleh NH, Ali FZ, Ku Abd Rahim KNH, Lee SW, Grieve E, Wu O. (2023) Prescribing pattern of targeted therapy in advanced renal cell carcinoma: utilising real-world evidence (RWE) in clinical practice for disinvestment initiatives in Malaysia. *Guidelines International Network (GIN) Hybrid Conference 2023*, Glasgow, United Kingdom, 19th-23rd September 2023.

Kamaruzaman HF, Grieve E, Ku Abd Rahim KN, Izzuna MMG, Lee SW, Romli EZ, Abdullah MH, Wu O. (2023) A survey on stakeholder perspectives on disinvestment of low-value health care interventions and practices in Malaysia. *GIN Hybrid Conference 2023*, Glasgow, United Kingdom, 19th-23rd September 2023.

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c) Panel discussions and plenary sessions

Kamaruzaman HF, Farokhian P, Torres-Rueda S, Baker P. Achieving UHC Requires Disinvestment as Well as Investment: Experience of Malaysia, Iran and Uganda. Center for Global Department (CGD) Talks, 31st January 2023 [online].
Webinar recording link: https://www.cgdev.org/event/achieving-uhc-requires-disinvestment-well-investment-experience-malaysia-iran-and-uganda

Babidge W, Kar SS, Park JY, Kamaruzaman HF, Isaranuwatchai W. Innovative Approaches in Tackling HTA Challenges: *"Can Disinvestment Shift Resources Towards Higher Value Technology?"* HTAsialink Conference 2023, 4th-7th September 2023, Putrajaya, Malaysia.

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Author's declaration and contribution statements

I, Hanin Farhana Kamaruzaman, declare that I am the sole author of this thesis, except where the contribution of others has been acknowledged, as below. The work in this thesis has not been submitted in any form for another degree or professional qualification at the University of Glasgow or any other institution.

Contribution statements

Chapter 1: The drafting of this chapter was led by myself, with consultation and suggestions from my supervisors, Prof. Olivia Wu and Dr. Eleanor Grieve.

Chapter 2: The conceptualisation of this review was led by myself and my supervisors Prof. Olivia Wu and Dr. Eleanor Grieve. I performed the search, data extraction, analysis and manuscript drafting. The search was validated, and the manuscript reviewed and edited by my supervisors. All co-authors provided feedback on the analysis; interpretation of results; manuscript; and response to reviewers' comments.

Chapter 3: The drafting of this chapter was led by myself, with consultation and suggestions from my supervisors, Prof. Olivia Wu and Dr. Eleanor Grieve.

Chapter 4: The conceptualisation and methodological design of this study was led by myself, my supervisors Prof. Olivia Wu and Dr. Eleanor Grieve, as well as the co-authors from the Ministry of Health Malaysia (Ku Nurhasni Ku Abd Rahim, Izzuna Mudla Mohamed Ghazali, Lee Sit Wai, Erni Zurina Romli and Mohamed Hirman Abdullah. I wrote the first draft of the protocol and revised it following input from supervisors and all co-authors. I led the distribution of the survey, data collection, and data cleaning, with help from Ku Nurhasni and Lee Sit Wai. I performed the primary analysis and manuscript drafting, and all co-authors provided feedback on the analysis; interpretation of results; manuscript; and response to reviewers' comments.

Chapter 5: The conceptualisation and methodological design of this study was led by myself, my supervisors Prof. Olivia Wu and Dr. Eleanor Grieve, as well as the co-authors (Ku Nurhasni Ku Abd Rahim, Izzuna Mudla Mohamed Ghazali, Lee Sit Wai, Erni Zurina Romli and Mohamed Hirman Abdullah). I wrote the first draft of the protocol and revised it following input from supervisors and all co-authors. I led the pilot interviews, with assistance from Habibah Kamaruzaman. I conducted all the interviews and transcribing, with validation of the transcription done by Erni Zurina and Habibah Kamaruzaman. I performed the primary analysis and consulted Evi Germeni for initial findings of the themes and sub-themes. I led the manuscript drafting, and all co-authors provided feedback on the analysis; interpretation of results; and manuscript preparation for journal submission.

Chapter 6: The drafting of this chapter was led by myself, with consultation and suggestions from my supervisors, Prof. Olivia Wu and Dr. Eleanor Grieve. Online discussions with Assoc. Prof. Dr. Sitaporn Youngkong, the MCDA expert from Mahidol University, were conducted twice (May and September 2024) to get insights on MCDA in disinvestment decision-making and to review the developed framework. Advice from Dr. Nicola McMeekin, a research associate with experience in conceptual models from the University of Glasgow, was also sought in the beginning of developing the framework.

Chapter 7: The drafting of this chapter was led by myself, with consultation and suggestions from my supervisors, Prof. Olivia Wu and Dr. Eleanor Grieve.

For the first case study in this chapter (Interferon-alpha-2a in advanced renal cell carcinoma), I wrote the first draft of the protocol and revised it following input from supervisors and all co-researchers (Ku Nurhasni, Lee Sit Wai, Nik Nuradlina Nik Adnan, Nur Hazalina Mohd Salleh, and Fawzi Zaidan Ali). The data collection on prescribing patterns in two Malaysian hospitals was done by Nik Nuradlina and Nur Hazalina. I performed the data analysis, and all co-authors provided feedback on the analysis and interpretation of results.

For the second case study (colorectal cancer screening programme in Malaysia), the conceptualisation and methodological design of this study was led by myself, with consultation and suggestions from my supervisors, Prof. Olivia Wu and Dr. Eleanor Grieve. I conducted the analysis, and my supervisors provided feedback on the analysis, interpretation of results and discussion on the findings from the case study.

For the pilot workshop with Malaysian healthcare stakeholders, the conceptualisation, slides presentation, and documents preparation were led by me with consultation and suggestions from my supervisors, Prof. Olivia Wu and Dr. Eleanor Grieve. Group work was conducted primarily by myself, and facilitators for each group were from the Malaysian Health Technology Assessment Section. I performed the analysis and presented the outcomes from the workshop to my supervisors for feedback.

Chapter 8: The drafting of this chapter was led by myself, with consultation and suggestions from my supervisors, Prof. Olivia Wu and Dr. Eleanor Grieve.

Abbreviations

A4R	:	Accountability for Reasonableness
ASEAN	:	Association of Southeast Asian Nations
BIA	:	Budget impact analysis
CBA	:	Cost-benefit analysis
CCA	:	Cost-consequence analysis
CEA	:	Cost-effectiveness analysis
CPG	:	Clinical practice guidelines
CRC	:	Colorectal cancer
CUA	:	Cost-utility analysis
GDP	:	Gross domestic product
HEHTA	:	Health Economics and Health Technology Assessment
HTA	:	Health technology assessment
HTAi	:	Health Technology Assessment International
HTR	:	Health technology reassessment
ICER	:	Incremental cost effectiveness ratio
IFN	:	Interferon
INAHTA	:	International Network of Agencies for Health Technology Assessment
ISPOR	:	International Society for Pharmacoeconomics and Outcomes Research
KII	:	Key informant interview
LMIC	:	Lower- and middle-income countries
LVC	:	Low-value care
MaHTAS	:	Malaysian Health Technology Assessment Section
MAUT	:	Multi-Attribute Utility Theory
MCDA	:	Multicriteria Decision Analysis
MOH	:	Ministry of Health
NICE	:	National Institute for Health and Care Excellence
NHB	:	Net health benefit
NMB	:	Net monetary benefit
PBMA	:	Program Budgeting and Marginal Analysis
PSRA	:	Priority setting and resource allocation
QALY	:	Quality-adjusted life years

RCC	:	Renal cell carcinoma
RCT	:	Randomised controlled trial
RWD	:	Real world data
RWE	:	Real world evidence
SMART	:	Simple Multi-attribute Rating Technique
SMARTER	:	Simple Multi-attribute Rating Technique Exploiting Ranks
UHC	:	Universal health coverage
UK	:	United Kingdom
UMIC	:	Upper-middle-income countries
US	:	United States
WHO	:	World Health Organization
WTP	:	Willingness-to-pay

Chapter 1: Introduction

1.1 Overview of chapter

This introductory chapter provides a general overview of the thesis, focusing on disinvestment initiatives within the broader context of priority setting and resource allocation in healthcare and the concept of low-value care (LVC). Subsequently, the chapter includes a note on the Malaysian healthcare system, which is an integral component of this study. The chapter then delves into the research motivations, tracing its development over time and serving as a guide to the structure and content of the thesis.

1.2 Background

1.2.1 Priority setting, resource allocation, and disinvestment

Priority setting and resource allocation (PSRA) are fundamental components of a sustainable healthcare system, particularly in the face of constrained budgets and growing expectations for high-quality care. It encompasses the processes and decisions made at various levels of healthcare systems to allocate resources effectively amidst limited funding and increasing demands (1, 2). While no single definition exists, it is broadly understood as the activity of determining what health services to provide, how, where, and for whom (3).

Priority setting with or without resource allocation occurs at three tiers in healthcare decision-making: macro-, meso-, and micro-levels (4). The macro-level involves national or global decisions on resource allocation across the health system. The meso-level focuses on regional, provincial, or district priorities, dividing resources among competing services. At the micro-level, decisions are made at the hospital or facility level, prioritising funding for individual patients (4). A formal framework for PSRA at various levels guides decision-making systematically, promoting more equitable and efficient use of resources in healthcare. Despite the potential benefit

of it, there is a lack of research exploring whether explicit PSRA processes can effectively contribute to cost containment at the regional or national level within healthcare systems (2).

Many healthcare systems are grappling with a dual challenge of managing limited resources while striving to improve health outcomes in achieving universal health coverage (UHC). Since it is not feasible to fund all potentially beneficial treatments, boundaries must be established, and difficult decisions must be made to optimise the use of limited resources through priority setting. Alongside this challenge is the concept of disinvestment, an emerging strategy aimed at reallocating resources away from low-value or obsolete practices and interventions to areas of higher value (5). It involves a deliberate process of identifying and removing interventions that no longer meet the criteria of clinical or cost-effectiveness (6).

A systematic review by Kaur et al. (2019) highlighted that cost-effectiveness, health benefits, and equity were found to be the most used criteria in PSRA for public health investment decision-making in the lower- and middle-income countries (LMIC) (4). However, the same could not be directly said about disinvestment, as the two may differ primarily in focus and context, reflecting their distinct objectives. Setting priorities for investment emphasises potential future benefits, while for disinvestment, the focus is mainly on reducing inefficiencies and wastages, and removing underperforming interventions. A more crucial element is, disinvestment must consider the impact of removing a service on existing workflows, stakeholder acceptance, and patient care continuity, which is less relevant for investment. Therefore, there is a need to further explore the criteria used and the relationships between the above components to effectively implement disinvestment initiatives.

1.2.2 Low-value care (LVC)

The general belief that ‘more is better’ in healthcare, frequently referred to as the Mae West Hypothesis, suggests that an abundance of technology is inherently beneficial (7). However, the expansion of LVC challenges this concept, as such

practices not only offer limited clinical benefit but also impose substantial opportunity costs, making them both inefficient in terms of quality of care and resource spending, and potentially harmful, which jeopardises patient safety. Despite this, the adoption of low-value technologies in clinical practice often occurs passively, lacking structured guidance or formal mechanisms to address the impact (8). Therefore, a systematic approach to identifying, evaluating, and determining the appropriate course of action for low-value technologies has become a key area of interest, not only within the field of health technology assessment (HTA) but also among health economists striving to address uneconomic growth (9).

Low-value care was described as interventions that, according to the best available evidence, provide minimal or no benefit to patients and may lead to unnecessary harm or costs, or where the associated costs are disproportionate to the benefits provided (10). This includes tests or treatments lacking substantial evidence of effectiveness, potentially resulting in adverse patient outcomes such as unwarranted follow-up procedures or side effects (11). In a larger perspective, any health technologies, including public health programmes and interventions that yield minimal benefits, can also be classified as LVC. Examples of LVC include the overuse of non-indicated antibiotics, unnecessary imaging procedures, potentially inappropriate medications for elderly patients, routine blood investigations in asymptomatic individuals, and excessive laboratory tests (12). In this case, disinvestment can help fight LVC by making sure that technologies, medicines, or services are only used on the patient groups that are most likely to benefit. This stops them from being abused or given to people who are not supposed to get them, which is also known as “indication creep” or leakage (13).

1.2.3 Example of proposed disinvestment programme

Disinvestment processes are proposed for various reasons, with the most common being evidence of clinical ineffectiveness or inappropriate use. Other factors include concerns about safety and the need to reduce costs. Additionally, low compliance with medical device use, variability in how interventions are applied across

jurisdictions, and diagnostic issues such as low sensitivity and specificity also prompt proposals for disinvestment (14).

Various disinvestment programmes have been implemented, which are covered in Chapter 2. As an example of a proposed initiative, the Italian National Health System allocated over €4 billion from the Recovery and Resilience Plan (RRP) to modernise hospital technology, creating an opportunity to revitalise disinvestment processes for medical devices (15). This initiative aimed to reallocate resources to high-value, underutilised services through health system planning, and citizen involvement as well as optimise resources by replacing low-value practices with cost-effective, clinically beneficial alternatives.

Within the Italian national healthcare system, the proposed framework outlines a process for identifying candidates with potential for disinvestment based on cost-saving opportunities, employing both bottom-up and top-down approaches (Figure 1-1). The bottom-up approach engages stakeholders, including professional societies, patient associations, and healthcare companies, to propose technologies for disinvestment. In contrast, the top-down approach relies on dedicated units to identify candidates through methods like horizon scanning and reassessment. Following that, prioritisation and reassessment of candidates are conducted using specific analyses, which then determine the decision outcomes, either retention, limitation of use, or complete abandonment (15).

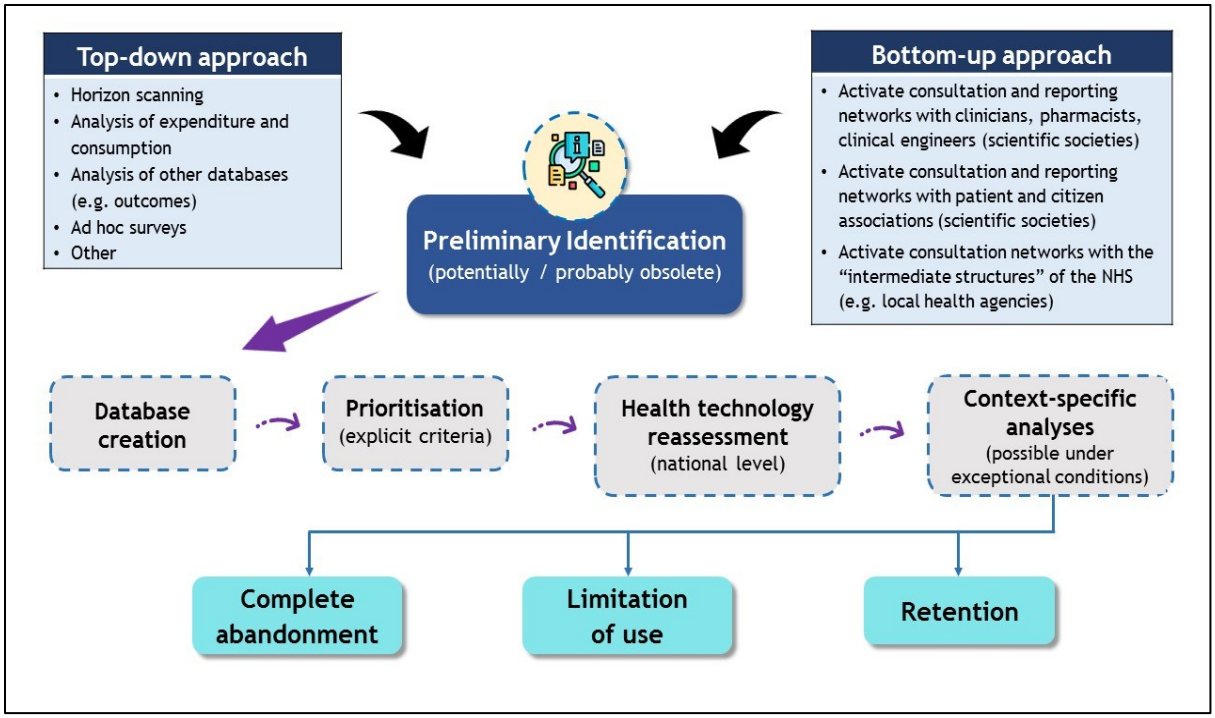

Figure 1-1: Disinvestment process approach for medical devices in Italy (15).

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Although the above disinvestment framework has been developed, the implementation has yet to move into operational practice. The proposed framework offers a timely opportunity for practical application, particularly in the context of modernising hospital technology equipment funded by the RRP. With the recent government decrees aligned with European Union Regulations for medical devices, this effort explicitly supports reviving the Italian national HTA programme and incorporating disinvestment strategies (15).

1.3 A note on geographical scope: Malaysian healthcare system

Classified as an upper-middle-income country (UMIC), Malaysia maintains a dual-tiered healthcare system comprising a government-funded public sector and a market-driven private sector (Figure 1-2). In its public sector, healthcare services are primarily delivered by the Ministry of Health (MOH). However, additional services are also provided by other ministries, including the Ministry of Higher Education, Ministry

of Defence, Ministry of Women, Family and Community Development, Ministry of Home Affairs, and the Ministry of Housing and Local Government (16). Private healthcare in Malaysia operates on a for-profit basis, providing faster access to services and a broader range of options, primarily through a fee-for-service payment model (17). It encompasses both general practitioner services at private clinics and specialised care at hospital facilities.

The public healthcare system, primarily financed through general taxation, offers highly subsidised services with minimal patient contributions. For example, consultations, investigations, and medications at specialist outpatient clinics are available for a nominal fee of MYR 5.00 (approximately GBP 0.90 or USD 1.088) (18). This contributed to a significant burden on the public system, including high patient load, limited resources, and escalating healthcare costs. Around 80% of patients in the country rely on public healthcare services, which consistently experience an increase in admissions. Many of these patients are classified as “walk-ins”, meaning they lack prior appointments or are returning for regular check-ups (19). These factors place substantial pressure on the system’s performance and capacity.

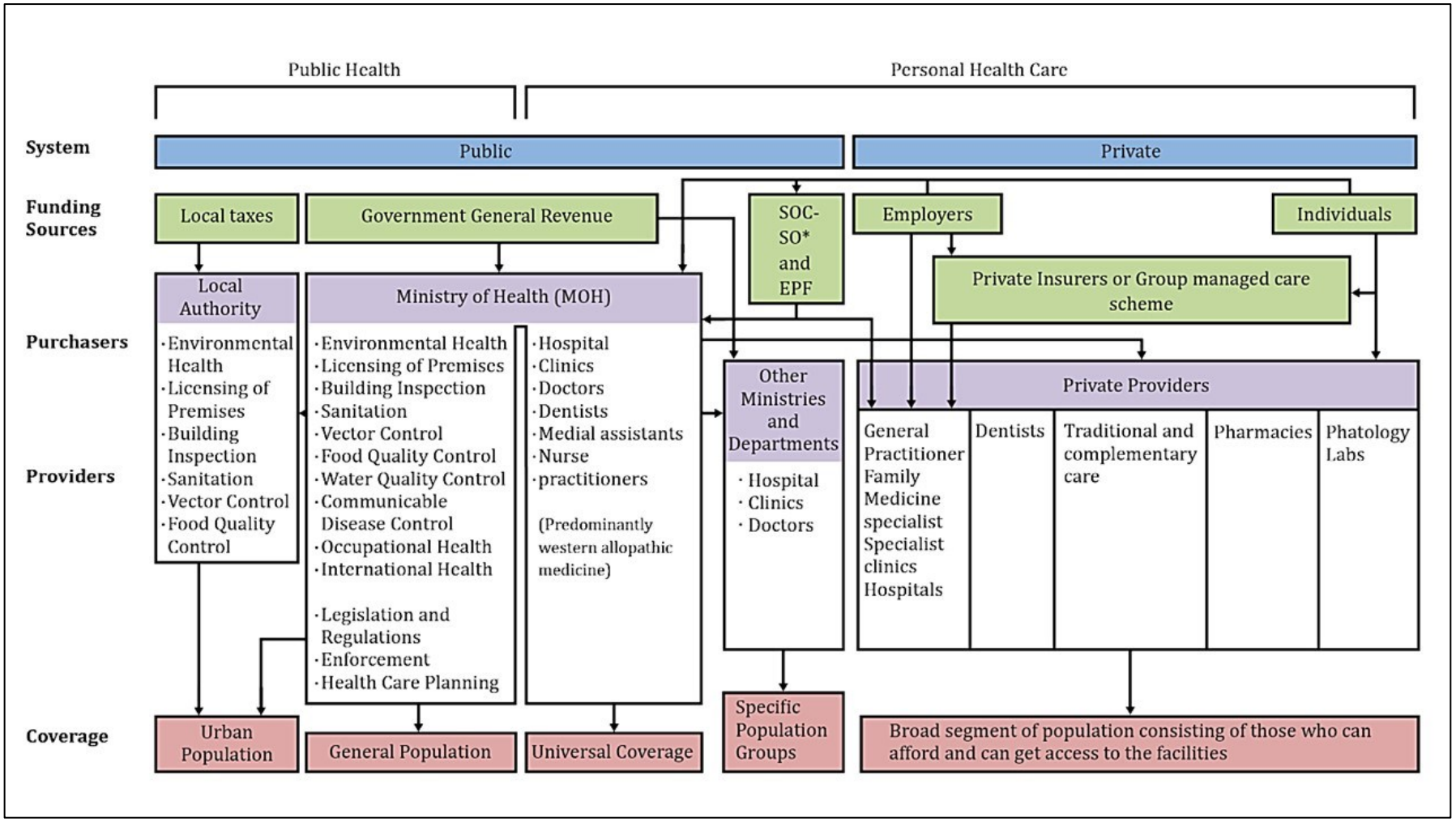

Figure 1-2: Schematic overview of Malaysian healthcare system (16)

The Malaysian MOH comprises two main components: technical programmes and the administrative arm. The six technical programmes include Public Health (covering public health and primary healthcare), Medical Services (hospitals and specialist care), Oral Health, Pharmaceutical Services, Food Safety and Quality, and Research & Technical Support. Each programme is led by a Deputy Director General or Senior Principal Director, who reports to the Director General of Health. Additionally, the administrative functions, such as Management and Finance, are overseen by respective Deputy Secretary Generals, reporting to the Secretary General (16).

Within the MOH Malaysia, there is a strong commitment to ensuring access to high-quality healthcare for all residents, primarily delivered through a nationwide network of government-based clinics and hospitals (16, 17). While urban centres in Malaysia are equipped with world-class public and private hospitals featuring state-of-the-art medical equipment and highly specialised care, rural areas continue to face significant challenges in accessing quality healthcare facilities. The disparity between urban and rural healthcare is evident in the limited availability of infrastructure, fewer healthcare professionals, and longer travel distances for patients in provincial regions. This gap often leads to delays in diagnosis and treatment, lower health outcomes, and a reliance on less-equipped community health clinics. Addressing these inequities is essential to ensure that all Malaysians, regardless of location, have access to comprehensive and high-quality healthcare services. While public healthcare remains a more affordable option, private healthcare offers advantages such as shorter waiting times due to a higher doctor-to-patient ratio (20).

1.3.1 Healthcare financing and health expenditure

Malaysia’s healthcare system strives to balance public provision and private sector participation, aiming to deliver accessible and affordable healthcare to its population. Public health expenditure accounted for 52.26% of total health expenditure in 2022, reflecting a commitment to enhancing healthcare services (21). Between 2020 and 2022, Malaysia's total health expenditure as a percentage of gross domestic product (GDP) fluctuated from 4.73% in 2020, 5.02% in 2021, and 4.41% in

2022 (21). Despite that, the health expenditure remains lower than the global average for UMIC which is 6% (22), prompting discussions on the need for further investment to address emerging health challenges. The Parliament of Malaysia recently announced that the national budget for 2025 will allocate approximately MYR 45.3 billion to the MOH, a 9.8% increase from the previous year's allocation. Budget 2025 introduced a significant policy shift, transitioning from universal, nearly free healthcare for all citizens to a system of targeted healthcare subsidies, a departure from Malaysia's longstanding approach to healthcare financing.

Reflecting on the recent announcement, the role of National Health Financing in Malaysia is at an important crossroads, requiring transformation to meet the evolving demands of a sustainable and equitable healthcare system. This discussion revolves around strategic purchasing and the development of a clearly defined benefits package, which dictate the allocation of resources to optimise health outcomes and safeguard the population's finances. As these initiatives gain traction, the need to establish a balance between investment in new, high-value technologies and the disinvestment of low-value or obsolete practices becomes increasingly urgent. Robust HTA inputs are essential to guide evidence-based decisions on the benefits package, ensuring resource allocation aligns with value, equity, and efficiency. Without such guidance, Malaysia risks perpetuating inefficiencies and inequities, underscoring the necessity of health financing transformation for long-term sustainability.

1.3.2 Disinvestment initiatives in Malaysia: an opportunity

Disinvestment, in particular, holds significant relevance for Malaysia, where the need to optimise healthcare expenditures and reallocate resources toward high-value interventions is becoming increasingly apparent (23). A landmark development in this context is the approval of the Health White Paper by the Malaysian Parliament in June 2023, which outlines a roadmap for healthcare reform to be implemented over the next 15 years, with aspirations aimed at building a resilient healthcare system (24). Central to this reform is the third pillar of the Health White Paper, which focuses on ensuring sustainable and equitable health financing. The proposed strategies under

this pillar include increasing investments in health; ensuring comprehensive and fair coverage for all citizens; and optimising healthcare expenditures to achieve greater efficiency and effectiveness. This reform agenda presents a unique window of opportunity to integrate healthcare disinvestment into Malaysia's broader health financing strategy. By aligning disinvestment efforts with the stated goals, Malaysia can systematically identify and phase out low-value health technologies and practices, thereby freeing up resources for high-priority and cost-effective interventions.

The Malaysian Health Technology Assessment Section (MaHTAS), established in 1995 within the MOH, plays a pivotal role in addressing policy-related healthcare issues and promoting evidence-based clinical practice. Initially focused on assessing new health technologies, MaHTAS gradually expanded its scope to include health technology lifecycle activities, such as horizon scanning for emerging and innovative technologies, and development of evidence-based Clinical Practice Guidelines (25). Beginning 2015, MaHTAS incorporated health economics modelling into its HTA process in providing cost-effectiveness evidence. Notably, a cost-effectiveness threshold of one GDP per capita per quality-adjusted life year (QALY) gained was established in ensuring the adoption of value-for-money technologies and supporting decision-making related to health technologies in Malaysia (26).

Traditionally, HTA produced by MaHTAS focus on evaluating new interventions as a single technology against a comparator or standard care. However, implementing HTA recommendations is often time-consuming and resource-intensive. For instance, the HTA recommendation in 2011 to use HPV DNA as the primary screening tool for cervical cancer, compared with Pap smear, took nearly a decade to gain policy approval in 2020 (23). This raises a critical question: "Should the methodology in HTA directly identify opportunities for de-implementing current practices to expedite implementation, especially when the assessed interventions are proven to be cost-effective?" Therefore, this thesis also serves as an opportunity to clarify the role of

HTA in disinvestment and assess whether incorporating disinvestment considerations into HTA process is both practical and beneficial for the Malaysian healthcare system.

1.4 Research motivation

The motivation for this PhD research emerged from my limited knowledge of how HTA could address the complexities of resource allocation and decision-making in healthcare systems, despite my years of experience working in the HTA field. As a widely used tool, HTA informs decisions on the adoption, reimbursement, and use of health technologies at various stages of their life cycle (27). Beyond these conventional applications, HTA has also been proposed as an evidence-based framework for technology optimisation, aimed at improving safety, quality, and the appropriate use of resources through reassessment processes (28). Recognising these possibilities, I was intrigued by its potential to support disinvestment initiatives, an area where the Malaysian healthcare system lacks a structured framework. The original focus of my PhD was, therefore, to explore how HTA could serve as a tool to develop a disinvestment framework tailored to national healthcare needs.

However, over time, engaging with the concept of disinvestment revealed significant barriers in its implementation, beyond utilising HTA as its tool. Policy-makers and healthcare stakeholders often shy away from the process due to concerns such as insufficient evidence (29, 30), fear of public criticism or backlash (31), and the ethical and practical complexities that make it a sensitive topic for discussion (32). Moreover, there is a notable disconnect between decision-making processes and the implementation of HTA as a tool for disinvesting low-value health interventions and practices. These challenges highlight the need for deeper exploration of how HTA can overcome such obstacles and contribute effectively to resource reallocation in healthcare systems.

In addition, research in disinvestment is essential because healthcare systems worldwide are under increasing financial strain, requiring more effective resource

allocation method to ensure sustainability. Despite significant progress in the awareness of using HTA as a tool for decision-making, the transition from theory to implementation remains a persistent challenge. This gap is compounded by policymakers' and stakeholders' resistance, often rooted in an uncertainty about the outcomes of disinvestment initiatives (33, 34). Additionally, the misconception that disinvestment can occur naturally without intervention ignores the reality of systemic inertia. Left unaddressed, this passive approach leads to continued inefficiencies, including the allocation of resources to low-value or obsolete practices, while high-value innovations are delayed or underfunded. The cost of inaction is inevitable: patient outcomes suffer, equity issues deepen, and the opportunity to maximise the value of healthcare spending is lost.

This PhD seeks to determine whether HTA is the right vehicle for carrying out disinvestment or whether complementary approaches are necessary in certain contexts. While HTA provides a strong foundation, it may not always fully address the complex and diverse nature of healthcare disinvestment. This realisation calls for reflection within the HTA community on the need to expand the methodologies or adopt alternative strategies to better tackle disinvestment questions. I believe it is essential to think beyond the current HTA framework when addressing resource allocation challenges.

On a personal note, this research represents a significant responsibility. I take pride in being the first healthcare professional in the Ministry of Health Malaysia to pursue a PhD in Health Technology Assessment. While my research topic was initially considered overly ambitious for a PhD project and challenging to implement as a national health policy, I viewed it as an opportunity to address a critical gap in our healthcare system. Supported by a government scholarship, this journey has been driven by a strong commitment to contributing to the improvement and sustainability of the Malaysian healthcare system.

1.5 Thesis aims and objectives

The overarching aim of this thesis is to investigate the implementation of disinvestment initiatives within the healthcare system, with a focus on understanding the facilitators that support the process and the challenges that hinder its effective execution.

The specific objectives of the thesis are:

1. To conduct a comprehensive scoping review to define the concepts and purpose of healthcare disinvestment, explore the methods employed, analyse the role of stakeholders, and identify the facilitators and challenges to its implementation.
2. To examine the methodological approaches adopted by other countries and HTA agencies in implementing healthcare disinvestment initiatives.
3. To explore the perceptions, practices, and acceptance of Malaysian healthcare stakeholders toward disinvestment initiatives, including their views on the feasibility of implementing disinvestment frameworks in Malaysia.
4. To develop a criteria-based framework for priority setting and decision-making process regarding the disinvestment of low-value health technologies and practices.
5. To illustrate the analytical process of identifying and assessing candidates for disinvestment through evidence synthesis and value-based evaluation.

1.6 Structure of the thesis

Following the guidance from the College of Medical, Veterinary, and Life Sciences (University of Glasgow, 2023/2024), I opted to present my PhD using the “thesis by alternative format.” This format allowed me to publish several components during the course of my research, ensuring outputs were timely, setting clear milestones, and avoiding the challenging task of later condensing thesis chapters into publishable articles. Therefore, this thesis is organised into eight chapters, combining the

traditional thesis format for five chapters and journal articles that are published or in the process of submission for the rest.

My PhD thesis is structured as follows:

Chapter 1 served as the introduction to my thesis by outlining the background of disinvestment in healthcare and establishing the context for the research. I then detailed the rationale behind selecting this topic for my PhD and articulated the specific objectives of the study. The chapter concludes with an overview of the Malaysian healthcare system, which forms a geographical scope of this research.

Chapter 2 is comprised of a published scoping review that sought to compile and analyses information from existing reviews on the concepts and objectives of healthcare disinvestment, the methods and approaches employed, the involvement of stakeholders, and the facilitators and barriers to its implementation.

Chapter 3 explores methodologies used for healthcare disinvestment through a literature review and analyses of case studies. It maps the design and components of these approaches, evaluates the issues they address, and highlights their limitations. This chapter provides insights into the strengths and weaknesses of current methods, offering guidance for improving disinvestment decision-making.

Chapter 4 is comprised of a published online survey that focuses on understanding how Malaysian healthcare stakeholders perceive and approach disinvestment initiatives. It aims to identify current practices in the healthcare system and explore key components for implementing disinvestment frameworks from the stakeholders' perspectives.

Chapter 5 is comprised of a key informant interview which has been prepared for journal publication. This chapter aims to thoroughly examine the findings of the previously conducted online survey, specifically focusing on defining criteria for

evaluating disinvestment candidates, identifying obstacles, and gathering stakeholders' perceptions on feasible ways to enhance the acceptance and implementation of disinvestment within the Malaysian healthcare system.

Chapter 6 synthesises and triangulates the findings from Chapters 2 to 5 and applies one of the methodological approaches as a decision-making framework, guided by stakeholders' perspectives, to support the healthcare disinvestment process. It also introduces the concept of the "value of de-implementation" in evaluating disinvestment candidates.

Chapter 7 presents two case studies showcasing potential approaches to implementing healthcare disinvestment initiatives in Malaysia, utilising both bottom-up and top-down strategies. The latter part of the chapter describes the pilot testing of the framework developed in Chapter 6, conducted in collaboration with Malaysian healthcare stakeholders.

In Chapter 8, I provide a comprehensive discussion and conclusion of the thesis. I present the synthesis of the research undertaken, summarise the key findings, and highlight overarching themes linking the chapters. This discussion examines the contributions of this thesis to the field of healthcare disinvestment, its implications for policy and practice, and highlights areas for future research. I also share personal reflections on the insights gained and conclude with perspectives on advancing healthcare disinvestment initiatives in Malaysia.

Chapter 2: Disinvestment in healthcare: a scoping review of systematic reviews

2.1 Foreword

The motivation behind this scoping review stemmed from the recognition that, despite the critical need for efficient resource allocation, there is a paucity of knowledge within the global landscape on how disinvestment is being conceptualised and implemented in various healthcare settings. By synthesising existing knowledge and identifying gaps, this scoping review provided a foundation for my doctoral research project and guided me on the crucial aspects that needs to be addressed, such as stakeholder involvement, methodological analysis, and implementation. I chose the scoping review of systematic reviews because it allows for an expedited process of gathering and mapping evidence while still preserving the depth and comprehensiveness of the information collected.

The article has been published in the International Journal of Technology Assessment in Health Care. It is reproduced here with permission by Cambridge University Press; therefore, the content of this chapter is in accordance with the published version in terms of the spelling and structure, with minor modifications to the included tables. I have taken complete charge of the entire project and assumed full accountability for it. In this chapter, the phrases ‘we’ and ‘our’ are employed to acknowledge the contribution of all authors.

2.2 Title, authorship and publication details

Kamaruzaman, H.F., Grieve, E. and Wu, O. (2022) Disinvestment in healthcare: a scoping review of systematic reviews. International Journal of Technology Assessment in Health Care, 38(1), e69. © The Author(s), 2022. Published by Cambridge University Press. DOI: https://doi.org/10.1017/S0266462322000514. *(reproduced with permission)*

Disinvestment in healthcare: a scoping review of systematic reviews

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Disinvestment; Health technology reassessment; Resource allocation; Value-based decision making

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2.3 Abstract

Objectives: Disinvestment from low value health technologies is growing globally. Diverse evidence gathering and assessment methods were used to implement disinvestment initiatives, however, less than half of the empirical studies report reduced use of the low-value services. This scoping review aimed to synthesize the information from available reviews on the concepts and purposes of disinvestment in healthcare, the approaches and methods used, the role of stakeholders and facilitators and barriers in its implementation.

Methods: This scoping review was guided by the Joanna Briggs Institute Manual for Evidence Synthesis and PRISMA statement for scoping review. Published reviews on disinvestment were identified from scientific databases including health technology assessment (HTA) Web sites using the terms “disinvestment,” “health technology reassessment,” and “healthcare.” The data obtained was synthesized narratively to identify similarities and differences across the approaches based on the prespecified categories.

Results: Seventeen reviews were included with thirty-four initiatives identified across sixteen countries at various levels of implementation and responsible agencies for the activities. Two most used methods to facilitate disinvestment decisions are Programme Budgeting and Marginal Analysis (PBMA) and HTA. Stakeholder involvement is the most important aspect to be addressed, as it acts as both facilitator and barrier in disinvestment initiatives implementation.

Conclusions: Disinvestment programs have been implemented at multilevel, involving multi-stakeholders and using multiple methods such as PBMA and HTA. However, there is a lack of clarity on the additional dimensions of technical analysis related to these tools. Further research could focus on technology optimization in healthcare as part of overall health technology management.

2.4 Background

Health systems across the globe are increasingly recognizing that in ensuring the efficient delivery of care, it is crucial to complement judicious investment in new healthcare technologies with strategies to reduce the use of ineffective and inefficient interventions. These strategies, commonly referred to as disinvestment initiatives, are a growing priority for international health policy in maximizing value and improving quality of care (35). However, removing resources from a health system is more difficult than adding new resources with many existing technologies having been diffused into service delivery before evidence-based clinical and cost-effectiveness criteria were applied. Furthermore, as new health interventions come along, the older ones may no longer offer comparable values. In addition, the lack of consistent and transparent systems to identify these technologies contributes to a degree of clinical and cost-effectiveness uncertainty (36).

Numerous studies on disinvestment initiatives and health technology reassessment (HTR) have been published, describing processes at various levels. However, the success of the initiatives such as “Choosing Wisely” campaigns, the National Institute for Health and Care Excellence (NICE) “Do Not Do” list in England and the US Preventive Services Task Force has been mixed, with less than half of identified studies reporting a reduction in the utilization of these low-value services (37). Additionally, the global COVID-19 outbreak has forced many countries to devote a significant portion of their resources to combating the pandemic. Early estimates in twenty-two countries, mostly high-income economies, show that healthcare spending rose significantly in 2020, more than in previous years (38). Therefore, promoting active disinvestment in this current climate is timely to help re-strategize value-based priority setting and resource reallocation to aid economic recovery.

We undertook a scoping review of existing reviews to comprehensively synthesize the large body of information from published studies on disinvestment in healthcare. The aim of this scoping review was to describe the approaches and methods used in disinvestment processes of health technologies. We also identified the facilitators and

barriers with regards to carrying out disinvestment and explore the role of stakeholders particularly among clinicians who act as a bridge between policy makers and patients.

2.5 Methods

2.5.1 The Scoping Review Protocol

A *priori* protocol was developed following established scoping review frameworks from the Joanna Briggs Institute (JBI) Manual for Evidence Synthesis (39). The reporting of this study conforms to the PRISMA statement for scoping review standards or PRISMA-ScR (40).

2.5.2 Purpose Statement of the Scoping Review

The purpose of this scoping review is to clarify the concepts and definitions of disinvestment in the published literature and identify key characteristics of existing disinvestment initiatives that had been implemented. In achieving these, we intended to map the data from the retrieved studies based on five categories: (i) concepts and terms used in disinvestment in healthcare; (ii) purpose of disinvestment; (iii) methods and processes in disinvestment; (iv) stakeholder involvement in disinvestment; and (v) facilitators and challenges in disinvestment implementation.

2.5.3 Systematic Search Strategy

a. Identification

The main electronic bibliographic databases used for evidence searching: MEDLINE (Ovid), Embase, Web of Science, and Scopus. Other sources used were NIHR Journals Library, Centre for Reviews and Dissemination as well as health technology assessment (HTA) Web sites and databases (INAHTA and HTAi). Based on a scoping review by Niven et al. (30) on de-adoption in healthcare, forty-three terms on “disinvestment” were identified, including “HTR,” “delisting,” and “de-implementation” (Supplementary 2-1). Focusing on healthcare disinvestment, our search strategy was confined to fourteen synonyms of “disinvestment” and combined with “healthcare” or “health care” (Supplementary 2-2 and 2-3). The initial search was conducted on 4 Feb 2021

and repeated on 3 Jan 2022 to identify any additional publications. Literature was also identified from the references of the retrieved articles using citation tracking, snowballing method and recommendation by experts in conferences or forums.

b. Inclusion and Exclusion Criteria

Specific inclusion and exclusion criteria were established to include all review types containing terms and concepts, descriptions or methods relating to disinvestment in healthcare (Supplementary 2-4). These criteria were applied using automatic sorting function in the databases and manually. A publication period was determined to ensure that we included the papers that are contemporary and relevant to current practice, without jeopardizing the concept of "research field maturity" (41). For practicality, we only include articles published between year 2001 and 2021 which considered as acceptable to perform a representative review on disinvestment in healthcare. Additional automatic screening filters were applied for English only and types of research ("review articles" or "reviews").

c. Screening and Eligibility

The titles and abstracts of the articles were checked to ensure that the studies matched the predetermined inclusion criteria. A paper was considered eligible if it was secondary research on disinvestment initiatives, such as systematic reviews, scoping reviews, pragmatic reviews, overviews, interpretative reviews, and critical interpretative synthesis. An article was included when the study covered any of the components outlined in the inclusion criteria. The lead author carried out the initial screening and the results were presented to the co-authors for checking.

2.5.4 Data Extraction, Synthesis, and Analysis

Data were extracted using a predesigned data extraction table and synthesized narratively to identify similarities and differences across the approaches. The general description and findings from each article included in the review were summarized according to the following characteristics: publication year, type of reviews, country, organization or agency in charge of the program, scope of health technologies,

methods used and description on disinvestment initiatives including the process, stakeholder involvement, as well as facilitators and barriers in its implementation.

Content analysis was employed to identify the pattern of data, and the findings were organized into the stated categories using shared similarities or relationships of the information (42). Descriptive data analyses were performed to report the frequencies and quantitative findings from the included reviews.

2.6 Results

Seventeen reviews on disinvestment initiatives were included for synthesis and analysis, as shown in PRISMA flow diagram (Figure 2-1). Eight reviews described international disinvestment initiatives with descriptions on countries that already implemented disinvestment programs (29, 30, 32, 34, 37, 43-45). Two of the included studies discussed regional disinvestment initiatives, in European HTA agencies (6) and in Latin American countries (46).

Whilst the majority (n=13) of the included reviews described disinvestment for health technologies and services in general (6, 13, 30, 34, 37, 43-50), two reviews focused on disinvestment strategies in pharmaceuticals (32, 33) and two studies on non-pharmaceuticals (29, 31). Four of the reviews proposed methods or frameworks for disinvestment or HTR (13, 30, 34, 49), mainly for identification and prioritization processes. One review specifically explored the related terms and definitions in disinvestment using “de-adoption” as the key term (30), and one review focused solely on stakeholders’ involvement in disinvestment, specifically healthcare professionals (31).

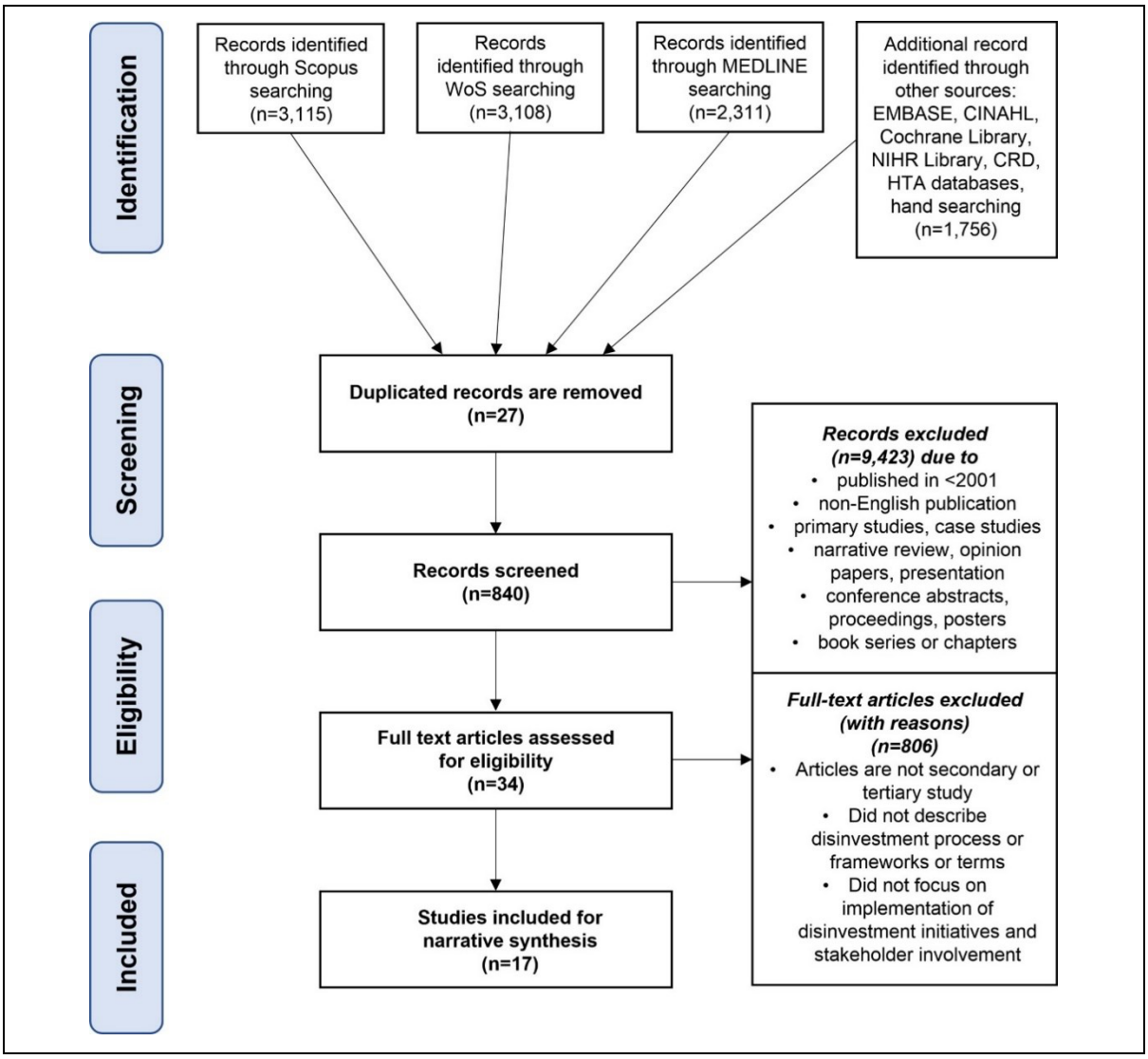

Figure 2-1: PRISMA flow diagram of the scoping review (51)

We identified thirty-four disinvestment initiatives across sixteen countries, operating at various levels by different types of agencies responsible for carrying out the activities (Figure 2-2). Among the programs implemented internationally, the most quoted is the Choosing Wisely campaign launched in 2012 by the American Board of Internal Medicine and adapted by many countries and agencies. The majority of national level initiatives fall under the responsibility of the HTA agencies in that country (43). Uniquely, Canada and Spain initially started with regional-based disinvestment initiatives before expanding to a national program (34).

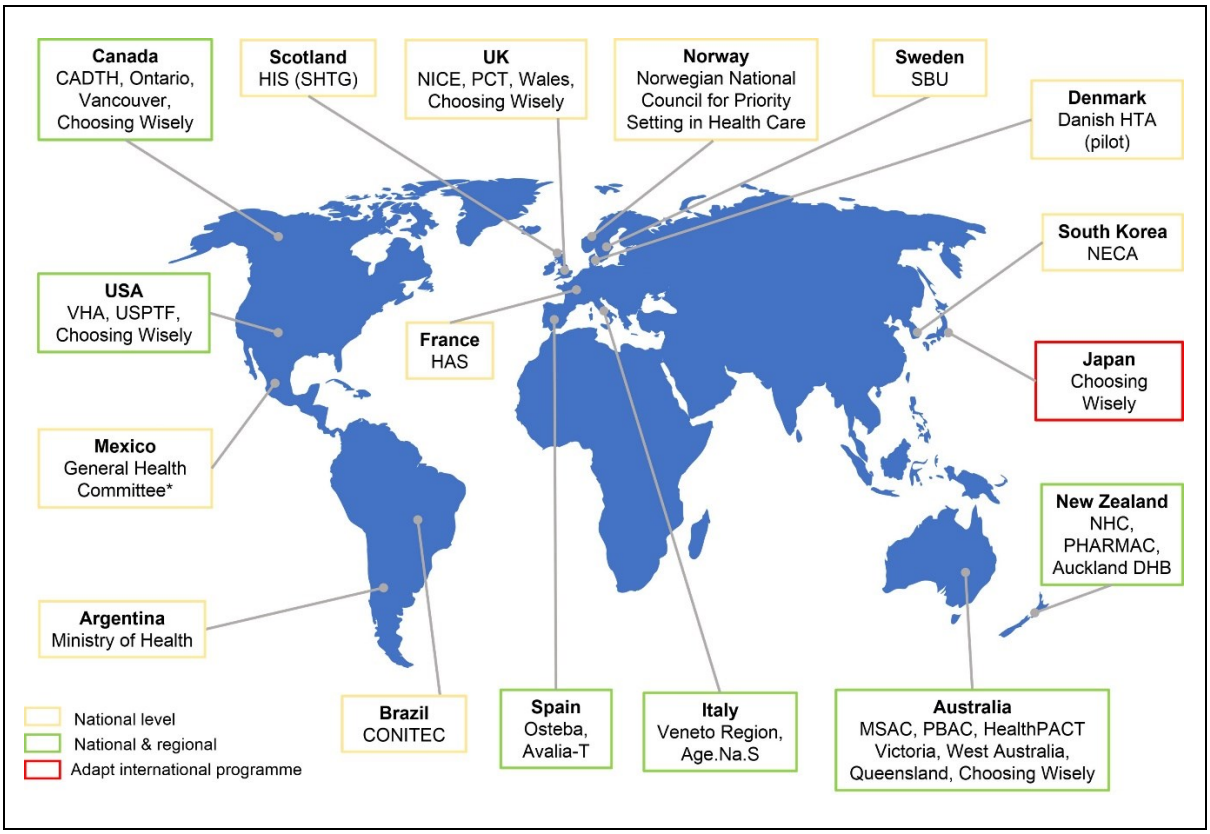

Figure 2-2: Countries with disinvestment initiatives and the agencies involved.

Agencies acronyms: Age.Na.S, Agency for Regional Healthcare; CADTH, Canadian Agency for Drugs and Technologies in Health; CONITEC, Brazilian National Committee for Technology Incorporation; DHB, District Health Board; HAS, Haute Autorité de Santé Compréhensive Drug Review; HealthPACT, Health Policy Advisory Committee for Technology; MSAC, Medical Services Advisory Committee; NECA, National Evidence-based healthcare Collaborating Agency; NHC, National Health Committee; NICE, National Institute for Health and Care Excellence; PBAC, Pharmaceutical Benefits Advisory Committee; PCT, Primary Care Trusts Programmes; PHARMAC, Pharmaceutical Management Agency; SBU, The Swedish Council on Health Technology Assessment; SHTG, Scottish Health Technologies Group; USPTF, US Preventive Services Task Force; VHA, Veterans Health Administration Comprehensive Review.

There are several information gaps on some of the implemented programs. For example, from the review in Latin American countries (46), there are only few documented records of disinvestment activities despite various programs that have been carried out in the region based on survey responses conducted. Another example is the Danish Centre for Health Technology Assessment's (DACEHTA) pilot on disinvestment, in which the only source of information on this project was a 2005 conference abstract on the improper utilization of imaging technologies in Denmark (29). Table 2-1 summarized the details of the included studies and description of disinvestment initiatives based on the predefined categories.

Table 2-1: Summary of included reviews (type and number of articles, concepts and terms, purpose of disinvestment, implementation and areas of disinvestment, and new framework proposed for disinvestment or health technology reassessment)

Author & publication year	**Review type & number of articles included**	**Clarifying concepts and terms for disinvestment** (Yes / No)	**Purpose of disinvestment**	**Disinvestment implementation** (Local / Country-level / Regional / International / Not specified)	**Areas of disinvestment** (general / pharmaceuticals / non-pharmaceuticals)	**Propose framework for disinvestment / HTR**
Walsh-Bailey et al., 2021	Scoping review of frameworks and models in healthcare, public policy, business fields (n=27)	No	Based on action targets for the interventions (reduce, replace, restrict, and remove)	Not specified	General	No
Mitchell et al., 2021	Systematic review of qualitative studies (n=12)	No	(i) Resource reallocation (ii) Cost-effective spending (iii) Benefits to patients and community	Not specified	Non-pharmaceuticals	No
Embrett et al., 2020	Systematic review of qualitative studies (n=106)	**Yes** - to provide clarity and enhance communication	Resource withdrawal	Not specified	General	No
Esandi et al., 2020	Interpretative review (n=17)	No	(i) Optimisation of care (ii) Resource reallocation	Not specified	General	**Yes** - ATM framework (to guide the strategies in identifying candidates for disinvestment)
Calabrò et al., 2018	Systematic review of deliverables from European HTA organisations (n=10)	No	(i) Sustainability of healthcare system (ii) Availability of new health technologies (iii) Resource constraints	Regional (European HTA agencies)	General	No

Author & publication year	**Review type & number of articles included**	**Clarifying concepts and terms for disinvestment** (Yes / No)	**Purpose of disinvestment**	**Disinvestment implementation** (Local / Country-level / Regional / International / Not specified)	**Areas of disinvestment** (general / pharmaceuticals / non-pharmaceuticals)	**Propose framework for disinvestment / HTR**
Soril et al., 2018	Overview of systematic reviews (n=not mentioned) followed by expert stakeholder consultation	**Yes** - to provide a clearer vision regarding managing existing technologies in the system	For optimal technology use	Not specified	General	**Yes** - a structured 6-questions approach to frame optimal technology use in guiding HTR
Agirrezabal et al., 2017	Systematic review of published and unpublished articles (n=11) followed by online questionnaire	No	(i) Resource reallocation (ii) Re-investment in health technologies with better value (iii) Sustainability of healthcare system	Regional (Latin America countries)	General	No
Chambers et al., 2017	Systematic review of empirical evaluations of disinvestment initiatives (n=18) and identifying international programmes	No	(i) Invest in higher value care (ii) Increase health care efficiency	International	General	No
Maloney et al., 2017	Systematic literature review (n=40)	**Yes** - the use of more neutral terms, such as "reassessment," improve stakeholder (clinicians, patients, industry) engagement	(i) Optimizing the use of a drug technology (ii) Improving the efficiency and quality of health care	International	Pharmaceuticals	No
Orso et al., 2017	Systematic literature review (n=38) with data collection on socio-economic indicators and the existence of HTA agencies from countries in OECD, BRICS and Indonesia	No	(i) Resources re-allocation (ii) Supporting policy makers in disinvestment decisions (iii) Improving quality of care (iv) Rationalization of resources	International and Regional (OECD countries, BRICS [Brazil, India, China, South Africa] and Indonesia)	General	No

Author & publication year	**Review type & number of articles included**	**Clarifying concepts and terms for disinvestment** (Yes / No)	**Purpose of disinvestment**	**Disinvestment implementation** (Local / Country-level / Regional / International / Not specified)	**Areas of disinvestment** (general / pharmaceuticals / non-pharmaceuticals)	**Propose framework for disinvestment / HTR**
Seo et al., 2016	Systematic literature review (n=45) followed by interviews with experts from NICE (UK) and Osteba (Spain)	No	(i) Increase the efficiency and quality of care (ii) Enhance the optimal use of health technologies (iii) Value for money/cost-effective	International and Country-specific (UK, Canada, Australia, Spain)	General	**Yes** - HTR process for South Korean
Mayer et al., 2015	Systematic literature review (n=120) followed by questionnaire and interviews with international experts	**Yes** (no specific reason mentioned)	(i) Improve quality of health care and patient safety (ii) Reduction of the waste of resources (iii) Reallocation of resources	International	General	No
Niven et al., 2015	Systematic literature review (n=109)	**Yes** – to provide guide for the de-adoption of services and clinical practices, and directing future research (no clear, established taxonomy for de-adoption)	Resource optimisation	International	General	**Yes** - synthesis model for de-adoption process
Parkinson et al., 2015	Systematic literature review (number of articles included not mentioned)	No	Reallocation to higher value interventions	Country-specific (UK, France, Canada, Australia and New Zealand)	Pharmaceuticals	No
Garner et al., 2013	Selective review of Cochrane systematic reviews - scan the 'implications for practice' section in the authors' conclusions of new or updated Cochrane reviews (n=28)	No	Not mentioned	Not specified (using Cochrane reviews as identification tool for disinvestment)	General	No

Author & publication year	**Review type & number of articles included**	**Clarifying concepts and terms for disinvestment** (Yes / No)	**Purpose of disinvestment**	**Disinvestment implementation** (Local / Country-level / Regional / International / Not specified)	**Areas of disinvestment** (general / pharmaceuticals / non-pharmaceuticals)	**Propose framework for disinvestment / HTR**
Polisena et al., 2013	Systematic literature review of disinvestment case studies (n=14)	No	Resource re-allocation to more beneficial services / programmes	International	General	No
Leggett et al., 2012	Systematic literature reviews (n=36)	**Yes** - to differentiate between "disinvestment" and "health technology reassessment"	(i) Minimise waste and inefficiency (ii) Reduce harms and variation in practice (iii) Maintaining quality of care (iv) Healthcare system sustainability (v) Optimal use of technology	International	Non-pharmaceuticals	No

2.6.1 Clarifying Concepts and Terms in Disinvestment

Six reviews highlighted the need to clarify the concepts and terms used in disinvestment (29, 30, 32, 44, 48, 49). Among the reasons given are to provide a clearer vision regarding managing existing technologies in the system (49), to enhance communication (48) and to improve engagement among stakeholders (32).

Due to overlapping concepts, stakeholders involved in managing healthcare resources tend to use disinvestment interchangeably with the following terms; rationing (52), HTR (34) and obsolete technologies (32, 44) (Table 2-2). The earliest definition of disinvestment by Elshaug et al. (5) focused on the withdrawal of resources in reducing ineffective, harmful or low-value medical services with the aim of improving health of patients. Rationing has, instead, the underlying premise of scarce resources; meaning the prioritization of resources will result in certain services being excluded from funding, thus denying people from potentially beneficial services (48). HTR is the process of identifying low value practices that may or may not lead to disinvestment decision. It is more acceptable to stakeholders as it does not assume the removal of funding (32) and is not meant as a rationing tool.

Table 2-2: Definition of terms

Disinvestment	• The process of (partially or completely) withdrawing health resources from any existing healthcare practices, procedures, technologies, or pharmaceuticals that are deemed to deliver little or no health gain for their cost, and thus are not efficient health resource allocations (5).
Rationing	• The full or partial withdrawal of resources from a medical service that is clinically expected, on average, to result in a patient achieving diminished health benefits (48). It may result in exclusion of services from public funding, hence denying people from potentially beneficial technologies.
Health technology reassessment	• A structured, evidence-based assessment of the clinical, social, ethical, and economic effects of a technology currently used in the healthcare system, to inform optimal use of that technology in comparison to its alternatives (32).
Obsolete technologies	• Any health technology in use for one or more indications, whose clinical benefit, safety, and/or cost-effectiveness have been significantly superseded by other available alternatives or are not supported by evidence (32, 34).

2.6.2 Understanding the Purpose of Disinvestment

Although disinvestment is frequently associated with budgetary concerns and affordability, it can also be prompted to enhance efficiency and quality of care through reformation of service provision (52). Based on our analysis (see Table 2-1 and Supplementary 2-5), the purpose of disinvestment initiatives can be grouped into four themes (Figure 2-3): (i) enhance value-based spending (6, 29, 31, 34, 44, 46, 47); (ii) resource reallocation (6, 13, 29, 31, 33, 37, 43-48); (iii) improving quality of health care (13, 29-32, 34, 37, 43, 44, 47, 49); and (iv) informed policy making (6, 43). Clarifying the goals of disinvestment would help people understand that it is a tool for improving access to effective solutions, not for eliminating technologies and withdrawing resources on a large scale.

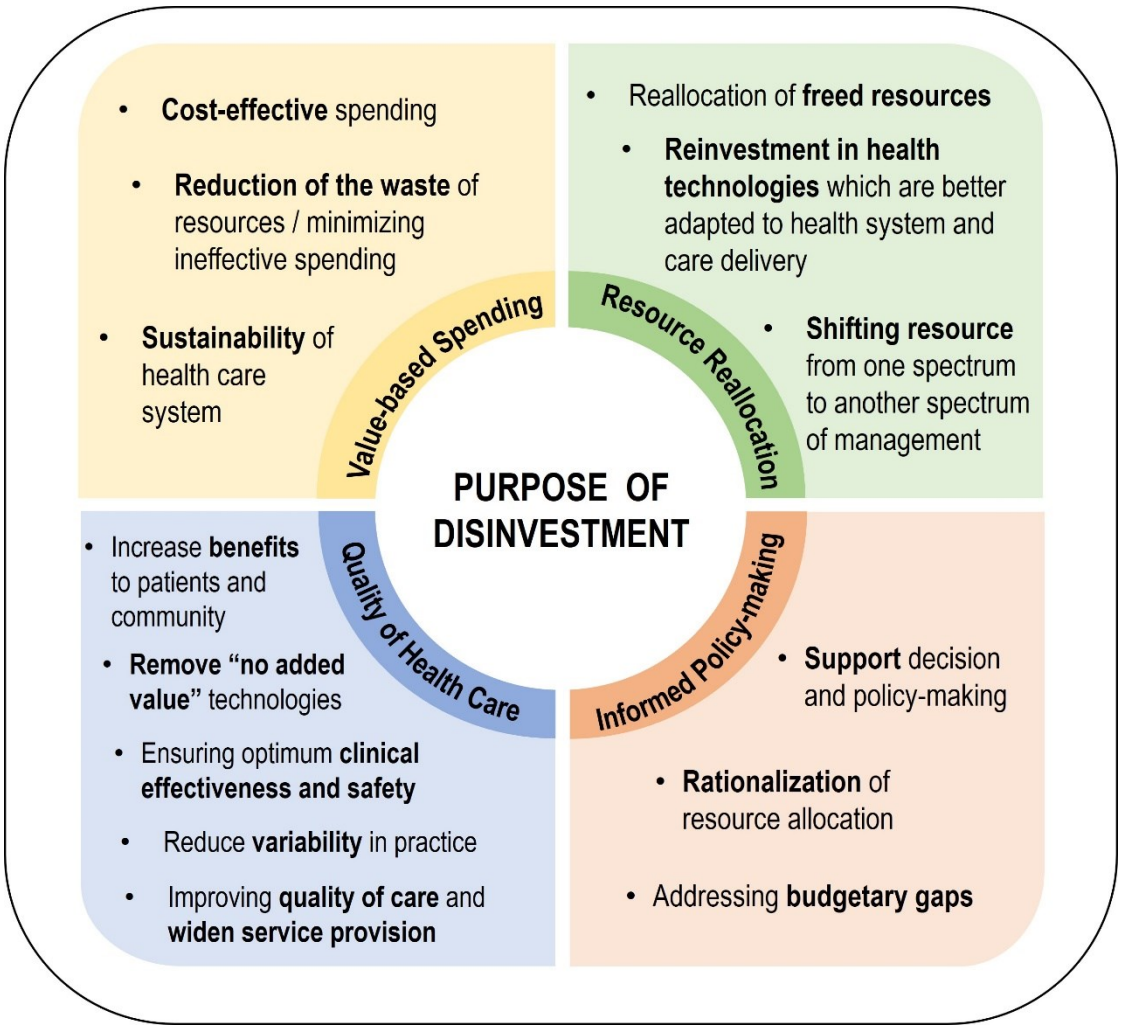

Figure 2-3: Rationale and purpose of disinvestment

2.6.3 *Methods and Processes in Disinvestment*

Most of the reviews (n=15) described processes and methods of disinvestment. Generally, the disinvestment process includes identification, prioritization, assessment or reassessment, decision, and dissemination (summarized in Supplementary 2-6). In some reviews, implementation and monitoring of the decision were also included in the process. Identification and prioritization were the least standardized in terms of methods, criteria and evidence used across HTA agencies. In certain contexts, there is overlap in these processes, which potentially lead to some confusion in the roles and criteria.

a. Identification Process

Three components related to identifying candidates for disinvestment were triggers for identification, source of identification and implementation of the process (Table 2-4). Identification can be done through established methods such as Horizon Scanning or based on the input from clinical experts and program managers. It can also be linked with the HTA process that assumes a "one-in-one-out" policy in which, for each new technology considered, the current technology is also taken into consideration for reassessment (29).

Identifying candidates for disinvestment can be performed in two ways, "ad hoc methods" and "embedded methods." Ad hoc methods are specifically devised and implemented to find suitable technologies for disinvestment and usually are not carried out on a regular basis (13). For embedded methods, the identification process is performed routinely alongside other organizational activities (13).

Table 2-3: Elements in identification process of disinvestment

Triggers for identification of candidates	Implementation of identification process
• Presence of new research evidence • Conflicting practice to clinical practice guidelines (CPG) / recommendations • Variations in care / practice • Evidence of public interest or controversies • Harmful to patients (safety issues) • Decreased frequency of use • Low-value interventions / practices • Presence of new technology • Legacy technologies • Leakage / indication creep	• Ad hoc identification method • Embedded identification method • Fixed time for reassessment • Criteria-based identification method • Identification through established methods / frameworks / tools • Efficient, systematic and transparent processes • "One-in-one-out" policy
Source for identification process	
• Scientific evidence (Clinical guideline, Cochrane Reviews, HTA reports, literature / publications) • Consultation with experts (clinical specialist, technical advisory committee, programme coordinator) • Administrative record / databases (e.g. utilisation, prescription, adverse events databases)	

b. Prioritization Process

Eleven reviews outlined common prioritization criteria such as the evidence on efficiency or effectiveness, cost-effectiveness and safety of the technology, existence of available alternatives, the total cost, and disease burden. These criteria are usually aligned with the purpose of disinvestment, for example, the rationale for inclusion of “cost of inefficient drugs” from a budgetary planning is to allow for investment in technologies with higher value (32).

A specific tool for prioritization, the PriTec Prioritization Tool develop by the Galician Agency for Health Technology Assessment was mentioned in three included reviews (6, 32, 34) (Table 2-4). It is a three-domain weighted prioritization exercise with a score system that allows for the ranking of health technologies according to a set of specified criteria (6). Additional criteria for prioritization process include evidence of futility (34, 43), strength of supporting evidence on lack of efficacy (30, 33), cost (34, 43, 44) and opportunity cost (45).

Table 2-4: Tools and criteria in the prioritization process

PriTec Prioritization Tool (AVALIA-T)	Other prioritization criteria
Domain 1: Population / Users • Burden of disease / disease frequency • Frequency of technology use • Patients preferences **Domain 2: Risk / benefits** • Efficacy / effectiveness / validity • Adverse effects • Risks if de-adoption / disinvestment takes place **Domain 3: Cost / Organisation / Others** • Efficiency • High budget of technology (e.g. maintenance costs)	• Evidence of futility • Promising evidence on existing alternative • Not for vulnerable populations • Small benefits (lack of improvement for health) • Time-based / duration (technology life cycle) • Strength of evidence on lack of efficacy • Using existing tools for priority setting (e.g. tools for HTA / Early Awareness and Alert Systems / Horizon Scanning) • Opportunity cost

c. Assessment Process

There is little information from the retrieved articles on technical assessment for disinvestment. Twelve articles included methods similar to the components used in HTA for investment: disease burden, safety, clinical and cost-effectiveness, and overall value including ethical, legal, and social aspects (Supplementary 2-6). It was highlighted that an assessment should also evaluate the feasibility of implementation and analysis of consequences, both intended and unintended (32).

We identified two commonly used frameworks to facilitate disinvestment decisions, namely Program Budgeting and Marginal Analysis (PBMA) and HTA. It is argued that PBMA is usually used to assess the distribution of resources for health services within a fixed budget plan, while HTA is mainly focused on single technology appraisals for public and social healthcare system and is not a framework specifically intended for disinvestment (34). Other method is Accountability for Reasonableness (A4R) which was applied in Sweden's healthcare priority setting to address the concepts of rationing, rationalization, ranking priority setting, and structured quality improvement (45). However, the information on A4R as method for disinvestment is scarce and limited to Swedish healthcare setting.

d. Type of Disinvestment Decisions

The outcomes of disinvestment decisions were mixed. Some reviews highlighted the requirement of making decisions (i.e., binding judgments) (34, 44, 48), while some outlined the resulting outcomes that may occur following the assessment (i.e., non-binding information) (32, 33, 37, 45, 46, 49). According to Mayer and Nachtnebel (44), the implementation of disinvestment decisions may result in one of these four conditions: (i) a change in application or scope of use; (ii) full or partial resource withdrawal; (iii) complete removal from practice, or (iv) no change to the practice. However, the impact of these decisions on resource withdrawal must be judicially evaluated for their influence on patients' health based on the clinical effectiveness and on the availability of a suitable alternative (48).

e. Dissemination Process

Active dissemination through online or printed recommendation reminders, HTA reports, commissioners' guides, clinical guidelines, and journal publications were the most common means (32, 34, 43, 44). It can also be done through conferences and knowledge transfer programs (34), face-to-face communications with target groups (44), and making direct changes to formulary or reimbursement listings (32). In Spain, a software was embedded with the Guideline for Not Funding existing health Technologies in the health system whereby progress and reports are emailed to the stakeholders once the evaluation is completed (6, 34). More passive dissemination includes publishing the recommendation lists on Web sites such as "Do Not Do" and Choosing Wisely, in online uncertainties databases and short reports (43).

2.6.4 Stakeholders Involvement in Disinvestment Initiative

Only one systematic review by Mitchell et al. (31) focused on capturing healthcare staff perspectives and reactions toward disinvestment initiatives. In other reviews, the roles of stakeholders were described and discussed mainly in the context of the processes, facilitators, and barriers of disinvestment programs (see Supplementary 2-6). Stakeholders usually involved are clinicians and other first-line responders in care provision, clinical and political decision makers, patients or

their representatives, researchers, health economists and academics, as well as citizens representing the public (43). They may be involved as members of a special committee, for instance, members of the Technology Appraisal Committee under NICE are drawn from the National Health Service, patient organizations, academia, and pharmaceutical or medical device industries (34).

2.6.5 Facilitators and Challenges to Disinvestment Initiatives

We identified several facilitating factors. First, the participation of a diverse range of stakeholders with varying roles and expertise is a critical factor in increasing program acceptance (30, 31, 34, 37, 44, 48). This, combined with an evidence-based strategy and transparent process, further enhanced the acceptance (13, 30-32, 34, 44, 49). Thirdly, the consideration on local context when evaluating the candidates for disinvestment and in formulating recommendations facilitates implementation (13, 30, 44, 46). Various dissemination strategies were also customized to relevant target groups, making the information more acceptable and comprehensible (32, 43, 44, 48).

Several main challenges and barriers were identified and grouped into three categories, namely *perception barriers, technical or scientific barriers,* and *organizational barriers*.

a. Perception Barriers

Healthcare professionals often perceive that removing an existing health technology is of greater disadvantage than refusing to embrace a new health technology of comparable value (34). Removing or changing existing technology or practise may not be favourable since trained doctors view technology as an integral element of their job (31, 34, 37). For fear of being questioned by patients, some healthcare workers are reluctant to discontinue legacy therapies, such as older drugs, which have never been evaluated for cost-effectiveness (31). The assumption that disinvestment reduces prescriber and patient choice, and by reducing patient subsidies is also a main motivation for refusal (33).

b. Technical / Scientific Barriers

It is vital to convince stakeholders that withdrawing the technology would be harmless and that keeping it would be counterproductive (34). In some circumstances, the absence of robust evidence to support withdrawal decisions hinder the acceptance of disinvestment (30). A joint NICE-Cochrane pilot project found that specific review methods such as Cochrane systematic reviews were more likely to establish an absence of evidence rather than evidence of a lack of efficacy or effectiveness (50).

Technical challenges include variation in selecting and prioritizing health technologies for disinvestment (13). Failure to translate the suggested recommendations into binding guidelines and link them to adjustment in coverage decisions may result in stakeholder dissatisfaction (44).

c. Organizational Barriers

Stakeholders frequently lack the political, administrative, and clinical will to support disinvestment initiatives (32). Therefore, there is often a reluctance to devote appropriate resources to disinvestment programmes, such as educating specialists and HTA reviewers, providing incentives for implementation, and financing for related research to cover information and data shortages (29, 32). Hence, having enough resources to support disinvestment programs is critical to ensure its sustainability (37).

Among the solutions proposed are the provision of international platforms for collaboration and development of transparent, adaptable disinvestment models, which can be achieved through multistakeholder engagement (32). Furthermore, the presence of strong leadership may also expedite acceptance and facilitate implementation by emphasizing the need of constructive disinvestment activities through better resource allocation (44).

2.7 Discussion

Disinvestment is a complex process of decision making influenced by systemic linkages between value-based spending, resource reallocation and quality of healthcare delivery. Despite the favourable outcomes behind the ideas, in practice, the process seems to be notoriously challenging in terms of scientific, political and ethical aspects (36). Our scoping review aimed to summarize the findings of a growing body of evidence on healthcare disinvestment. We undertook a comprehensive systematic search of disinvestment initiatives globally using a broad lexicon of terms to identify all relevant programs on disinvestment including HTR and assessment of low-value technologies.

In England in the UK, disinvestment initiatives have been carried out implicitly through NICE's current projects, with various outputs available on its Web site (53). The established processes employed by NICE are conducted through technology appraisals, recommendation reminders, and commissioning guidelines for clinical practice. The procedures are comparable to those used in its HTA projects for investment and reimbursement, in which a systematic and thorough approach to evidence appraisal, as well as multistakeholder participation, is required to reach a conclusion on technology disinvestment (54). Because HTR activities are carried out alongside other existing initiatives, there is no specific disinvestment framework or process formally created by NICE. Although frequently cited in the included reviews, the "Do Not Do" database had been removed from the NICE Web site in November 2017 (*NICE Communications Coordinator of Enquiries, pers. commun., 16 Aug 2021*) and any recommendations that were potentially cost saving have since been assessed using the cost saving and resource planning guidance under NICE activities (55).

The current plethora of terms and concepts in describing this process creates substantial confusion. Indirectly, it may influence stakeholders' engagement as well as the acceptance of the initiative, hence, a more neutral term such as HTR has been proposed to improve understanding (13, 29, 32). Whilst there are arguments raised by researchers on making a distinction between disinvestment and HTR, we believe that the differences are very subtle with some overlapping

concepts, and it does not change the rationale of disinvestment. However, it is noteworthy that this process does not happen in a vacuum. Those involved in disinvestment are always aware of costs, even if cost reduction or reallocation of funds is not the primary motivation. Although they do not consider themselves to be rationing, HTR followed by disinvestment coupled with resource reallocation can appear very similar to rationing.

Analyzing the spectrum of disinvestment activities, stakeholder involvement would appear to be one of the most important aspects that needs to be addressed, allowing for higher acceptability, applicability, comprehension and political will. Early and continued stakeholder participation throughout the HTR activity, transparency in methodologies and processes, and ongoing knowledge transfer can all help to foster meaningful engagement (49). This is pivotal given their involvement in the provision of care and to avoid misperception in the purpose and process of disinvestment (31).

Barriers and challenges involving stakeholders' engagement are particularly profound during the implementation phase. Disinvestment efforts that lack of support from top level can lead to disengagement among frontline stakeholders tasked with implementation, particularly when the program's resources are limited (49). Some ideas for improving active engagement from these key stakeholders include incentivizing them to conduct more research to fill data gaps and contextualize critical data for reassessment purposes (32). In this instance, short-term resource allocation for disinvestment efforts is almost always unavoidable in order to realize long-term efficiency improvements (44).

Even though PBMA and standard HTA processes have been identified as the most used methods from our findings, there are differing views on their use in the context of disinvestment and resource reallocation. PBMA has had some difficulties in achieving disinvestment choices, and the outcomes in terms of permitting resource release are not always satisfactory (56). On the other hand, HTA was established with reimbursement rather than disinvestment in mind, as it is a valuable instrument for generating evidence in decision making and not a specially

designed framework for disinvestment (1). There is a need to revisit disinvestment methods to capture policy-beneficial outputs beyond or within PBMA and HTA, particularly in terms of technical analysis and what constitutes acceptable evidence. Common methods which can be applied within both these frameworks include the use of economic evaluation and multicriteria decision analysis (MCDA). Furthermore, the growing importance of real-world evidence in the context of disinvestment maybe highlighted more explicitly to accelerate and broaden its use in disinvestment.

A robust HTR, on the other hand, is part of the trajectory of health technology management, which also includes continues reassessment of technologies for improved health care. Future research could shift the emphasis away from disinvesting, and more on the appropriateness and scope of technology utilization, including resource reallocation to technologies with higher value to the patients.

Strengths and Limitations of This Scoping Review

The comprehensive search strategy and thorough analysis of the literature on this topic are the key strengths of this scoping review. Due to substantial number of publications in this area, we focused on synthesizing the evidence from the existing reviews to systematically summarize their findings in issues related to disinvestment. We covered aspects on clarifying the concepts, the methods and processes of disinvestment, the types of evidence used in the evaluations, and stakeholder involvement in the implementation of disinvestment initiatives. Other studies have tended to focus only on specific aspects of disinvestment in healthcare, such as the identification and prioritization processes (13), initiatives in specific regions, countries or within HTA agencies (6, 34, 46), and specific health technologies such as pharmaceuticals (32, 33) or non-pharmaceuticals only (29, 31). This review also highlighted the facilitators and barriers in disinvestment, which we consider as critical components in implementing the initiatives.

We also acknowledge some limitations in this review. Most of the included publications only discussed disinvestment initiatives in high-income countries. It is possible that we overlooked unpublished, informal, or small-scale initiatives in

low-and-middle income countries, which equally grapple with resource reallocation and value-based healthcare spending. Furthermore, small studies on disinvestment from regional areas may be classified or published as quality improvement and thus escape the scope of this review. Another limitation in this review is the lack of details on additional dimensions of using HTA in disinvestment process as it is not well-expanded in the included articles. We also recognize that there is limited information on the impacts of the proposed initiatives reported in the included articles. These can be improved by focusing the research on a specific disinvestment program or agency that has already implemented disinvestment initiatives, which could be conducted through case studies on the evaluation and monitoring of related policy.

2.8 Conclusion

With the growing emphasis for transparent and systematic processes of resource allocation, disinvestment initiatives have been a priority in countries and agencies worldwide despite the complexity of its implementation. There are plethora of terms and concepts in disinvestment in healthcare, but the purposes are consistent — toward value-based decision making and wise spending of resources to achieve maximum benefits for population health and improvement in the quality of care. Disinvestment programs have been implemented at various levels in many countries, but the success of these initiatives has been mixed. This scoping review also highlights the critical role of stakeholder involvement in disinvestment. The most used tools for assessing candidates for disinvestment are PBMA and HTA; nevertheless, there is a lack of clarity on the additional dimensions of technical analysis related to these tools. Further research could focus on technology optimization in healthcare, which includes continuous reassessment of health technologies as part of overall health technology management and resource reallocation to higher value technologies.

Declarations

i. Conflicts of interest:
   - The authors declare that they have no conflict of interest.

ii. Financial support:
   - This research received no specific funding from any agency, commercial, or not-for-profit sectors. Hanin Kamaruzaman receives scholarship for her PhD in University of Glasgow from Ministry of Health Malaysia

Authors' contributions:

We, the authors listed above, attest that (i) each author contributed to the conception and design or analysis and interpretation of data and the writing of the article; (ii) each has approved the version being submitted; and (iii) the content has not been published nor is being considered for publication elsewhere.

2.9 Updating the review

To ensure the review remains contemporary, I performed an additional round of database searches on OVID Medline and Embase on 25th July 2024 using the same search terms and inclusion criteria. Out of the fifty-eight titles acquired from the search technique, four additional reviews were published related to healthcare disinvestment, and the scopes covered in these reviews are relevant to the inclusion criteria in my scoping review (see Table 2-5).

The most recent scoping review by Falkenbach et al. (2023) examined the reporting of direct costs associated with de-implementation interventions in randomised controlled trials (RCTs) for low-value care and the impact of these strategies on healthcare costs (57). Out of 227 studies included in the review, fifty provided data on costs or the influence on healthcare expenses. Merely 8% of the studies included information about the overall costs or cost per unit, and even fewer provided detailed information on costing methods or separated costs related to different phases of de-implementation. In studies that do include cost information, only non-numerical information on economic impacts is reported and direct costs of de-implementation strategies are excluded, making it difficult to assess the economic impact of these strategies. The review concluded that cost information in de-implementation research is necessary as it has practical implications for healthcare decision-making (57).

A comprehensive collection of theories and frameworks used in de-implementation research were analysed in a scoping review published in 2022 with the aim of understanding the factors that influence efforts to reduce or eliminate low-value care (58). There were three types of theories or frameworks identified for understanding influences on the outcomes of de-implementation initiatives: determinant frameworks, classic theories, and implementation theories. While the Theoretical Domain Framework was the most commonly used determinant framework, theories related to behavioural change and process evaluation are dominant in understanding and explaining the relation between stakeholder motivation and perceptions in implementing de-implementation activities. Interestingly, the findings from this scoping review strengthen the initial

conclusions I drew about stakeholder engagement. By accepting that implementation of these initiatives requires awareness and knowledge sharing from multiple perspectives at various levels, it gave me clarity on the next steps that I should embark on for my research project, which is the crucial role of involving stakeholders by engaging them early in the planning for disinvestment programme.

In a two-phase multi-method study (59), Leigh et al. (2022) initially conducted a systematic review to map the determinants of de-implementation in the form of barriers and facilitators that influenced the discontinuation of a clinical practice or care. Subsequently, semi-structured interviews were carried out with decision-makers and healthcare professionals working in adult critical care medicine to investigate the similarities between the factors identified in the systematic review and those encountered in critical care medicine (59). The ten most frequently cited determinants for both barriers and facilitators identified in the systematic review are identical to those covered in my scoping review. Interestingly, this study demonstrated that the differences in attitudes towards behavioural change among decision-makers and healthcare professionals are influenced by how de-implementation is presented within the context of clinical practice. Framing de-implementation as a chance to save costs or redistribute resources was seen as a facilitator, while presenting it as a way to decrease costs was seen as a barrier that might impede the acceptance of such initiatives (59). This is an essential information that is useful to me, particularly during the phase of raising awareness among stakeholders to gain support for disinvestment initiatives.

Another systematic review focused on low-value services in cancer care delivery (60), emphasised the necessity of transitioning from passive de-implementation (i.e., involves solely on sharing evidence and hoping that clinicians willingly adopt the new guidelines unprompted) to active de-implementation (i.e., organisation-initiated strategies to reduce low-value care, such as modifying workflows and implementing systems that facilitate change). Relying on clinicians to change their practice in the absence of well-designed de-implementation interventions is unlikely to reduce LVC. Hence, a multistep de-implementation strategy based on

the Plan-Do-Study-Act cycle was recommended to help clinicians involved in cancer care reduce overuse of tests and treatments while also enhancing adherence to the guidelines. This cycle involved an audit of clinicians' practice data in comparison to evidence-based guidelines, followed by feedback to clinicians on their baseline practice data and any differences with the guidelines.

In summary, these additional reviews are in line with my earlier conclusion: **stakeholder involvement** is pivotal in achieving effective disinvestment. This was echoed by Leigh et al. (2022) and Alishahi Tabriz et al. (2022), who identify stakeholder collaboration and communication as facilitators, while clinician resistance, entrenched norms, and insufficient stakeholder support remain barriers (59, 60). A broader stakeholder engagement is needed to incorporate public and patient-centred considerations, such as satisfaction and societal acceptance, into the discourse on disinvestment (60). In addition, the findings in my scoping review highlighted the lack of clarity in technical analysis tools, which resonates with findings from Falkenbach et al. (2023), underscoring the need for detailed economic evaluations, hence advocating for precise cost reporting (57). The call for the systematic application and development of theories and frameworks tailored to de-implementation by Parker et al. (2022) (58) aligned closely with my suggestion for future research, which emphasised refining existing frameworks to address gaps through continuous reassessment of health technologies and the optimisation of resource allocation.

Table 2-5: Summary of additional systematic reviews *(searched between February 2022 and July 2024)*

Author & publication year	Review type & number of articles included	Clarifying concepts and terms for disinvestment (Yes / No)	Purpose of disinvestment	Disinvestment implementation	Areas of disinvestment	Propose framework for disinvestment / HTR
Falkenbach et al., 2023	Systematic scoping review of RCTs (n=227) and reports that included cost and cost benefit components (n=50)	Yes – "disinvestment" and "de-implementation"	Not mentioned	International	General	No
Parker et al., 2022	Scoping review (n=48)	Yes – "de-implementation of LVC"	Reduce unnecessary practice and eliminating low-value care	Not specified	General	No
Leigh et al., 2022	Systematic literature review (n=172) followed by stakeholder interviews	No	Not mentioned	International	General	Yes – mapping of findings from the review and interviews to the published Conceptual Model for Facilitating De-implementation
Alishahi Tabriz et al., 2022	Systematic review of peer-reviewed studies (n=12)	No	Reducing low-value care involving overuse of tests and treatments	International	Cancer care delivery	Yes – multistep de-implementation intervention (Plan-Do-Study-Act cycle)

Chapter 3: Methodological approaches for disinvestment in healthcare

3.1 Background

Building on the findings from the previous scoping review, it became evident that HTA and PBMA are the most commonly utilised approaches for disinvestment in healthcare. However, the review did not comprehensively address the application of these tools within the disinvestment process, leaving significant knowledge gaps. This chapter delves into the methodological approaches to healthcare disinvestment by conducting an in-depth literature review and analysing examples from published case studies that utilise various tools. This analysis allows me to map the design and components of these approaches, assess the problems they were designed to address, and identify shortcomings in their application. By doing so, this chapter contributes to a deeper understanding of the strengths and limitations of existing methodologies, offering insights to guide future improvements in the disinvestment decision-making process.

3.2 Health technology assessment (HTA)

Health technology assessment is extensively utilised as a standard policy instrument to inform decision-makers responsible for regulating the introduction and utilisation of pharmaceuticals, medical devices, and other technologies, including complex interventions, within health systems, such as through reimbursement and pricing mechanisms. The procedures were undertaken using diverse methodologies, including policy formulation and research objectives; however, the primary aim of HTA is to facilitate healthcare decision-making, which addresses all components, including the governance and how HTA processes are defined; assessment of the research information; contextualisation of the research outputs into decisions; and the implementation and monitoring of these decisions (Figure 3-1) (61).

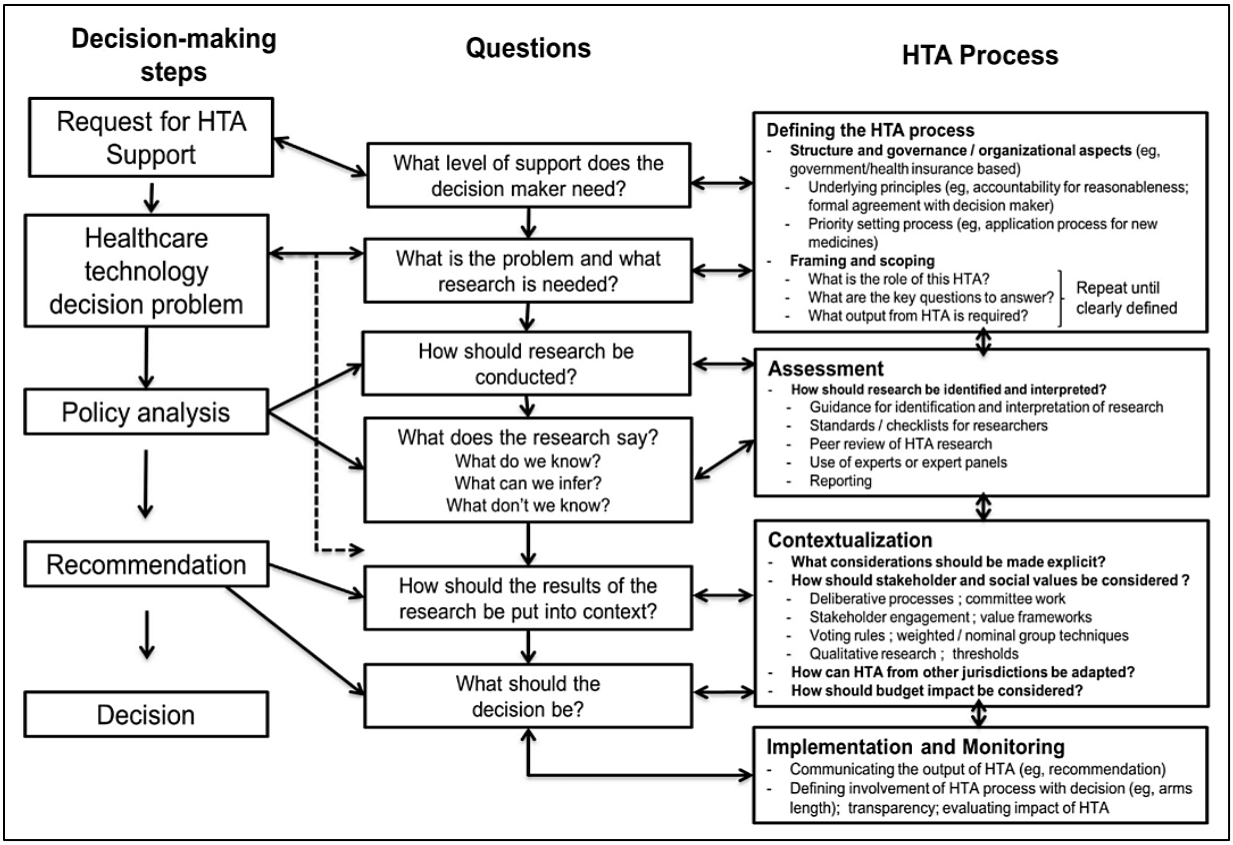

Figure 3-1: Components of health technology assessment (HTA) within the healthcare decision-making process (61). *(adopted with permission from Elsevier)*

Evidence synthesis, as part of HTA, plays an important role in supporting evidence-based decision-making. While HTA focuses on systematically evaluating the benefits, risks, and costs of healthcare technologies using robust analytical methods, evidence-based decision-making often incorporates additional factors, such as affordability, ethics, feasibility, and acceptability (61). These broader considerations require contextualisation of assessment findings through approaches like deliberative processes, which have been incorporated in many national HTA agencies such as the United Kingdom, Scotland, Australia, Canada, (62) as well as Malaysia (25). Therefore, HTA is a powerful tool for evidence-based decision-making, as it integrates rigorous evidence synthesis with practical, context-sensitive deliberative processes involving stakeholders. This dual approach ensures that decisions are both scientifically grounded and tailored to the specific needs and realities of the local context.

The new and internationally accepted definition of HTA was developed by a joint task group co-led by the International Network of Agencies for Health Technology Assessment (INAHTA) and Health Technology Assessment International (HTAi), accurately describe what HTA is, including the interdisciplinary nature of HTA, which should not be limited to only health economics, for instance. The definition of HTA is: *"a multidisciplinary process that uses explicit methods to determine the value of a health technology at different points in its lifecycle. The purpose is to inform decision-making in order to promote an equitable, efficient, and high-quality health system"* (63). This demonstrates that HTA can be effectively applied at various stages of a health technology's lifecycle, including the pre-market phase, market approval, post-market evaluation, and ultimately, the disinvestment stage (Figure 3-2).

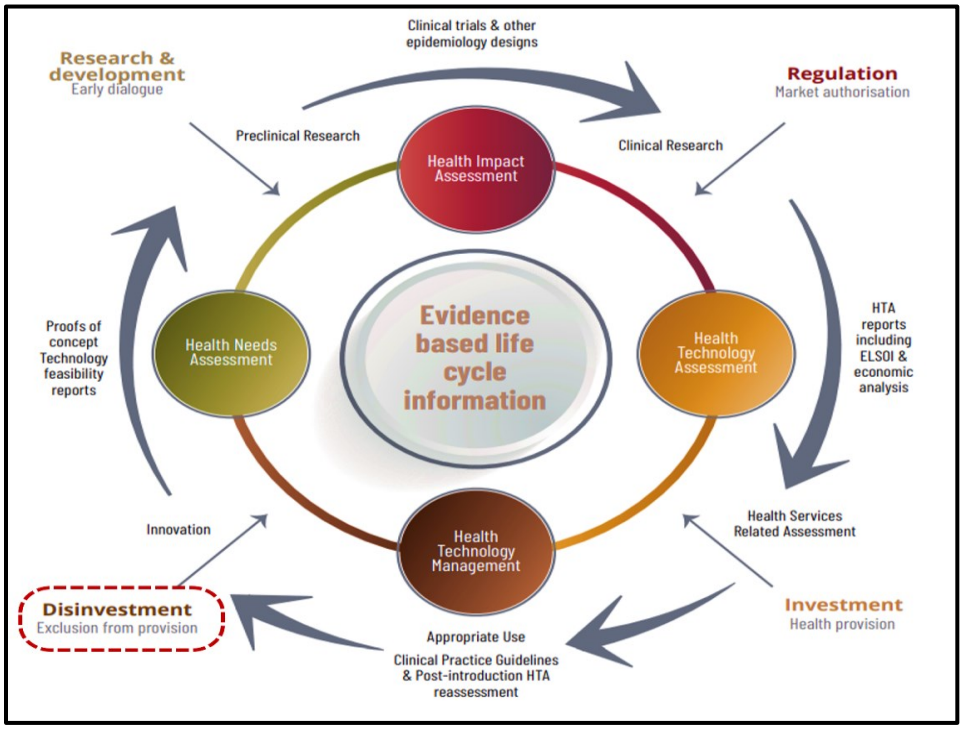

Figure 3-2: The life cycle of health technologies concept, adapted from (64).

**ELSOI: ethical, legal, social and organisational issues.*

Kirwin et al. (2022) proposed the life cycle HTA framework (LC-HTA) to address challenges involving uncertainty in decision-making as well as to encourage continued generation of and adaptation to new evidence (27). The LC-HTA framework integrates HTA processes with life cycle management, streamlining methods to reduce analysis time while enhancing decision confidence. This framework enables reassessment terms to be set and offer HTA agencies additional decision pathways. Responsiveness to new evidence is enhanced by incorporating decision rules and streamlining the reassessment process, supported by routine administrative data and registries. Figure 3-3 describes the LC-HTA framework in alignment with the chronological progression of a technology's life cycle, beginning with the initial HTA. Over time, the process evolves into a cyclical pattern where technologies move between reassessment, adoption, and non-adoption phases (27).

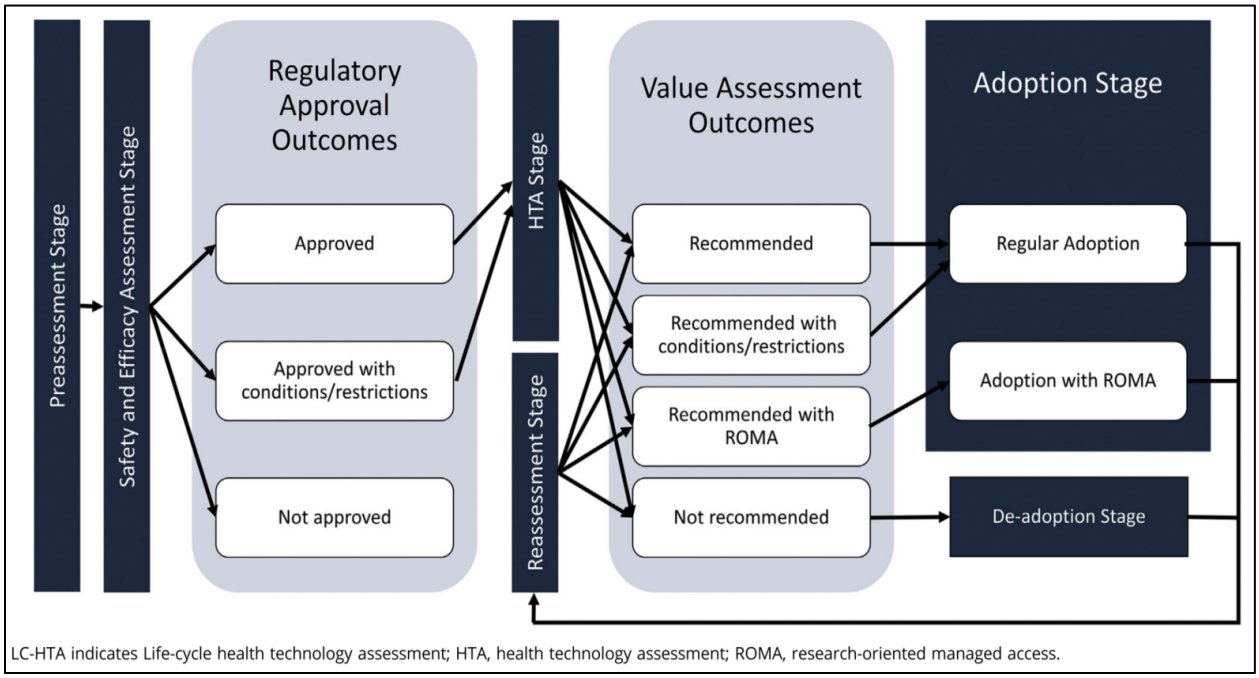

Figure 3-3: The Life cycle-HTA framework *(source: Fig. 1 in (27), permission obtained under Creative Commons CC-BY license). Dark shaded square boxes represent LC-HTA stages; lighter shaded rounded boxes represent outcomes. White rounded boxes represent statuses within stages and outcomes.*

3.2.1 Disinvestment using HTA and reassessment

Disinvestment and health technology reassessment (HTR) have recently garnered greater attention within the HTA community, with particular focus on methodological approach, implementation, and discussion on the impact of the decisions from these processes. However, challenges persist in selecting specific technologies for potential disinvestment. Identifying and prioritising topics for HTA can be an effective strategy to guide decisions on which areas to assess, especially when resources for assessments are limited (65). While this process is crucial, it is also highly context-dependent, with assessments often focusing on evaluating a single technology for a specific indication. Although often used interchangeably, the term HTR is typically associated with the HTA process specifically aimed at guiding disinvestment or de-implementation decisions.

Mitton et al. (2019) argued that although HTA holds potential as a tool for supporting disinvestment, its primary purpose is not to implement or operationalise disinvestment opportunities (1). Instead, HTA is designed to generate evidence relevant to the evaluation and management of healthcare technologies. Employing HTA as the operational method for the disinvestment process should be approached with caution, as the criteria for assessing technologies for investment may differ from those used for disinvestment. Although HTA and HTR reports address similar analytical dimensions—such as scientific evidence on efficacy, effectiveness, safety, costs, technology usage, and social impact—HTR analyses often lack consistency in applying these criteria due to limited supporting evidence. Of these dimensions, efficacy, safety, and technology usage are the most influential factors in guiding decision-making for disinvestment as reported by the National Committee for Health Technology Incorporation (Conitec) in Brazil (66).

The National Evidence-based Healthcare Collaborating Agency (NECA) in South Korea has been utilising HTA process as the method for reassessment of established technologies in the healthcare system since 2018 (67). Branding it as HTR, this activity seeks to promote the appropriate use of health technologies by both clinicians and

patients, while also guiding informed decisions on health insurance policies in the country. The ultimate goal of this initiative is to enhance the efficient allocation of healthcare resources on the covered, selective and preliminary benefits, as well as to encourage the effective utilisation of health technologies. In a span of five years, the HTR group has developed around 130 recommendations for technology in current use. Among the challenges outlined by the NECA in utilising HTA method in technology reassessment are limited use of real-world evidence (RWE) in the form of national health insurance claims data, to facilitate disinvestment decision and evaluating the outcomes of HTR as part of the monitoring process for its implementation (67). Given that HTA traditionally do not evaluate the value of implementation for recommended health technologies, it is unsurprising that NECA encounters these challenges in its HTR programme.

3.3 Programme budgeting and marginal analysis (PBMA)

Programme budgeting and marginal analysis is a priority-setting framework utilised in the health sector since 1974 (68), about 50 years after its inception. It was introduced to facilitate healthcare decision-making over resource allocation by integrating a priority-setting process that considers both outcomes and costs incurred by alternative uses of limited resources in geographically defined area, such as regional health authorities. While HTA primarily evaluates specific technologies within a fee-for-service payment mechanism, PBMA focuses on assessing the allocation of resources for health services and technologies within a fixed budget plan (34). In several publications, PBMA has been reported to significantly influence priority-setting activities across various healthcare jurisdictions (68-71).

As the name implies, PBMA consists of two components; **programme budgeting** and **marginal analysis**. Programme budgeting is an evaluation of resource distribution, categorised into meaningful programmes, aimed at monitoring future resource allocation in the planning mechanism, either within specific care programmes (e.g. maternity services) or across several care programmes (68, 72). Marginal analysis, on

the other hand, refers to the assessment of the incremental benefits and costs associated with a proposed investment, or, in the context of resource release, the forfeited benefits and reduction in costs of a proposed disinvestment (72). In operationalising the framework, five essential questions regarding resource utilisation must be posed (68, 73):

i. What resources are available in total?
ii. In what ways are these resources currently spent?
iii. What are the main candidates for more resources and what would be their effectiveness?
iv. Are there any areas of care that could be provided to the same level of effectiveness but with fewer resources, so releasing those resources to fund candidates from?
v. Are there areas of care which, despite being effective, should have fewer resources because a proposal from is more effective (per dollar spent)?

The initial two questions address programme budgeting, while the remaining three focus on marginal analysis (68).

As PBMA advocated for multidisciplinary members as the composition of the advisory panel, the framework has demonstrated success and promising potential in fostering collaboration between clinicians and managers, aligning resources with health outcomes, and balancing clinical autonomy with financial accountability (73). However, the positive output of the activities varies depending on the way success was defined. High success rate reported if the positive side of implementing PBMA taken from the context of 'better understanding of the programme evaluation' and 'partial or full implementation of the advisory panel's recommendations' (74). However, less than fifty percent success rate reported when it was defined in terms of 'making decisions on disinvestment or resource reallocation', and 'sustaining the use of the framework for future resource planning'.

Presence of key leaders and technical experts in carrying out PBMA is crucial, as the framework is not widely understood just by learning the basic concepts of it. The key

enablers for successful implementation of PBMA were the presence of influential champions within the organisation and the involvement of a health economist, both of which enhance commitment and the long-term adoption of PBMA as tool for resource planning mechanism (74). In addition, the design and implementation of this framework within an English Primary Care Trust emphasised that the key reason for acceptance and endorsement of PBMA was its capacity to mitigate decibel rationing which manifest as across-the-board budget reductions or uniform service cutbacks, irrespective of their value or impact (75).

3.3.1 Implementing PBMA in healthcare decision-making

Programme budgeting and marginal analysis serves as an effective framework for collaboration between clinicians, health or hospital managers, and budget holders. It supports allocative efficiency, enabling resources to be distributed across programmes to maximise health benefits, which is a key focus for commissioners (76). Additionally, PBMA enhances healthcare delivery by promoting technical efficiency, ensuring objectives are achieved at the lowest possible cost, which is a priority for providers. Therefore, PBMA is applied in health services with limited budgets, where additional funding is seldom provided, necessitating the optimal utilisation of existing resources.

A primary benefit of employing a structured PBMA approach is that, it promotes greater transparency in decision-making and enables clear comparisons among various investment and disinvestment alternatives. There are eight stages in a PBMA priority setting exercise with description of key activities (Table 3-1) and considerations for each stage are elaborated in Supplementary 3-1 (76, 77). Stages 1 to 6 represent the initial phase of the PBMA process, during which the working group, composed of multidisciplinary members, undertakes planning, prioritization, analysis, and formulates recommendations. Stage 7 marks the phase where the outcomes of the PBMA exercise are disseminated, and decisions are made regarding the implementation of the recommendations. Finally, Stage 8 involves follow-up and monitoring, where the implementation of current decisions is reassessed to inform future strategies and resource planning.

Table 3-1: Stages of programme budgeting and marginal analysis (PBMA)

PBMA Stage	Activities
1. Choose a set of meaningful programmes	• Identify activity in a specific budget or spend • Establish a PBMA panel
2. Identify current activity and expenditure in those programmes	• Identify current activity • Identify expenditure of that activity • Establish and operationalisation group
3. Think of improvements	• Liaise with experts and stakeholders
4. Weigh up incremental costs and incremental benefits and prioritise a list	• Create a list of criteria to appraise resource reallocation candidates • Rank or assign weightings to these criteria • Create a list of candidates and gather evidence for each one
5. Consult widely	• Allow the PBMA panel to review evidence and discuss the candidates for resource reallocation
6. Decide on changes	• Recommendations for disinvestment and investment • State the monetary value of the disinvestment and investment recommended
7. Effect the changes	• Present recommendations for disinvestment and investment to managers and directors who have the power to implement them
8. Evaluate progress	• Re-evaluate recommendations in the future

Adapted from Brambleby and Fordham (2003)(76); Charles and Edwards (2019)(77)

The advantages of using PBMA as a decision-making tool for resource allocation are mainly on the transparency and systematic approach of the evaluation process. At system-level, PBMA was praised for being robust, structured, evidence-based, and inclusive, effectively minimising the influence of powerful individuals (75). While at the group and individual level, it drives changes in knowledge, attitudes, and practices related to priority-setting (78).

3.3.2 Using PBMA for decision-making in healthcare disinvestment

Although PBMA was favoured over historical budgeting for investment decision-making, its application for disinvestment poses several challenges. Mortimer (2010) identified four key barriers to using PBMA for disinvestment: *(i) specifying the budget constraint*; *(ii) determining the scope of the programme budget and availability of supporting evidence for analysis; (iii) the composition and role of the advisory group or panel*; and *(iv) the presence of incentives or disincentives for contributing to a "shift list" of disinvestment options and resource reallocation* (56). The arguments for these challenges are as below:

(i) ***Specifying the budget constraint:*** the connection between investments and disinvestments in the PBMA process is diminished when budget limitations are inadequately defined or seen as a decision variable (56). There were apprehensions over the trade-offs between investments and disinvestments, with some perceiving financial considerations as excessively prioritised (75).

(ii) ***Scope of the programme budget and evidence to support analysis:*** the inability to sufficiently distinguish the scope of the programme and the parameters needed to carry out PBMA exercise may affect the process (56). Gathering reliable data on costs, cost-effectiveness and benefits to inform the programme budget is another hurdle (69, 74), particularly when integrating social care, where data is less established compared to healthcare (79).

(iii) ***Composition and role of the advisory and working groups:*** advisory panels and working groups must be carefully composed to ensure fair representation from key stakeholders, such as programme managers, financial department and clinical care (56). It is essential to develop organisational capacity for workers to engage in the process amidst other conflicting responsibilities, as insufficient capacity may impact advisory group membership and result in meeting absences, hence causing the process to stagnate (79).

(iv) Incentives for/against contributing to a 'shift list' of options for disinvestment and resource release: creating a list of potential disinvestment areas is one challenge, but implementing these recommendations and reallocating resources accordingly is another. As a result, achieving success in decommissioning, disinvesting, or redeploying resources has often been difficult, even by using PBMA. The release of resources may be more feasible when they are directly redeployed from areas experiencing service contraction to those undergoing service expansion (56). Since PBMA depends on managers and clinicians to identify disinvestment areas, they may lack motivation if freed resources cannot be reinvested into alternative interventions or services within the same programme (80).

3.3.3 Introducing PBMA for hospital-level disinvestment decision in Malaysia

In June 2022, I collaborated with the co-researchers from MaHTAS to conduct a workshop aimed at raising awareness and engaging Malaysian healthcare stakeholders on employing PBMA for resource allocation and disinvestment decisions at the hospital level. The workshop explored the feasibility of integrating value-based assessment into prioritisation processes. The outcomes were subsequently presented at the HTAi Annual Meeting in Adelaide (May 2023) and published in an article documenting Malaysia's journey in disinvestment initiatives (23).

The workshop gathered Directors from public hospitals, fostering leadership discussions on optimising healthcare resources. Participants were introduced to the principles of investment and disinvestment decision-making, as well as the application of PBMA as a decision-making framework. Through group exercises, they engaged in prioritisation tasks by assessing hypothetical 'wish lists' and 'shift lists' to redistribute resources within a constrained budget.

The workshop concluded that PBMA is an effective instrument for resource reallocation and emphasised the importance of stakeholder active participation for successful priority setting and decision-making. Also, stakeholders responded

positively to integrating disinvestment and value assessment into resource reallocation. One of the challenges in adopting PBMA, as highlighted from the workshop, was that the shifting of resources may need to consider the magnitude of the impact on the services, as the higher-level hospitals implementing the changes may also be responsible for other smaller hospitals, for instance, in a hospital cluster system that is implemented in Malaysia. Therefore, monitoring the change process is crucial and auditing system should be in place to manage transitions effectively.

3.4 Cost-utility analysis (CUA)

Incorporating economic evaluations into healthcare decision-making and policy development has significantly improved the efficiency of healthcare spending by focusing on “value for money”. Cost-utility analysis (CUA) stands out as the most widely used and preferred economic evaluation in HTA, particularly for evaluating the cost-effectiveness of healthcare interventions. By generating incremental cost-effectiveness ratios (ICERs), CUA provides a quantifiable measure of the additional cost per QALY gained, offering clear guidance on whether an intervention is cost-effective when compared against a willingness-to-pay (WTP) threshold. This approach is especially valuable in resource-constrained settings, as it supports evidence-based decisions to allocate resources effectively. As such, CUA is the recommended framework for assessing drug cost-effectiveness in Organization for Economic Co-operation and Development (OECD) countries (81). The adoption of CUA in the HTA framework for decision-making has also been growing in several Southeast Asian countries, including Malaysia, Indonesia, Thailand, and Singapore (82). For example, in the Malaysian healthcare system, the implicit cost-effectiveness threshold that has been used is 1 GDP per capita per QALY gained to determine whether an intervention is value for money for investment purposes (26).

In the English local commissioning cycle, new interventions are evaluated during strategic planning based on needs assessments, service reviews, and policy objectives (83). Costs are often assessed within an accountancy framework to stay within budget

limits, with outcomes and costs considered sequentially rather than simultaneously, as in economic evaluations. This creates a disconnect between the use of economic evidence at the national level and its application in local commissioning. While national bodies like NICE provide guidance based on economic evidence using CUA, they lack direct commissioning or budgetary responsibilities (83). As a result, interventions deemed cost-effective nationally may face resistance from local commissioners due to their financial impact on local budgets.

While CUA is a valuable tool for evaluating the cost-effectiveness of healthcare interventions, its application in disinvestment or rationing decisions has notable limitations, as outlined below.

3.4.1 Lack of consideration on budget constraints

Despite its potential in ensuring the value of health interventions, CUA does not help decision-makers manage resource allocation within fixed budgets, which is usually the case at the regional or local level. In general, existing methodologies for economic evaluations are designed for national decision-making and are considerably less applicable at the local level (83). Therefore, using CUA in determining the best options for the implementation or de-implementation of health technologies at regional or local levels might not work well, as it unable to explicitly factor in non-financial healthcare resource limitations that may hinder the adoption or de-adoption of cost-effective technologies. In addition, at local and regional levels, costs often focus on additional resources for personnel and procurement of new equipment, while potential disinvestments in other services are rarely considered.

3.4.2 Challenges in capturing real-world context

In many instances, CUA frequently depends on economic modelling based on assumptions that may insufficiently capture real-world complexities, including implementation barriers and irrecoverable sunk costs. Decisions to discontinue interventions are influenced by practical factors, such as political resistance, equity concerns, and the feasibility of reallocating saved resources. These elements are not

readily incorporated into conventional CUA models, hence unable to provide detailed guidance for investment and disinvestment decisions at the provider level. In particular, CUA alone lacks practical tools for translating policy decisions into actionable standard practices, such as utilising a resource, process, and outcomes framework across the care pathway to support changes like adopting new tests or improving existing practices (84). These broader considerations can be addressed within a comprehensive HTA framework, where CUA serves as one component of the overall assessment.

3.4.3 Limited consideration of equity

As CUA assumes a uniform valuation of QALYs across populations, it is potentially ignoring the equity issues critical to disinvestment or rationing decisions (85). While equity in budget constraints often requires prioritising interventions for disadvantaged groups, as have been emphasised by the Malaysian healthcare stakeholders, this may not align with the final output of CUA results. Therefore, CUA alone is insufficient to address the whole elements of disinvestment initiatives, particularly the preservation of equity for underserved populations. Distributional cost-effectiveness analysis offers a potential approach by explicitly incorporating equity considerations, but its application in healthcare disinvestment requires further exploration.

3.5 Multi-criteria decision analysis (MCDA)

Since disinvestment is a complex process involves identifying and withdrawing resources from low-value or obsolete healthcare practices, it requires robust and transparent methodological framework. One such promising approach is MCDA, a decision-making tool designed to integrate multiple, often conflicting criteria into a structured evaluation process. Unlike HTA methods that primarily rely on CEA or CUA, MCDA offers the advantage of incorporating diverse dimensions of value, such as health benefits, equity, feasibility, and stakeholder preferences, into a comprehensive assessment (86). This feature makes MCDA particularly suited for healthcare systems grappling with complex trade-offs in disinvestment decisions. In addition, techniques

in MCDA allow the users to clarify relevant criteria, their importance, and their application in assessing alternatives, which enhance decision-making consistency, transparency, and legitimacy (87).

There are various descriptions of MCDA available, but the most accepted definition is *"an umbrella terms to describe a collection of formal approaches which seek to take explicit account of multiple criteria in helping individuals or groups exploring decisions that matter"* (87, 88). The application of MCDA methods was evident in different healthcare areas such as policymaking, resource allocation, determining benefits package lists, pharmaceuticals reimbursements, at hospital level, as well as specific clinical area such as cancer care (89). For instance, MCDA was used to assess spending on reducing tobacco-related harm across South Yorkshire's four local authorities and particularly suited for public health decision-making, as they formally integrate data alongside qualitative and quantitative judgments, making them effective in contexts where evidence is incomplete and policies are often value-driven (90). In Thailand, the MCDA priority-setting process was utilised between 2009 and 2010 to develop a universal coverage benefit package (91). This approach evaluated the cost-effectiveness of various interventions while incorporating stakeholder preferences into the decision-making process. These examples highlight the significant potential of MCDA to enhance healthcare decision-making by delivering high-quality, consistent, and transparent recommendations, particularly in areas like reimbursement and resource allocation.

3.5.1 Steps in conducting an MCDA for decision-making

The International Society for Pharmacoeconomics and Outcomes Research (ISPOR) established a task force to explore the use of MCDA in healthcare decision-making, in view of the approach increasingly applied in the healthcare sector to address complex decision-making challenges (87, 92). The task force aimed to provide foundational guidance and recommendations on effectively utilising MCDA methods, bringing together international experts from diverse fields, including HTA, healthcare research, epidemiology, health economics and modelling, among others. The task

force provides an overview of the main steps involved in conducting MCDA for decision-making (Table 3-2), and this guidance has been used widely as a reference by healthcare researchers and HTA agencies.

3.5.2 Typology of MCDA approaches

Following the ISPOR MCDA Task Force, a systematic review was conducted by MCDA and HTA experts, complemented with intensive discussions using various review rounds, provide consensus statement on the benefits and limitations of the use of MCDA for HTA agencies (88). Three categories of MCDA studies have been identified: qualitative MCDA, quantitative MCDA, and MCDA employing decision rules. Different types of MCDA study exhibit varying performance regarding the quality, consistency, and transparency of recommendations concerning healthcare priorities. It was advised that HTA agencies should, at a least, conduct qualitative MCDA by implementing the initial three steps of the process (labelled as partial MCDA): defining the decision problem, selecting the criteria that reflect relevant values, and constructing the performance matrix (88).

Quantitative or full MCDA, offers supplementary advantages over partial MCDA. The quantitative value measurement model eases the cognitive burden of considering multiple criteria at once and minimises the influence of dominant participants during deliberations, thereby improving the quality of recommendations. Additionally, applying consistent criteria scores and weights across the evaluation of different technologies enhances the reliability of the recommendations and augments the transparency upon communicating the decisions to the public (88). On the other hand, MCDA activities employing decision rules (known as structured deliberation) are mainly utilised by HTA agencies in the Netherlands and the UK, possesses the capacity to enhance the development of recommendations (88).

Table 3-2: Steps for value measurement process in the ISPOR MCDA Good Practice Guidelines Checklist.

MCDA step	Description	Recommendation
1. Defining the decision problem	• Identify objectives, type of decision, alternatives, stakeholders, and output required.	a. Develop a clear description of the decision problem. b. Validate and report the decision problem.
2. Selecting and structuring criteria	• Identify criteria relevant for evaluating alternatives.	a. Report and justify the methods used to identify criteria. b. Report and justify the criteria definitions. c. Validate and report the criteria and the value tree.
3. Measuring performance	• Gather data about the alternatives' performance on the criteria and summarise this is a "performance matrix".	a. Report and justify the sources used to measure performance. b. Validate and report the performance matrix.
4. Scoring alternatives	• Elicit stakeholders' preferences for changes within criteria.	a. Report and justify the methods used for scoring. b. Validate and report scores.
5. Weighting criteria	• Elicit stakeholders' preferences between criteria.	a. Report and justify the methods used for weighting. b. Validate and report weights.
6. Calculating aggregate scores	• Use the alternatives' scores on the criteria and the weights for the criteria to get "total value" by which the alternatives are ranked.	a. Report and justify the aggregation function used. b. Validate and report results of the aggregation.
7. Dealing with uncertainty	• Perform uncertainty analysis to understand the level of robustness of the MCDA results.	a. Report sources of uncertainty. b. Report and justify the uncertainty analysis.
8. Reporting and examination of findings	• Interpret the MCDA outputs, including uncertainty analysis, to support decision-making.	a. Report the MCDA method and findings. b. Examine the MCDA findings.

Adapted from Table 2 (87) and Table 1 (92) of ISPOR MCDA Emerging Good Practices Task Force Reports.

Deliberation has become a standard practice in decision analysis, as it facilitates an interactive social process of engaging key stakeholders' discussion around transparent, criteria-based outcomes from systematic assessment (93). In the context of supporting HTA agencies using MCDA for healthcare priority-setting, incorporating a deliberative component is strongly recommended (88). This approach enables committees to flexibly interpret decision-making criteria and account for all relevant considerations, which potentially enhancing the quality of recommendations. To ensure consistency and transparency, agencies should document and report these deliberations, including the rationale behind their final recommendations (88).

3.5.3 Combining multiple approaches for disinvestment process

While there are slight differences between PBMA and MCDA, their methodologies can align to enhance decision-making in healthcare. In a PBMA process, MCDA might be applied to evaluate and rank options based on multiple factors, adding depth to the decision-making framework. The ability of the MCDA approach to handle qualitative and subjective criteria can complement PBMA's focus on economic efficiency, which eventually provides a more holistic assessment.

Mitton et al. (2019) proposed a combined framework of PBMA and MCDA for priority-setting and resource allocation, by incorporating input from HTA to decide on areas for investment and disinvestment as shown in Figure 3-4 (1). It was narrated that decision-makers often cite a lack of robust evidence for making informed choices, and HTA can address this gap by aligning closely with the criteria relevant to the decision-making context. However, challenges persist in areas like disinvestment and public engagement, where clarity and consistency are lacking. This highlights the need for shared pathways to guide both HTA practitioners and decision-makers navigating complex choices within constrained resources.

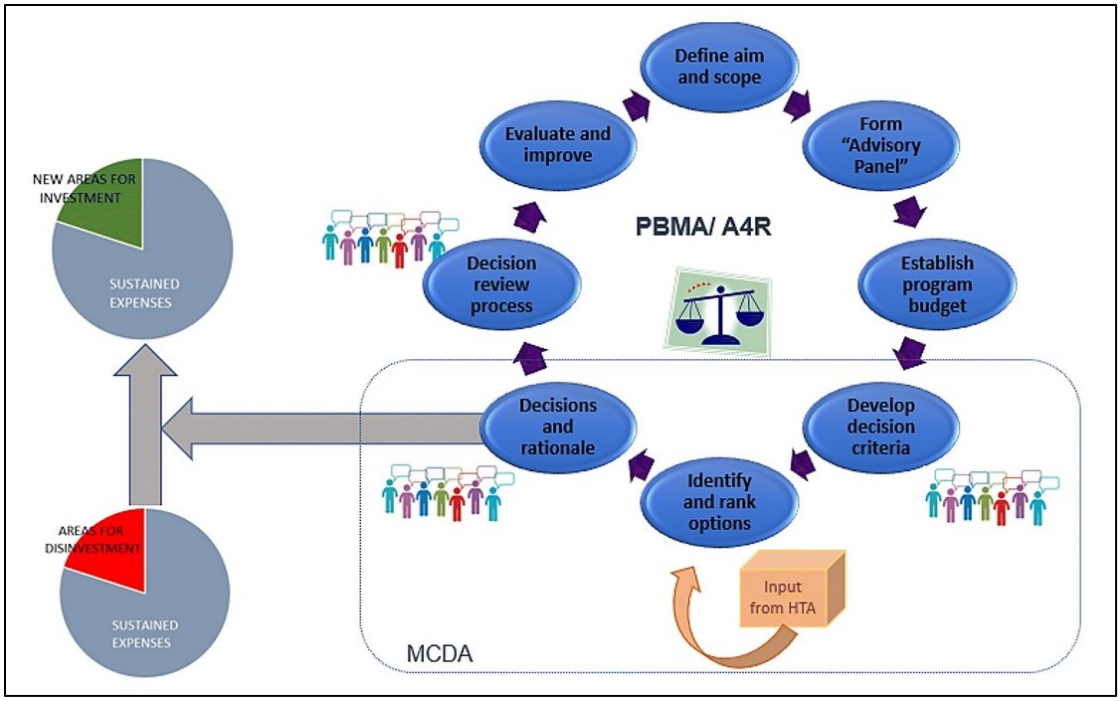

Figure 3-4: Framework on priority setting and resource allocation with HTA input.

The speech bubbles represent stages where public engagement is pertinent.

(source: Fig. 1 in (1), permission obtained from Springer Nature)

A more recent work by Collins et al. (2023) proposed a combined framework for priority setting that integrates PBMA, MCDA, and Accountability for Reasonableness (A4R). Developed through co-production with stakeholders from local Health and Social Care Partnerships in Scotland and national organisations, the framework was designed for easy adoption by local entities with limited external input (79). It integrates additional stages from both literature and stakeholder input to meet A4R conditions, enhancing existing PBMA and MCDA processes while explicitly outlining guiding principles (Figure 3-5). The framework fosters collaboration among organisations for resource allocation. However, this combined framework places less emphasis on disinvestment or reducing low-value interventions, as it prioritising the integration of health and social components for resource allocation decision-making instead.

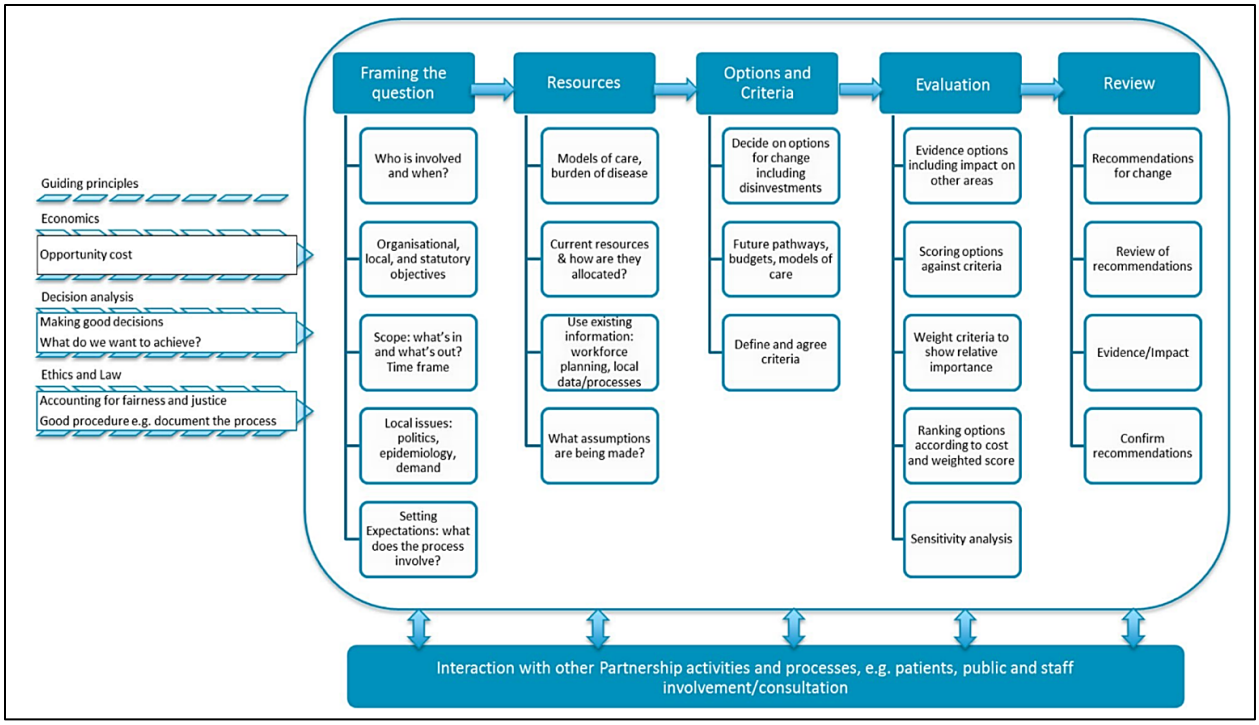

Figure 3-5: Combined framework for priority setting. *(source: Fig. 3 in (79), permission obtained under Creative Commons CC-BY license).*

3.6 Examples of healthcare disinvestment case studies

During the process of identifying potential case studies for my research project, I came across several published examples that utilised the various tools discussed in this chapter. To compare and analyse their methodological approaches, I synthesised the findings and outcomes of these case studies, which are summarised in Table 3-3. This section highlights four examples that employed the HTA approach, three that applied the PBMA framework, and one that used MCDA as a decision-making framework for the inclusion and exclusion of pharmaceuticals in national medicine formulary.

Table 3-3: Example of case studies and methodological approaches used in assessment for disinvestment

Author, year, country (ref)	Technology / programme	Methodological tool / framework	Criteria for outcome measurement	Results / Decision	Comments for discussion
Soril (2021), Canada **(94)**	Medical practice (red blood cell [RBC] transfusion practices in intensive care unit, ICU)	**HTA – multimodal (Phase III)** • Retrospective observational study • Meta-analysis • Controlled, pilot before-and-after implementation study with cost analysis • Survey with clinicians and nurses	• **Transfusion practices** (survey on behavioural change) • **Cost analysis** • **Audit of transfusion practices** after implementing intervention modality (education and feedback from clinical leaders)	• Study site: 2.2 transfusions per admission pre-intervention and 1.9 transfusions per admission post-intervention. • Control site: similar (pre: 2.1; post: 2.0). • Total cost of RBC transfusions per ten admissions: o Study site: $15,110 pre-intervention and $13,383 post-intervention o Control site: $14,832 pre-intervention and $13,629 post-intervention	Survey findings: - 51% staff neither agreed nor disagreed that knowing the information about past RBC transfusion practices in their ICU changed the way they order transfusions for their patients. - 58% neither agreed nor disagreed that their practice change will continue.
Lemos (2018), Brazil **(95)**	Pharmaceuticals (IM Interferon [IFN]-beta-1a for patients with relapsing-remitting Multiple Sclerosis) Alternatives: • SC IFN-beta-1a, 1b • Glatiramer	**HTA – multimodal** • First: review based on Cochrane and network meta-analysis • Second: RWE from information system e-Critical Alberta followed by survey (healthcare staff)	**Clinical effectiveness, safety profile** - evidence of inferiority if compared to alternatives (exclusion from guidelines, causing public controversy) -cohort study and survival analysis on treatment failure (switching, relapse, death)	IM IFN-beta-1a excluded from the guideline for new patients, but allowing access to patients who currently on this treatment the option of continuing until treatment failure. • *CEA not done since IM IFN-beta-1a proven to be inferior in terms of the effectiveness compared to alternatives.*	Only direct cost of treatments included for consideration, but not the total cost. Initial decision was contested during public consultation.
Mundy (2017), Australia **(96)**	Medical procedures (Platelet-rich plasma [PRP] for knee osteoarthritis)	**HTA** – identification using Horizon Scanning approach. Non-systematic article reviews	**Clinical effectiveness** review (pain and function scores)	*MBS item number 13703 -> Medicare rebate is no longer payable for injections of PRP. - *Triggered by possible inappropriate use of MBS (activity and cost).*	Financial implication calculated based on 12-month projection showed cost-saving of AUD 2.8 million.

Author, year, country (ref)	Technology / programme	Methodological tool / framework	Criteria for outcome measurement	Results / Decision	Comments for discussion
Mnatzaganian (2015), Australia (97)	Diagnostic test (Serum cobalamin for unexplained fatigue) Alternatives: • 'Do not test and treat all with oral supplements' • 'Do not test and treat all with IM injections' • 'Do not test and do not treat'	**HTA** with decision tree modelling (CUA)	**ICERs (cost per QALY)** - inappropriate testing or over-testing potentially increases the number of false positive, which lead to a cascade of further investigations, incur additional costs, and inappropriate or unnecessary treatment.	- 'Do not test, but treat all with oral supplements' strategy is the most cost-effective. • *MBS item 66602 has been reviewed, and expected to have a reduction in use of this test in the future.*	Decision analytic model using short time horizon of 3 months.
Vernazza (2023), England (71)	Dental services within NHS dentistry in England at national level for 2015-2016 spending	**Programme budgeting and marginal analysis (PBMA)** with public value elicitation using WTP survey	**Criteria-based weighting and performance scoring** (local dental network chairs, dental commissioners, dental public health consultants, patient/public members, health economist) * *Scoring: -2 to +2 scale*	**- Investment:** new programme components to improve access to general dentists, care home dentistry, and extra support for dental public health input into local government decisions. **- Disinvestment:** Orthodontics, routine scaling, teeth polishing. - The final allocations left an unspent budget of £134 million.	Decision makers may pragmatically wish to partially invest the leftover resource in program components that scored well or were nearly funded. PBMA: an ongoing process where changes are evaluated.
Edwards (2014), Wales (69)	Public health programmes implemented with 25 initiatives shortlisted for assessment	**Programme budgeting and marginal analysis (PBMA)**	**Criteria-based voting** (health priority, expert opinions, stakeholder views, presence and robustness of effectiveness and cost-effectiveness evidence, impact on reducing inequalities)	- Complete disinvestment of 7 from 25 programmes (releasing GBP 1.5 million per annum). - Partial disinvestment of 3 programmes (GBP 7.3 million released). - Hypothetical allocation of additional GBP 5 million to top 3 priorities from PBMA exercise.	Emphasised the importance of using standardised units of benefit to enable comparisons across an entire range of interventions, even within public health setting.

Author, year, country (ref)	Technology / programme	Methodological tool / framework	Criteria for outcome measurement	Results / Decision	Comments for discussion
Mitton (2003), Canada **(98)**	Surgical department activities in a Canadian rural hospital	**Programme budgeting and marginal analysis (PBMA)**	Generation of 'wish list' focus on **expansion of existing programme** rather than addition/increasing the scope of service. List of resource release: interim scenario for cheaper sterilisation and reduced maintenance of endoscopy, reduced overtime, reduced callbacks (total of $23,110).	The expansion of surgical services at the hospital would require an annual cost of $206,600 Canadian dollars. Budget impact of revised proposal for resource release: 17 additional minor surgery days, cheaper sterilisation and reduced maintenance for endoscopy, reduced overtime saving (total savings $2075).	Source of data: expert opinion of the panel, administrative data (surgical booking trends), referral patterns and resource available on site at the hospital (top-down budgeting). Limitation: reliability and validity of data.
Yong (2021), Malaysia (99)	Pharmaceuticals (metered-dose inhalers for Chronic Obstructive Pulmonary Disease and Bronchial Asthma)	**Multicriteria decision-analysis (MCDA)**	**Non-economic criteria weights** represented 70% of the total analysis (patient suitability, patient benefits, comparative effectiveness, safety, clinical/practice needs, availability of economic evidence, reimbursement/listing in other countries). **Single economic criterion (cost of medicine)** weighted as 30% of the total analysis.	One potential medicine (out of three; 33%) be added to the national formulary and one existing medicine (out of 24; 4%) be removed/delisted. Other existing medicines remained unchanged. Final decision: no removal of any existing medicines or chemical entity.	**Not specifically for disinvestment or delisting, but more of testing the analytical framework of using MCDA in decision-making** for listing and delisting of proposed inhalers and already available inhalers. Several overlapped criteria (economic evidence with cost of medicine, patient benefits with comparative effectiveness)

Abbreviations: CEA = cos-effectiveness analysis; CUA = cost-utility analysis; HTA = health technology assessment; ICER = incremental cost-effectiveness ratio; IM = intramuscular; MBS = Medicare Benefits Schedule; QALY = quality-adjusted life year; SC = subcutaneous; WTP = willingness-to-pay.

From Table 3.3, there were various approaches to conduct assessment for disinvestment purposes. Even though HTA was one of the main methodological approaches used, the technical analyses differed based on the aim and trigger for the disinvestment activities, availability of supporting evidence, and the nature of clinical effectiveness of the candidate, such as in the case of intramuscular IFN-1b for relapsing-remitting Multiple Sclerosis (95). In Australia, regular assessment of the health benefits package under the Medical Services Advisory Committee (MSAC) applies a systematic approach, similar to traditional HTA, to review existing Medicare Benefits Schedule items (96). However, this process can be resource-intensive and costly, given limited healthcare budgets. Therefore, the horizon scanning method, which is primarily used to identify emerging healthcare technologies, has been employed to detect potential disinvestment targets in a rapid manner, offering opportunities to improve care quality, patient safety, and health system savings (96).

One of the limitations in the disinvestment evaluations of interventions reviewed through HTA case studies is the lack of explicit discussion on opportunity cost. While one study highlights potential cost savings (96), others did not address the broader implications of reallocating resources freed by disinvestment. In disinvestment specifically, it is beneficial to discuss the opportunity cost from disinvesting the candidate(s), as it underscores the potential value of redirecting limited resources toward high-value interventions. Without a clear analysis of what could be achieved with the resources saved, the evaluations risk presenting an incomplete picture of the true impact of disinvestment. This omission dampens the argument for or against discontinuing reimbursement for certain procedures, limiting the ability of decision-makers to fully understand the trade-offs involved.

Moreover, there exists uncertainty surrounding behaviour change in clinical practice which further complicates the assessment of disinvestment outcomes. For instance, in the study by Soril et al. (2021), HTA with multimodal approach was employed, however, more than half of the staff responding to the post-intervention survey neither agreed nor disagreed that knowing about past transfusion practices in ICU

influenced their decision-making, and 58% expressed ambivalence about the sustainability of practice changes (94). The study concluded that HTA or HTR process, as used by the authors, can extend beyond merely identifying and prioritising technologies to actively include change management efforts at the clinical practice level. However, the small-scale pilot evaluation revealed no significant reduction in the proportion of potentially inappropriate RBC transfusions following the intervention, as well as when comparing with the control site (94). This outcome highlighted a critical gap between the methodological rigour of the HTA model and the practical challenges of implementing its recommendations. Without aligning methodological precision with effective execution, the potential impact of HTA initiatives may remain unrealised.

Examples of PBMA approaches highlight two distinct scenarios. Two examples demonstrated its use for resource reallocation and decision-making on a national scale, focusing on public health initiatives in Wales (69) and dental services within NHS England (71). Another study showcased PBMA as a priority-setting tool for managing a limited budget within the surgical department of a public hospital (98). In both cases, panel members agreed that PBMA is a valuable and explicit method for prioritising resource allocation decisions. A key factor identified was the need for uniformity in expressing units of benefit to enable meaningful comparisons between assessed programmes. However, concerns about the validity and reliability of data persist, particularly when relying on RWE for decision-making at a single-facility level.

The three PBMA examples collectively highlight several limitations in the application of this approach, which are stakeholder commitment, representation, and the dilution of disinvestment objectives. A recurring issue is the inconsistent participation and engagement of stakeholders, which undermines the comprehensiveness and legitimacy of the recommendations. Edwards et al. (2014) discussed that only a small proportion of panel members completed the marginal analysis task, limiting the representativeness of the outcomes (69). In support of this issue, subjective influence of panel members coupled with limited responses from public representatives, such as

member of Parliaments in study by Vernazza et al. (2023), affected the reliability of the decision-making process despite PBMA approach being used in the most diligent way (71). Similarly, Mitton et al. (2003) highlighted the absence of broader representation from other service departments introduced concerns about fairness and transparency in reallocating resources at the hospital level (98). These challenges point to the need for inclusive and sustained stakeholder involvement to enhance the credibility and acceptance of PBMA processes.

Another significant limitation is the potential dilution of disinvestment objectives due to competing priorities, such as political acceptability and new investment opportunities. The narrow focus on a specific health improvement budget constrained the broader analysis of resource allocation, demonstrated by how subjective considerations in the final decision-making stages can shift attention from disinvestment to politically favourable investments in the example case study (71). Additionally, the lack of structured follow-up mechanisms weakened the effectiveness of PBMA, leaving implementation efforts ambiguous (69, 98). Therefore, balancing methodological rigor with practical considerations is essential in the PBMA framework, particularly to ensure that disinvestment objectives are addressed while also allocating resources for investment opportunities.

There is no specific case study focusing solely on using MCDA for disinvestment. However, Yong et al. (2021) applied MCDA for listing and delisting 27 respiratory inhalers for Chronic Obstructive Pulmonary Disease and Bronchial Asthma in the Malaysian MOH Medicines Formulary (99). Using criteria-based scoring and ranking methods, the expert committee recommended adding one new medicine and delisting one out of 24 existing medicines. Despite this, no medicine was ultimately removed, as the committee prioritised prescriber flexibility and patient access in line with personalised medicine principles. This suggests that while MCDA is effective for prioritising new medications for listing, it has limited impact on removing existing medicines from the national formulary (99).

3.7 Discussion

In this chapter, two 'popular' approaches for disinvestment were explored, namely PBMA and HTA (including HTR that is used in some HTA agencies). I also uncover the limitation in using CUA as analytical method to satisfy the objective of disinvestment, which seem to be not suitable due to its lack of ability to extend beyond QALY, among others. The question of "which method is the most suitable for assessment of disinvestment?" is unfortunately still unanswered.

The approach for the disinvestment process remains less established compared to investment-focused priority setting. Recognising that disinvestment is often perceived as a loss by affected stakeholders, health economists and HTA experts are frequently consulted to provide guidance, as recommended in PBMA. This underscores the necessity of 'getting the process right' to ensure legitimacy and fairness in decision-making while also promoting acceptance among those impacted (100). Undoubtedly, population needs and clinical effectiveness are central to these decisions; however, the availability and robustness of supporting evidence often pose significant challenges, as highlighted in other examples of disinvestment case studies.

Health technology assessment is a value assessment framework that enables evidence to be appraised, analysed, and collated to support healthcare decision-making in the context of technology management. While it provides valuable evidence to inform investment or disinvestment decisions, HTA does not engage directly with the choice-making process or account for competing claims on limited resources (1). It does not explicitly account for opportunity costs (100), inherently address broader value for disinvestment (1), or serve as a comprehensive methodology for resource allocation. Most of the works on HTA focus on deciding whether to include new technologies in covered services, placing significant emphasis on their adoption. Thus, utilising HTA for disinvestment requires some modifications, particularly on the multi-criteria approach that incorporates diverse types of evidence, reflecting a shift away from the traditional reliance on RCTs as the gold standard (100). This disconnect often limits its

impact, particularly when HTAs are commissioned as one-off assessments, leaving decision-makers without the broader context or relevant information needed to prioritise resources effectively. Additionally, deliberative methods are essential to foster debate, critically evaluate, and refine the outcomes of the prioritisation and resource allocation process before arriving at final decisions or recommendations.

Using CUA as a tool for disinvestment presents several challenges, including its limited consideration of budget constraints, difficulty in accounting for factors beyond cost and QALY maximisation, and insufficient attention to equity issues. Disinvestment opportunity is possible with CUA when an assessment identifies a dominant new intervention, one that is both more effective and less costly than the existing practice, resulting in cost savings as demonstrated by CUA. However, such cases are rare because introducing new interventions often requires additional resources, such as personnel and procurement of new equipment, which can offset the cost savings. Value assessment in disinvestment should not be limited to CUA or the maximisation of QALYs. Stakeholders may require more data than standard CUA when making evidence-based decisions related to disinvestment, which typically occurs separately from adoption decisions. What is missing in CUA is its ability to incorporate information beyond QALYs, such as equity, the burden on caregivers, the minimisation of catastrophic risks, and the trade-off value between the implementation and de-implementation of healthcare interventions. Hence, economic evidence from CUA alone is not adequate to support decision-making for disinvestment.

Based on positive feedback from Malaysian healthcare stakeholders during the workshop and insights from published case studies in Table 6-2, PBMA is considered more robust than traditional resource allocation methods, which often relied on historical trends, political influences, or “decibel rationing.” The well-defined decision criteria and high transparency of PBMA significantly contribute to this perception. There was also acknowledgement of the possibilities of developing investment proposals and exploring reallocations beyond merely balancing the budget (101). A notable advantage of PBMA is its ability to specify the scope of assessment at

the outset, enabling a focus on adjusting service levels rather than strictly eliminating or introducing programmes, though such extremes remain possible if warranted (101).

A pragmatic approach to PBMA emphasises utilising the information sources available within a given budget space, such as at the regional health authority level, within specific departments of health, or at the hospital level. This may include evidence from the literature but will more commonly rely on local data, administrative records, and expert opinions. Since opinions and contexts differ across settings, the outcomes of PBMA exercises are likely to vary. However, what important is not uniformity or generalisability of results but a clear understanding and consistent application of the framework's principles (68). In addition, harnessing the flexibility of PBMA to cater to the unique organisational requirement is crucial. A streamlined PBMA exercise that provides valid and widely shared information within the involved authorities can serve as an effective starting point. Rather than solely refining the methodology of PBMA, the focus for future application should lie in aligning the approach with organisational priorities (68), efficiency measurement, and implementation challenges.

Multi-criteria decision analysis, as explored in this chapter, is grounded in Multi-Attribute Utility Theory (MAUT), a well-established decision science framework that evaluates alternatives based on weighted criteria and synthesised value scores (102). The strength of MAUT lies in handling trade-offs across clinical, economic, and social domains, making it especially relevant for complex healthcare decisions. Its adaptability and ability to capture diverse stakeholder preferences, as noted by Chakraborty et al. (2023), make it a common foundation for MCDA in healthcare (102). It was also emphasised that utility-based approaches like MAUT can better align tools such as PBMA with health system goals (103). Incorporating MAUT thus strengthens the case for MCDA as a structured, transparent tool for supporting disinvestment decisions.

Although the use of MCDA in the disinvestment process is limited to only one example of medication delisting (99), this approach appears to hold significant promise. While

PBMA focuses primarily on economic principles like cost-effectiveness and health gains to inform decisions, MCDA is able to include qualitative and quantitative criteria such as clinical outcomes, patient preference, equity, and feasibility, which are often explicitly weighted according to stakeholders' values and considers trade-offs between competing objectives. A key difference between MCDA and PBMA lies in the use of a performance matrix, which highlights how each alternative performs against specific criteria (79). This matrix lists criteria across the top row and places options in the first column. The data within the matrix can then be quantified and represented numerically. However, the main drawbacks of using MCDA in disinvestment decision-making are the difficulty in defining the criteria and the complexity in developing the performance matrix to meet the disinvestment objectives, both of which require further refinement. As MCDA is a data-demanding exercise and prone to violation of foundational principles in terms of overlapping criteria or ‘double-counting’ (85), training of the assessing team, stakeholders, and the expert committee involved in decision-making using this approach is indispensable.

3.8 Conclusion

This chapter explored key methodological approaches to healthcare disinvestment, focusing on HTA, PBMA, CUA and MCDA. While each of these approaches offers distinct strengths, their effectiveness lies in how well they are adapted to the context in which they are applied. HTA provides a robust evidence base to inform decisions on healthcare resource allocation, especially in assessing the value for money of new technologies. However, its limitations include a focus on adoption of new technologies and inability to fully account for opportunity costs or broader prioritisation needs. Therefore, HTA should be viewed as part of the integral components within the overall disinvestment decision-making process. CUA remains a valuable tool for comparing interventions. Yet, its reliance on QALY maximisation alone may overlook other critical decision-making criteria, such as equity, ethical considerations, and stakeholder preferences, which are especially relevant in healthcare systems like Malaysia. PBMA stands out as a practical and flexible framework that allows for a

more holistic approach to resource allocation and facilitates transparent decision-making. Its ability to address both investment and disinvestment simultaneously makes it potentially relevant for Malaysia, where healthcare priorities are evolving amidst finite resources. The recognition of its value by the stakeholders highlights its potential to improve the transparency and robustness of resource allocation processes. The use of MCDA for disinvestment is yet to be explored, but the approach offers advantages due to its flexibility in incorporating multiple criteria within the value assessment framework, and known to be transparent and widely accepted for healthcare decision-making. Most importantly, the successful implementation of these methodologies requires a tailored approach that integrates evidence, stakeholder engagement, and deliberative processes to ensures that decisions are evidence-based, equitable, and aligned with the country's healthcare priorities.

Chapter 4: Stakeholders' perspectives on disinvestment of low-value healthcare interventions and practices in Malaysia: An online survey

4.1 Foreword

My previous scoping review in Chapter 2 highlighted the need to explore how stakeholders in healthcare perceive disinvestment, emphasising that their views and engagement are vital to the success of any disinvestment strategy. Engaging healthcare stakeholders in disinvestment initiatives allows for a more pragmatic approach to resource allocation, ensuring that decisions are informed by those who understand the complexities and challenges of healthcare delivery. This mixed-methods research was designed to explore the perspectives from Malaysian healthcare stakeholders on the components that influence the implementation of disinvestment initiatives, a topic that has never been explored before in Malaysia. This is one of the novel findings from this thesis. The study employed both a healthcare stakeholder survey using an online platform (Qualtrics) and semi-structured key informant interviews. Chapter 4 presents a publication based on the online survey, while Chapter 5 provides a detailed account of the methods and findings from the key informant interviews. This study addresses not only the technical components of disinvestment, but also the human dimensions of policy changes, integrating diverse perspectives to guide future disinvestment strategies. Such involvement helps mitigate resistance and encourages a collaborative approach, fostering an environment where decisions are made with broader support and understanding.

The article was published in the International Journal of Technology Assessment in Health Care on 15 November 2024. It is reproduced here with permission by Cambridge University Press. I have taken complete charge of the entire project and assumed full accountability for it. In this chapter, the phrases 'we' and 'our' are employed to acknowledge the contribution of all authors.

4.2 Title, authorship and publication details

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Stakeholders' perspectives on disinvestment of low-value healthcare interventions and practices in Malaysia: An online survey

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Keywords: disinvestment; stakeholder engagement; health technology reassessment; resource allocation; health care surveys.

4.3 Abstract

Objectives: Healthcare disinvestment requires multi-level decision-making, and early stakeholder engagement is essential to facilitate implementation and acceptance. This study aimed to explore the perceptions of Malaysian healthcare stakeholders to disinvestment initiatives as well as identify disinvestment activities in the country.

Methods: A cross-sectional online survey was conducted from February to March 2023 among Malaysian healthcare stakeholders involved in resource allocation and decision-making at various levels of governance. Response frequencies were analyzed descriptively and cross-tabulation was performed for specific questions to compare the responses of different groups of stakeholders. For free-text replies, content analysis was used with each verbatim response examined and assigned a theme.

Results: A total of 153 complete responses were analyzed and approximately 37 percent of participants had prior involvement in disinvestment initiatives. Clinical effectiveness and cost-effectiveness ranked as the most important criteria in assessment for disinvestment. Surprisingly, equity was rated the lowest priority despite their crucial role in healthcare decision-making. Almost 90 percent of the respondents concurred that a formal disinvestment framework is necessary and the importance of training for the program's successful implementation. Key obstacles to the adoption of disinvestment include insufficient stakeholder support and political will as well as a lack of expertise in executing the process.

Conclusions: While disinvestment is perceived as a priority for efficient resource allocation in Malaysian healthcare, there is a lack of a systematic framework for its implementation. Future research should prioritize methodological analysis in healthcare disinvestment and strategies for integrating equity considerations in evaluating disinvestment candidates.

4.4 Introduction

Disinvestment in healthcare calls for decisions to be made on several different levels ranging from the departmental, organizational, regional, and national levels. Low-value care (LVC), or patient care that provides no or low net benefit in specific clinical scenarios, continues to be one of the most pressing issues in healthcare worldwide, primarily because it increases costs, causes iatrogenic patient harm, and frequently impedes the delivery of high-value care (104). In addition, the persistence of LVC is attributed to the absence of de-implementation strategies despite major efforts to minimise it over the previous decade (60). In these times of escalating demand for efficiency, there is a need for structured and explicit criteria shaping the disinvestment framework within health care.

Based on our scoping review of published systematic reviews (105), disinvestment programs were predominantly reported mainly in high-income countries, where most of these were championed by HTA agencies in that country. However, there are possibilities that informal or small-scale initiatives undertaken by low- and middle-income countries (LMIC) remain unpublished or undiscovered (105). This lack of documentation highlights a significant gap in the literature, underscoring the need for more research focused on disinvestment initiatives in LMICs to better understand their practices, challenges, and outcomes (106).

The implementation phase of disinvestment initiatives presents significant obstacles and complexities in terms of stakeholder engagement, owing primarily to insufficient support, collaboration and communication (59). A substantial disparity may exist between the way in which experts think disinvestment decisions should be made and how they are actually made at the ground level. This contrast between the technical and political aspects of disinvestment was apparent in the areas of change management, evidence generation and information sharing (107). Adding to the existing problems, there is a scarcity of information on gathering stakeholder viewpoints on the execution of disinvestment initiatives, with only twelve studies involving healthcare professionals reviewed by Mitchell et al. (31). Thus, it is critical

to include key stakeholders in disinvestment at every stage of planning and implementation to secure support and ensure the long-term viability of the initiatives.

Malaysia is classified by the World Bank as an upper-middle-income country and has a well-established dual-tiered system of healthcare services: tax-funded, subsidized government-led public healthcare, and a rapidly expanding private healthcare sector (25, 26). Within its public healthcare system, there are mainly two ways of resource allocation: *i) top-down or line item budgeting*, in which the financial allocation for healthcare depends on allocation by the central government and partly based on previous years (17), and *ii) bottom-up budgeting*, which involves new programs or interventions proposed by departments within the Ministry of Health, usually supported by evidence-based method such as HTA with economic evaluations (26). Meanwhile, the private sectors in Malaysia rely on fee-for-service as the primary method of payment for healthcare facilities (17). The role of HTA in policy formation and decision-making regarding health technologies has become increasingly important and influential over time (25). While Malaysia does not have an explicit benefits package, the effort towards having a formal and well-defined health benefits package in the country is currently ongoing and hence, requiring HTA method for its development.

In addressing the gaps in information on disinvestment initiatives with regards to country-specific socioeconomic, geographical distribution and stakeholder involvement, this survey aimed to describe the perceptions, practices, and receptivity of Malaysian healthcare stakeholders to disinvestment initiatives. The specific objectives of this research include identifying current activities in the Malaysian healthcare system and exploring the important components of implementing disinvestment frameworks from the perspective of key stakeholders in the country.

4.5 Methods

4.5.1 Study design

This study is part of a mixed-method research project that began with an online survey followed by semi-structured key informant interviews. The survey results are reported in this paper, while the interviews with stakeholders will be published separately.

4.5.2 Study population and recruitment strategy

Purposive sampling was used to identify survey participants from key stakeholders in Malaysia who may be involved in priority setting and decision-making for resource allocation at various health care levels. This includes decision-makers, budget holders, and program managers within the four major Programs in the Ministry of Health (MOH) Malaysia, regional and local leaders such as health state directors, hospital directors, and heads of public health sectors. Participants were also recruited from health care providers, specifically doctors, pharmacists, nurses, and allied health professionals. We also included researchers from local universities offering healthcare courses and research institutes that may be involved in studies related to resource allocation and quality improvement initiatives to obtain a holistic perspective.

Stakeholder representatives were identified from the publicly accessible list of program managers on the Malaysian MOH website (www.moh.gov.my), the list of heads of clinical services in MOH, as well as specific databases for healthcare providers and researchers accessible by MOH personnel. Significant efforts were made to engage potential healthcare professionals involved in resource allocation decision-making with the survey advertised on the Malaysian MOH website, Malaysian Health Technology Assessment Section (MaHTAS) social media, and chain-referral sampling by the experts in HTA and health economics who are part of the MaHTAS Technical Advisory Committee. The initial sample size was 320, based on the identification of stakeholders according to departments and clinical services. Secondary identification of participants was accomplished through the final question in the survey

(snowballing), and the survey link was also shared by individuals among their networks. As such, additional samples were identified as the survey progressed.

4.5.3 Questionnaire development and validation

The questionnaire was developed based on our scoping review (105), published literature related to healthcare disinvestment (14, 100, 108, 109), and scoping reviews of theories, frameworks and models on the de-implementation of LVC (47, 110). There were twenty-three questions with a combination of open-ended questions with free-text responses, closed-ended questions using multiple choice format, sliding scales, as well as a clinical vignette with ranking-based option. Face validity and pre-testing of the questionnaire was performed by twelve researchers and healthcare professionals from the MOH Malaysia and the University of Glasgow. A content validity index assessment was conducted by six healthcare stakeholders from Malaysia (two program managers, two hospital administrators, a health economist, and a pharmacist) looking into the representativeness, relevancy and clarity of the questionnaire (Supplementary 4-1 to 4-3).

4.5.4 Survey design, distribution and data collection

We designed the online survey using Qualtrics Survey Software (Qualtrics, Provo, UT, USA). The survey questionnaire was structured in five sections: *i) background information; ii) knowledge and perceptions on disinvestment in healthcare; iii) disinvestment initiatives within organisation or workplaces; iv) facilitators and challenges in implementing disinvestment; v) receptivity and expectation on implementation of disinvestment initiatives in Malaysian healthcare system* (Supplementary 4-4). Participants were asked to suggest any other healthcare stakeholders who could contribute to the study. The survey concluded with an invitation to participate in the follow-up interview that was conducted after the survey closed.

The online survey questionnaire was distributed through emails, the MOH website, and social media platforms between February and March 2023. Reminders were sent two weeks after the first email for those identified on the mailing list. All survey data collection was undertaken using the Qualtrics online platform, and all responses were collected anonymously. To avoid participants taking the survey more than once, the "prevent multiple submission" feature was enabled in the Qualtrics system before distributing the survey.

4.5.5 Data analysis and reporting

Two investigators (H.F.K. and L.S.W.) independently reviewed all survey responses for clarity and completeness after exporting them from Qualtrics to Excel (Microsoft Corporation). Only completed surveys were included in the final analysis. This is a common practice in survey research that is used to gather the perceptions or opinions of participants, as analyzing incomplete responses may introduce bias and affect the validity of the findings (111). Frequencies of responses were calculated for close-ended questions, and free-text answers were analyzed using content analysis and designated a theme. We then investigated the frequency of each theme to identify the most common perspectives for reporting. We performed cross-tabulation and sub-group analysis for specific questions to compare the responses of different groups of stakeholders. This study was reported in accordance with the Consensus-Based Checklist for Reporting of Survey Studies (CROSS) (112) [Supplementary 4-5].

4.5.6 Ethical considerations

This study was approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia (NMRR-ID-22-02570-6PR-(IIR)) and the Research Ethics Committee, University of Glasgow (200220048). The survey was voluntary and anonymous, and consent was provided by the participants at the start of the online questionnaire.

4.6 Results

4.6.1 Survey responses

Supplementary Figure 4-6 presents the survey response flowchart. We issued 341 email invitations to participate in the survey based on the initial identification of key stakeholders in the Malaysian healthcare system, with additional invitations from websites, social media platforms, and snowballing. A total of 461 participants accessed the survey link and consented. However, the majority of these were excluded due to possible 'bots' (software that is programmed to do repetitive tasks for users), the completion of only the demographic data in the first section of the survey, and incomplete responses of less than 50 percent of the whole questionnaire. The final analysis included 153 completed surveys after data cleaning.

4.6.2 Survey respondent characteristics

Table 4-1 summarizes the characteristics of survey participants. A larger proportion of respondents were from MOH Malaysia, with fifty-two (34 percent) at the headquarters and sixty (39 percent) at medical centres, including MOH hospitals and university hospitals. Around 40 percent of participants were responsible for resource allocation decisions or managing budgets. Fifty-eight respondents (38 percent) were clinical care providers, including medical doctors, clinical pharmacists, nurses, and allied health professionals; and thirty-three were researchers, academics, or experts in HTA or health economics. Survey participants may have many professional responsibilities within the healthcare system; therefore, the primary roles were not restricted to a single category. The participants had diverse levels of experience in the healthcare system, with the majority having less than fifteen years of experience (86 percent), while 14 percent having more than fifteen years of experience in their current roles.

Approximately 70 percent of individuals had experience in decision-making processes at a single level of governance, comprising 45 percent at the local facility or organization level and 37 percent at the national level. However, 66 percent of those involved in multiple levels of governance were primarily engaged in decision-making at the national level. Over half of the respondents had experience with decision-

making related to non-pharmaceutical health technologies, including medical devices, surgical and medical procedures (53 percent), as well as in specific areas of care like public health and primary care (54 percent). Additionally, 38 percent had experience in pharmaceuticals and 31 percent in human resources. Based on the good mix of responses in relation to professional roles, workplace, years of experience in service, and level of governance in resource allocation decision-making, the sample of this study could be considered representative of Malaysian healthcare stakeholders (113).

As shown in Table 4-1, approximately one third (37 percent) of the respondents had previous experience with disinvestment or resource reallocation, with 27 activities reported (Supplementary 4-7). However, beyond quantitative metrics, the complexity of disinvestment decision-making in these activities is compounded by various interrelated components such as financial and budget adjustment (73 percent of the activities reported), affecting patient outcomes and implications in clinical care services (63 percent), as well as the development and enhancement of human resources and specialized skills (34 percent). Supplementary Figure 4-8 displays additional components associated with these disinvestment activities.

Table 4-1: Characteristics of survey respondents (N=153)

Variables / Description	N (%)
Workplace	
MOH Malaysia headquarters	52 (34)
State Health Department / District	19 (12)
Hospital / Medical centre (MOH, University hospital)	60 (39)
Primary health clinic / Dental clinic	7 (5)
Research institute / academia	10 (7)
Training institute (for nurses, assistant medical officer)	3 (2)
Not stated	2 (1)
Primary professional role*	
Resource allocation decision-makers / budget holders	62 (41)
Clinical care providers	58 (38)
Researchers / academicians / HTA or health economic experts	33 (22)
Others (desk officers, medical analysts, regulatory bodies)	23 (15)
Years of experience in current role	
Less than a year	5 (3)
1-5 years	57 (37)
6-10 years	42 (28)
11-15 years	28 (18)
More than 15 years	21 (14)
Level of governance or decision-making*	
Single level	***106 (69)***
National level	39 (37)
State / Federal territory level	7 (7)
Regional level (authority / district / region)	12 (11)
Facility / hospital / organisational level	48 (45)
Multiple level	***47 (31)***
Involving national level	31 (66)
At least involving state level	9 (19)
Regional & facility level	7 (15)
Type of health technologies or scope in the context of decision-making*	
Pharmaceuticals / drugs	58 (38)
Non-pharmaceuticals (*e.g. medical devices, digital technologies, surgical and medical procedures, screening and health programmes, diagnostic*)	81 (53)
Specific fields of care (*e.g. primary care, cancer, public health, food and nutrition)*	83 (54)
Work force / human resource	47 (31)
Others (e.g. ICT system, accreditation process, healthcare facilities)	7 (5)

As participant could select more than one option, it does not sum to 100%

4.6.3 Understanding the term 'disinvestment in healthcare'

In the context of Malaysian healthcare, the term 'disinvestment' emerges with varied connotations among survey participants (Figure 4-1 and Supplementary 4-9). Predominantly, it is characterized as the act of withdrawing investment or funding from healthcare initiatives or programs. This perspective underscores the perception that disinvestment is similar to rationing, which could potentially lead to the cessation of certain practices or services. A significant portion of respondents associate disinvestment with "*the necessity to stop offering LVC and wasteful programs*". This perspective is consistent with a comprehensive approach to disinvestment, which is a planned redistribution of resources from programs that do not demonstrate clinical effectiveness or provide equivalent value for the investment. Furthermore, some respondents believed that disinvestment involves "*decreasing the budget or funding for health-related programs*", showing an understanding of the importance of prudent financial management in the healthcare sector. Collectively, these interpretations highlight the diverse aspects of understanding disinvestment in the Malaysian healthcare system while still focusing on its importance in improving resource allocation and increasing the efficiency and efficacy of healthcare services.

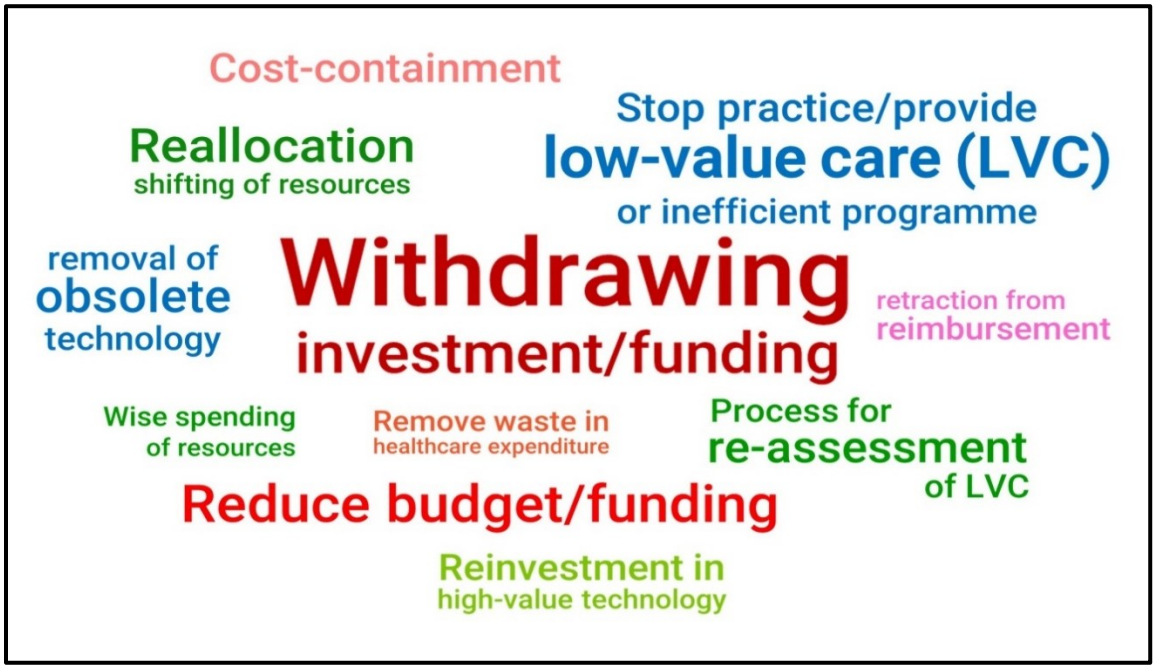

Figure 4-1: Word cloud for the description of 'disinvestment in healthcare'

4.6.4 Criteria in conducting assessment for disinvestment

In assessing candidates for disinvestment, respondents have ranked six criteria based on the options given in the survey (Figure 4-2). The top priority was evidence of clinical effectiveness, such as treatment effects and safety, changes in quality of life before and after intervention, and diagnostic accuracy. Evidence related to the program's cost and cost-effectiveness, which included the operating expenses compared to its benefits and the maintenance costs of a specific health technology, ranked second in importance. Sub-group analysis revealed that researchers prioritized evidence on cost and cost-effectiveness above clinical effectiveness criteria, resulting in a higher ranking for the former. Following that were the necessity and feasibility of assessing the disinvestment candidates, which include the presence of an alternative to replace or displace the candidate, the availability of data for analysis, and support by patients or the public in discontinuing treatment. In the fifth rank was the health technology life cycle, which looks at obsolete technologies, legacy items, and low uptake or utilization of therapies or interventions. The survey results revealed that despite their crucial role in healthcare decision-making, equity and fairness received the lowest priority rating for disinvestment criteria. However, this does not imply that the criteria are unimportant. In fact, when enquiring about the primary concern with the implementation of the disinvestment decision, several participants expressed worries about how disinvestment will affect treatment alternatives for vulnerable or disadvantaged groups in society.

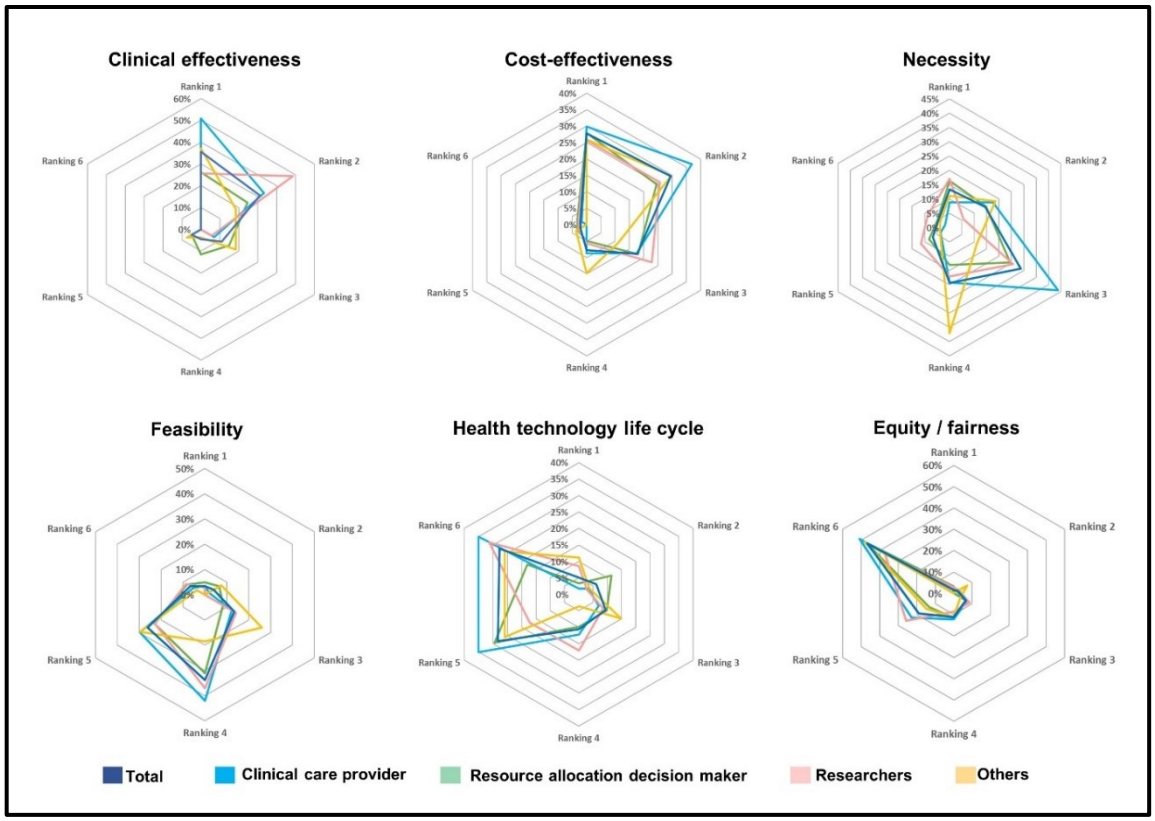

Figure 4-2: Criteria ranking in assessing disinvestment candidates

4.6.5 Perception on disinvestment initiative in Malaysia

In terms of acceptance and expectation, the majority (59 percent) of the respondents strongly agreed that there is a need for a formal framework for disinvestment *to evaluate and monitor previous decisions, to improve quality of care, and to implement a priority-based resource allocation process* (Figure 4-3 and Supplementary 4-10). Training is essential for the successful initiation of the disinvestment program, as indicated by 67 percent strongly agreeing. This aligns with the third component on insufficient knowledge among healthcare stakeholders on disinvestment, both in terms of performing assessments and implementing decisions. Respondents had varied reactions (agree, neither agree nor disagree, and disagree) when asked about the potential increase in workload due to disinvestment initiatives, indicating a reduced resistance to assuming the responsibility for implementing disinvestment decisions.

A sub-group analysis of stakeholders' perspectives on implementing disinvestment initiatives in Malaysia was conducted based on respondents' years of experience, and no difference was observed in the percentages of agreeing, neither agreeing nor disagreeing, and disagreeing on the four questions asked in the survey (see Supplementary 4-11).

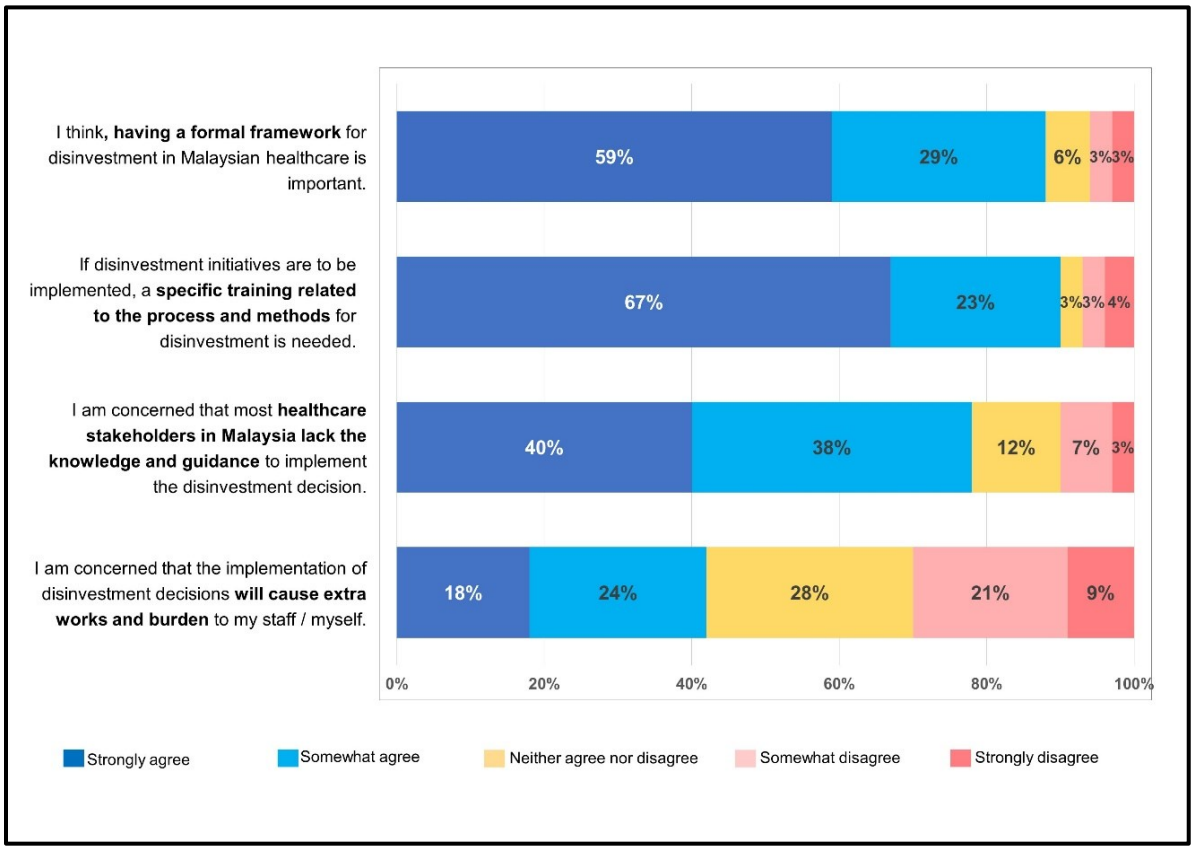

Figure 4-3: Perception on implementing disinvestment initiatives in Malaysia

Other responses to the stakeholders' expectations on the implementation of the disinvestment framework in Malaysia are outlined in Supplementary 4-12, which includes the provision of training and awareness platforms for stakeholders, the development of a health policy for disinvestment, improvements in quality of care and resource allocation, as well as a transparent and comprehensive process of disinvestment.

4.6.6 Facilitators and barriers in implementation of disinvestment process

Eighty-six percent of respondents identified organizational culture, particularly in terms of quality improvement and willingness to change, along with good leadership, as the key component in facilitating the disinvestment process, placing it as a top priority. The second facilitator is involvement of key stakeholders responsible for healthcare decision-making, such as organization leaders, budget holders, clinical care providers, patients or their representatives, and the public. This would allow for a wider range of viewpoints to be considered, promoting ownership and acceptance of disinvestment decisions. The establishment of a transparent and robust methodology for disinvestment and the integration of the local context into the formulation of recommendations for disinvestment were identified as additional facilitators. A sub-group analysis based on stakeholder roles revealed slight differences in the order of facilitators in implementing disinvestment initiatives (Supplementary 4-13).

The challenges in adopting the disinvestment process were categorized into scientific, organizational, and perceptual barriers (Figure 4-4). Seventy-eight percent of respondents identified the primary constraint as the lack of support and political will from stakeholders, followed by the high occurrence of conflicting priorities in decision-making and a lack of capacity or expertise in conducting the process (73 percent, respectively). Furthermore, 68 percent of respondents concurred that the absence of relevant data to support disinvestment decisions exacerbates the challenges.

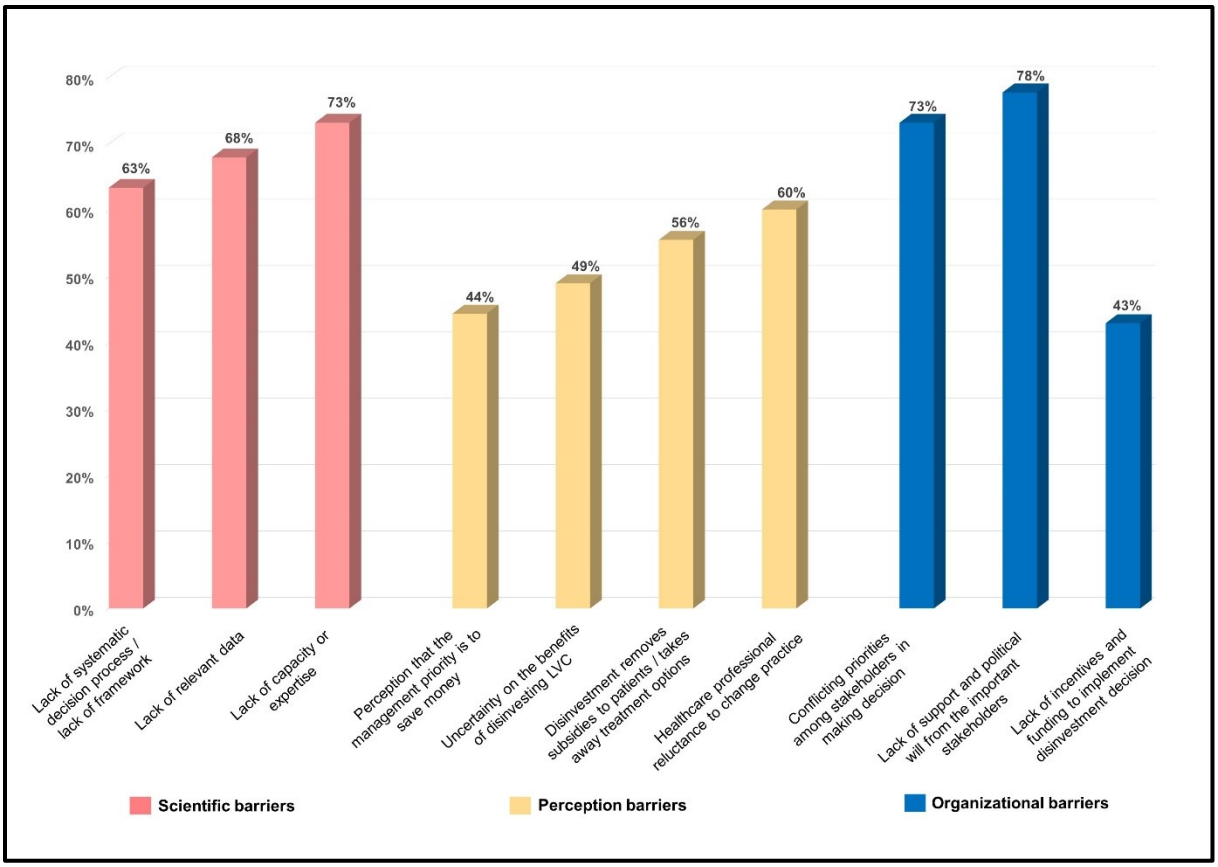

Figure 4-4: Barriers and challenges in implementation of disinvestment process

4.7 Discussion

This online survey highlights the views of 153 key stakeholders in Malaysia regarding healthcare disinvestment. It focuses on their experiences and perceptions of implementing the program and aims to identify factors that can either support or hinder the acceptance of this initiative. By capturing diverse stakeholder perspectives in the early phase of planning, this research has generated valuable insights to inform future national implementation strategies, thereby fostering clarity and leading to a more robust and inclusive framework pertaining to disinvestment activities.

In making judgments to de-implement clinical practice, healthcare professionals rely on various factors, such as updated evidence, patient expectations and characteristics, economic and regulatory considerations, as well as their own

expertise, clinical experience, and decorum (114). Engaging stakeholders early in the development of policy frameworks related to disinvestment in healthcare is crucial to ensuring that a diverse perspective is considered. This is the primary strength of our research, which is the first of its kind in relation to disinvestment initiatives in Malaysia and one of a few studies conducted in LMICs. We engaged healthcare stakeholders early in the process by gathering their perspectives from the planning phase of the proposed health policy. This is highly relevant at all levels of governance, although the implementation and method of assessment for disinvestment candidates could be different depending on the context and purpose of the activity.

In comparing the results of our survey with findings from LMICs, efforts have been made to identify similar studies from other countries on healthcare disinvestment and stakeholder perspectives on its implementation. Notably, only pertinent studies from Argentina, Mexico, and Brazil (46, 66) are available, providing information on the current state of disinvestment activities in these countries. Another paper described barriers and possible solutions in implementing Choosing Wisely framework in LMICs with a mention of Tanzania's experience (115). However, these articles did not incorporate the viewpoints of the key stakeholders. Other similar studies are mainly from high-income countries, particularly Canada and European region (14, 116-119).

To date, our understanding of priority setting and resource allocation (PSRA) in Malaysian healthcare has been restricted to the incorporation of criteria-based decision-making in HTA processes for funding and investment purposes, which have been established for more than two decades in the Malaysian public healthcare system (25, 26). The current study provides information on the criteria that respondents consider relevant to conducting evaluations regarding LVC de-implementation, which may influence decisions on disinvestment. Based on the priority of the criteria, we identified that clinical effectiveness and cost-effectiveness evidence are the two most important components, among others, which are also consistent with the criteria used in other PSRA frameworks (117) and the disinvestment processes in other countries (6, 109). This significant finding

emphasizes the importance of these criteria in shaping methodological analyses and decision frameworks for healthcare disinvestment in Malaysia. By acknowledging these key components as paramount, we can develop a robust and equitable approach to the framework for efficient healthcare resource allocation while optimizing patient outcomes.

The majority of the respondents rated equity and fairness as the lowest among all other options. This finding is especially unexpected as disinvestment means reallocating resources from current services, which could worsen problems connected to access and delivery of health care, especially involving the elderly and patients with rare diseases or who are terminally ill. Disinvestment is a part of a larger ongoing initiative to improve healthcare for vulnerable patient groups by addressing gaps in care delivery, hence we still need to address important questions about how de-implementation and health equity intersect (120). Therefore, it is crucial to prioritize equity considerations in disinvestment discussions to ensure that decisions are inclusive of the well-being of all population segments, especially those most susceptible to adverse health impacts. By understanding these important attributes, policymakers can use this information to increase public support for disinvestment by strategically choosing suitable measures and effectively communicating disinvestment decisions.

Disinvestment in healthcare can be intricate and challenging due to multiple barriers that exist at different levels. Our research identified key barriers to implementing disinvestment initiatives, including organizational and scientific challenges related to support, political will, and conflicting priorities among stakeholders, as well as a lack of expertise, data, and a systematic framework for assessment. This is similar to findings from previous studies (37, 116, 121) which eventually hinder decision-makers from accepting and supporting disinvestment initiatives. Another possible barrier that is not captured in our study is the political and public perception, as disinvestment can be an emotive and contentious issue (122). Decision-makers may face pushback from the public, healthcare professionals, and special interest groups; making it

difficult to implement and sustain disinvestment efforts. Therefore, integrating the local context into the formulation of recommendations for disinvestment is pivotal. Recognizing the unique healthcare landscape, cultural factors, and resource constraints of a particular region ensures that disinvestment strategies are tailored to address local needs and priorities effectively. By addressing these barriers and embracing the facilitators, it is possible to navigate the complexities of disinvestment with greater efficiency and acceptance from all stakeholders (28).

In terms of the acceptance and expectation of the disinvestment initiative, most respondents agree that there is a need for a defined, formal framework and guidelines for disinvestment. In this argument, we believe that healthcare professionals do not necessarily require guidance or instructions from others. They may be unwilling to confront the challenging issue, as defending it can lead to a complicated and messy situation. Establishing a clear framework for disinvestment enhances accountability and transparency in its implementation. There will always be individuals who oppose the disinvestment decision, and the guidelines will ultimately provide a level of protection beyond just counsel.

Strengths and limitations of the survey

This survey encompassed all levels of governance and administration within the Malaysian public healthcare system, including national, regional, and state levels, academics, as well as individual facilities such as hospitals, primary clinics, and departmental levels. Moreover, budgetary issues and resource distribution often link to disinvestment discussions. Therefore, the most effective method is to engage with budget holders and key officials in the Ministry of Health. In our survey, snowball sampling is critical to include healthcare workers with decision-making experience in resource allocation, even if they are not in leadership roles like unit manager, director, or executive committee member. We also included professionals and practitioners who specialize in specific healthcare areas such as community care, pharmaceuticals, mental health, and clinical support services.

The importance of this study on healthcare disinvestment in Malaysia is demonstrated by the substantial number of survey responses and the inclusion of key stakeholders, given the rarity of this issue in the country. Despite the unfamiliarity of the topic, the responses are insightful. Participants emphasized the importance of promptly implementing disinvestment initiatives, especially within the constrained healthcare budget and resources. Reflectively, this research successfully attracted stakeholders' attention due to its unique nature and the significant relevance of the topic, particularly in the post-COVID period, which had not been previously addressed. While we could not measure the response rate, we consider prioritizing an adequate number of representative respondents more crucial than achieving a high response rate, as recommended by a meta-analysis examining the overall response rate of online surveys in published research (113).

This study is constrained by the possibility of respondent bias. The main limitation of our study was associated with the methodology employed in our survey. The survey respondents were predominantly stakeholders in the public healthcare sector. Hence, it may be restricted to perceptions and activities within public health care facilities, while excluding the private sector. It is important to note that the assumptions and inputs in this research may not apply to the entire Malaysian population. Furthermore, there is limited awareness on healthcare disinvestment in Malaysia, leading to a significant percentage of survey participants withdrawing when questioned about their comprehension of the term "disinvestment in healthcare." Hence, the findings of our study should be taken with caution, as there is still a risk of response bias due to the insufficient sample size resulting from the non-measured response rate. Our findings are limited to healthcare professionals and do not incorporate the perspectives of the public or patients in the country. However, previous studies have indicated that citizens were more supportive of accepting healthcare disinvestment compared to those who viewed it as less significant (123).

We also recognized the insufficient information on the small-scale disinvestment efforts in Malaysian healthcare systems. This survey did not offer a comprehensive understanding of the processes and methods used to assess the reported disinvestment activities. Further clarification on the appropriateness and adaptability of methodologies used would be beneficial for knowledge transfer, as would developing a policy-focused methodological analysis for disinvestment in Malaysia. Hence, we extended the research by conducting key informant interviews to explore further on the components related to methodological analysis.

Directions for future research

The outcomes from this research project may support the need for improving or enhancing existing tools used in disinvestment, such as program budgeting marginal analysis and HTA, or possibly offer another innovative method beyond these two processes. Additional information is needed to prevent fairness or equity from being compromised by a lack of awareness of the boundaries on implementing disinvestment in healthcare, which could be a potential research project in the future.

Another potential research area is on patient and public perspectives in healthcare disinvestment, which requires a specific study of its own due to the complexity of shared decision-making between care providers and patients. Therefore, we suggest future research to address patient and public viewpoints on the de-implementation of LVC and its societal impact.

4.8 Conclusion

In general, healthcare stakeholders in Malaysia perceived disinvestment as a process of withdrawing or reducing healthcare funding by reallocating resources from inefficient services and reinvesting in high-value technology. Small-scale and informal disinvestment activities were documented in the Malaysian health system at various levels of care, but an organized and structured approach is still lacking. The criteria for the disinvestment process should include evidence of clinical effectiveness and cost-effectiveness, the necessity and practicality of disinvesting the intervention from

the system, the health technology life cycle, and equity or fairness. The majority concur that disinvestment requires a formal framework involving key stakeholders for guidance, and training on the method is crucial for its acceptance. Implementing disinvestment programs is challenging due to a lack of political will and organizational support, conflicting stakeholder agendas, and a lack of skills and relevant data to evaluate candidates for disinvestment. Future research should link methodological analysis to healthcare disinvestment as part of the resource allocation strategy and investigate approaches to incorporating equity and fairness in assessing disinvestment candidates.

Declarations

i. Conflicts of interest:
   - The authors declare no competing interests exist.

ii. Financial support:
   - This research received no specific funding from any agency, commercial or not-for-profit sectors. H.F.K receives scholarship for her doctoral study in University of Glasgow from Ministry of Health Malaysia.

Authors' contributions:

We, the authors listed above, attest that (i) each author contributed to the conception and design or analysis and interpretation of data and the writing of the paper; (ii) each has reviewed and approved the version being submitted; and (iii) the content has not been published nor is being considered for publication elsewhere.

Chapter 5: “Unloading the excess baggage”: Key informant interviews with Malaysian stakeholders on healthcare disinvestment initiatives

5.1 Foreword

The findings from our initial online survey (Chapter 4) identified several components that require further investigation. Firstly, the process for priority setting and resource allocation which covers the method and criteria used, source of data and evidence needed for assessment, and extent of stakeholder involvement. Secondly, although equity was listed as the least important from the survey, prior discussions that I had with other experts in this field emphasised the importance of incorporating discussions on equity in disinvestment, especially involving the disadvantaged groups such as patients with rare disease and end-of-life care. In addition, there could be gaps in understanding what equity in healthcare implies in the context of disinvestment. Aside from that, challenges and barriers that may hinder the successful implementation of disinvestment initiatives must also be investigated.

Based on the above reasons, I conducted a follow-up key informant interview with Malaysian healthcare stakeholders to examine their perspectives on disinvestment initiatives, which also covers strategies to enhance acceptance among stakeholders. I have formatted this chapter as a manuscript for submission to peer-reviewed journals, with the intention of publishing this study in the future. In this chapter, the phrases 'we' and 'our' are employed to acknowledge the contribution of all authors.

5.2 Title and authorship

"Unloading the excess baggage": Key informant interviews with Malaysian stakeholders on healthcare disinvestment initiatives

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Keywords:

Qualitative research; Disinvestment; Stakeholder participation; Low-value care; Equity.

5.3 Abstract

Objectives: This study aims to explore perspectives on disinvestment of low-value care and ineffective intervention in Malaysia's healthcare system, with a focus on establishing criteria for assessing disinvestment candidates, identifying potential barriers, and proposing strategies to improve the acceptance and its effective implementation.

Methods: Between March and May 2023, we conducted online, semi-structured interviews with 17 Malaysian healthcare stakeholders with different professional roles at various levels of governance and decision-making. Participants were recruited through a mix of purposive and snowballing sampling. Interviews were transcribed verbatim and analysed using inductive thematic approach in Atlas.ti.

Results: We identified four major themes: *'disinvestment as a catalyst for efficient resource allocation'*, *'disinvestment as a justifiable way of cutting budgets'*, *'challenges and barriers in implementation'*, and *'strategies for value-based assessment and effective implementation'*. Stakeholders viewed disinvestment both optimistically and sceptically in terms of its implementation but were unanimous in including equity as a key component in decision-making. Practical challenges and personal frustrations among healthcare professionals emerged as significant barriers to the implementation of disinvestment initiatives in Malaysia.

Conclusions: This study explored stakeholders' perspectives to enhance the acceptance and effective implementation of disinvestment initiatives while fostering accountability and collaboration among all key players. These findings highlight the need for targeted approaches to address both systemic and individual-level obstacles in advancing disinvestment initiatives. Collectively, this supports a more sustainable, patient-centred approach to healthcare resource reallocation.

5.4 Introduction

Healthcare systems worldwide face the persistent challenge of allocating limited resources to achieve optimal health outcomes. In this context, healthcare disinvestment often associated with reducing or removing funding for low-value or obsolete interventions, and emerges as a critical strategy for improving efficiency and sustainability (124). However, the success of active disinvestment initiatives often hinges on the level of support they garner from relevant stakeholders, including healthcare professionals, policymakers, and the public (109). In light of this, it will be crucial that policymakers engage comprehensively and early with stakeholders in the early design of disinvestment policies and their implementation framework. Such engagement will promote collaboration and address concerns that can lead to behavioural changes, building trust, alignment of priorities and ultimately increase the likelihood of successful implementation (125, 126).

The principle of HTA has been widely accepted globally, and recognising the value of HTA drives increased demand for its use. A key insight drawn from the HTA landscape in Asia highlighted that educating stakeholders, especially policymakers, about the importance of investing in HTA as a tool for decision-making can help address capacity-building challenges and promote equitable access to healthcare (127). Conventional HTA reviews usually provide recommendations related to new investments or the implementation of health technologies in the system. Often, the reviews lack recommendations for disinvestment, which could lead to the continued reimbursement of low-value technologies and the potential displacement of more valuable interventions (27). That said, implementing a disinvestment process may result in unintended consequences, as these decisions are often emotionally charged and politically sensitive. As such, assessment of disinvestment candidates or LVC may need to incorporate criteria that extend beyond the conventional parameters used in HTA for investment decisions. To ensure effective identification and de-implementation of these technologies and practices, it is essential to explore context-

specific enablers and barriers, providing a solid foundation for the successful implementation of future disinvestment initiatives (128).

A thorough understanding of the local context is essential in promoting acceptability of any new policy initiatives (129). When introducing disinvestment as a policy-driven component of value-based healthcare, it is crucial to incorporate qualitative insights and diverse perspectives from key stakeholders to complement existing theories and the growing body of evidence. This study forms part of a comprehensive mixed-methods research project exploring Malaysian healthcare stakeholders' perceptions, practices, and acceptability of disinvestment initiatives. We conducted an online survey to gather broad insights into stakeholders' views on disinvestment (130). To delve deeper, the research was augmented through key informant interviews (KII), aiming to uncover detailed perspectives on priority setting and resource allocation within Malaysia's healthcare system. This study specifically focuses on establishing criteria for assessing disinvestment candidates, identifying potential barriers, and proposing strategies to enhance the acceptance and integration of disinvestment initiatives in Malaysia's healthcare framework.

5.5 Methods

5.5.1 Study design, setting, and participant recruitment

The larger mixed-methods study was conducted in collaboration with the Malaysian Health Technology Assessment Section (MaHTAS), a government-based HTA agency in the MOH Malaysia. The qualitative part of the study sought to address the following questions:

1. How do stakeholders in Malaysia perceive disinvestment initiatives in the context of healthcare decision-making and resource allocation?
2. How do healthcare professionals make decisions on stopping funding or disinvesting low-value care or interventions at different levels of governance in the Malaysian healthcare system?
3. What are the facilitators and barriers for implementation of healthcare disinvestment initiatives or de-implementation of low-value care in Malaysia?

The target population for the study was described in detail in our online survey using purposive sampling, which included the Malaysian healthcare stakeholders involved in resource allocation and decision-making at various levels of governance, i.e. national, regional, departmental, and single facility (130). At the end of the survey, we invited the respondents to participate in a follow-up interview on healthcare disinvestment by providing their email and contact number for further communication. We also identified additional participants through a snowballing process, based on recommendations from interview participants and suggestions from professional contacts and experts.

5.5.2 Procedure

Survey respondents who agreed to participate in follow-up interviews (n=25) were contacted via email to confirm their interest and arrange an interview appointment. In addition, participants recommended from snowballing (n=4) were personally approached by email and provided with a brief overview of the research topic before invited to participate in the KII. Upon participants' agreement, the participant information sheet (Supplementary 5-1) and consent form were emailed to them. A semi-structured interview guide (Supplementary 5-2) was developed based on: (a) a review of relevant literature; (b) discussions within the research team; and (c) responses from the preceding online survey. The guide was pilot-tested with two participants, and adjustments were made as necessary. Informed consent was obtained from all participants prior to the interview session.

One-on-one interviews were conducted by H.F.K. (female, the lead researcher and PhD student receiving training in qualitative research) via the Zoom platform from March to May 2023, primarily in English. The flow of discussion varied among informants, with questions rephrased as needed and further probing employed given the semi-structured nature of the interview. The interviews lasted between 30 and 70 minutes (average duration of 35 minutes), depending on the responses provided by

the participants. All participants consented to be digitally recorded, with only audio recordings retained for analysis in a password-protected folder.

5.5.3 Data analysis

All the recordings were transcribed verbatim by H.F.K., with the aid of Zoom's transcription software, adhering to the standardised transcription protocol as recommended by qualitative research methodology guidelines (131, 132). To protect participants' confidentiality, identifying information was replaced with pseudonyms. Seventy percent (12 from 17) of the transcripts were reviewed by two researchers with qualitative research training (E.Z.R. and H.K.) to ensure accuracy and completeness. Each transcript was returned to the respective participant for content review, and the finalised versions were then uploaded into Atlas.ti software (version 24) for analysis.

In the initial stage, the lead researcher independently conducted open coding of the transcripts by thoroughly reading and re-reading each document to generate a preliminary coding framework. After two iterative rounds of coding, quotations attached to codes were summarised and organised into an Excel workbook (Microsoft Corporation) for further review by the research team. We refined the code list collaboratively by addressing any redundancies or conflicts to enhance code structure and clarity.

Using an inductive thematic approach, we grouped identified codes into broader themes and subthemes. These preliminary themes and subthemes were then presented to an experienced qualitative researcher (Ev.G.) for feedback. Following further refinements, emerging themes were finalised through continuous consultation with the supervisors (O.W. and El.G.) to maintain reflexivity (133) and to establish relationships between the identified themes and the concepts of disinvestment from the healthcare stakeholders perspectives. The COnsolidated criteria for REporting Qualitative research (COREQ) checklist (131) was used for the reporting of the findings (Supplementary 5-3).

5.5.4 Ethical considerations

The study was granted ethical approval by the Medical Research and Ethics Committee, Ministry of Health Malaysia (NMRR-ID-22-02570-6PR-(IIR)) and the Research Ethics Committee of the College of Medical, Veterinary and Life Sciences of the University of Glasgow (200220048).

5.6 Results

5.6.2 Participant characteristics

A total of 29 invitation emails were sent to the identified participants, of whom 17 fully participated in the study (Supplementary Figure 5-4). Four candidates initially expressed an interest to participate but decline before the interview due to health issues, personal reasons, and demanding work schedules. The participants were categorised based on their primary role in healthcare services, namely programme coordinators at MOH Malaysia (PRGM), hospital directors and administrators (HOSP), clinical care providers at hospitals and primary health clinics (CLIN) and researchers at research institutes and hospitals (RSCH).

Table 5-1 outlines the characteristics of our study participants. The majority (n=6) of participants were programme managers at the MOH Malaysia, overseeing areas such as public health, primary care planning, hospital and clinical services, health financing, and representation from a state health department. The remaining participants were four hospital administrators, four clinical care providers (a cardiologist, a family medicine specialist, a pharmacist, and an allied health professional), and three researchers from various research centres. Participants' years of experience varied by category and primary role, with most (n=9) having over 10 years of experience in healthcare decision-making.

Table 5-1: Characteristics of interview participants (n=17)

Participant	Experience	Sex	Roles in health care	Level of decision-making
PRGM01	15 years	Male	Programme manager, health policy and strategic planning, technical advisory	National, regional
PRGM02	8 years	Female	Programme manager	National
PRGM03	>10 years	Male	Programme manager, health policy and strategic planning, technical advisory	National
PRGM04	8 years	Female	Programme manager, health policy and strategic planning, technical advisory	National
PRGM05	12 years	Female	Programme manager, health policy and strategic planning, technical advisory	National
PRGM06	13 years	Male	Programme manager	Regional, state
HOSP01	13 years	Female	Hospital management and administration	National, regional, state, local healthcare facility
HOSP02	7 years	Female	Hospital management and administration	State, local healthcare facility
HOSP03	4 years	Male	Hospital management and administration	Local healthcare facility
HOSP04	7 years	Female	Hospital management and administration	Local healthcare facility
CLIN01	14 years	Male	Clinical care provider, healthcare research, technical input, leader of professional society	National, regional, local healthcare facility
CLIN02	8 years	Male	Clinical care provider, technical input / advisory	Local healthcare facility
CLIN03	14 years	Female	Clinical care provider, technical input / advisory	Regional, state, local healthcare facility
CLIN04	10 years	Male	Clinical care provider, healthcare research	Local healthcare facility
RSCH01	6 years	Male	Programme manager, healthcare research	National, state
RSCH02	>10 years	Female	Health policy and strategic planning, healthcare research	National, state
RSCH03	4 years	Male	Healthcare research	Local healthcare facility

5.6.3 Key findings

The initial inductive thematic analysis generated 101 codes from the interviews. Revisions to the original coding framework resulted in the finalisation of 63 codes, which more accurately reflected the data. Four major themes identified from the KII were *'disinvestment as a catalyst for efficient resource allocation'*; *'disinvestment as a justifiable way of cutting budget'*; *'challenges and barriers towards disinvestment initiatives'*; and *'strategies for value-based assessment and effective implementation'*. The themes and subthemes analysed from this study are summarised in Figure 5-1.

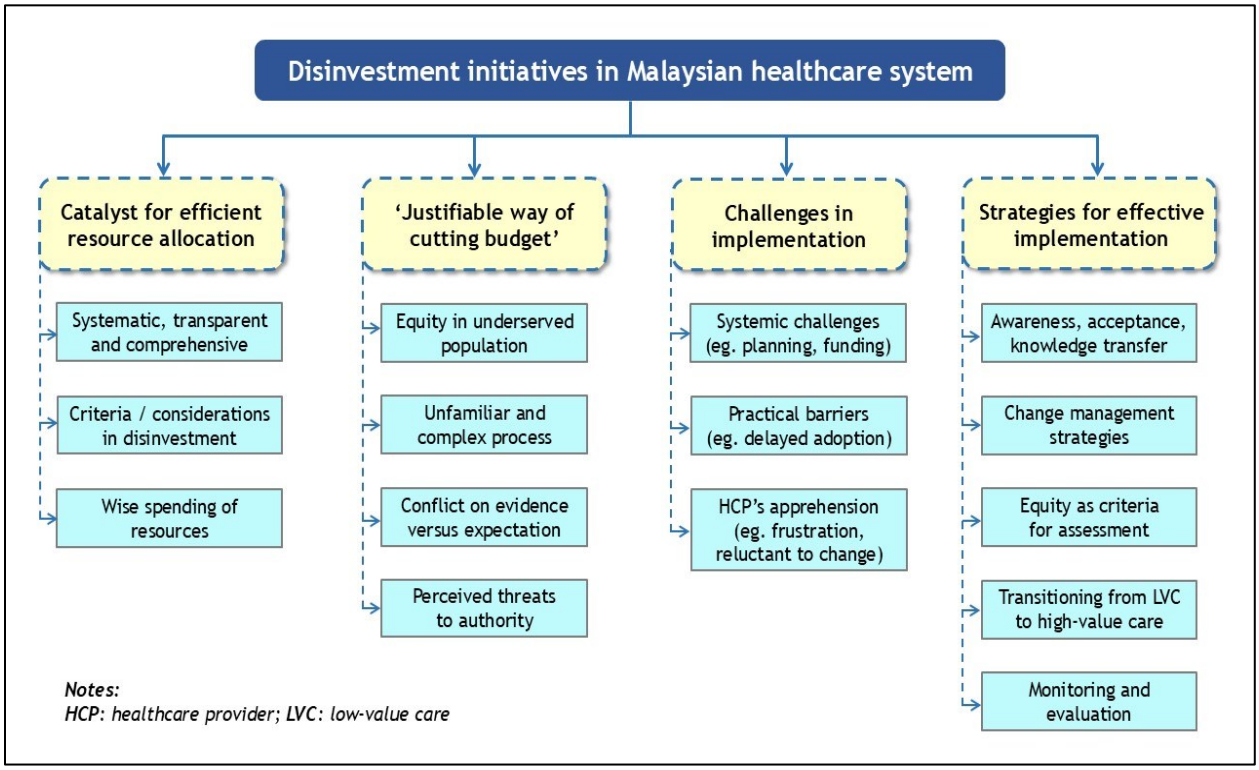


Figure 5-1: Summary of themes and subthemes from key informant interviews.

(Major themes are in the yellow boxes. Subthemes [light blue boxes] that were identified most frequently are listed first within their respective groups.)

5.6.4 Theme 1: Disinvestment as a catalyst for efficient resource allocation

In general, the majority of the participants had an optimistic perspective on the potential of disinvestment to enhance healthcare decision-making in resource allocation. Participants expressed that when disinvestment is approached holistically, involving stakeholders, and in a comprehensive manner, it can serve as a powerful tool for prioritising resource use more effectively. They highlighted the importance of clear criteria and considerations in the disinvestment process, which help ensure that decisions are both fair and aligned with healthcare priorities. This theme encapsulates a forward-looking view, with participants envisioning disinvestment as not just a cost-cutting measure but as a strategic pathway to investing in advancements that offer higher value to both patients and providers.

a. Systematic, transparent and comprehensive process

When examining the key elements of disinvestment activities, most respondents concurred that evaluating existing elements in the treatment list or care provision necessitates a systematic, comprehensive, and transparent approach. Participants expressed that:

> *"First, the analysis itself. And then we bring that evidence to our stakeholders and get feedback from them, whether it is implementable or not. It must be systematic." (PRGM05)*

> *"The principle on which we need to focus and prioritise is first, transparency. For example, in the pharmaceutical's disinvestment, we need to be transparent about the evidence, the cost-effectiveness. And we must make sure there is no conflict of interest." (CLIN03)*

Moreover, the active involvement of stakeholders, particularly clinicians, will enhance adoption and a deeper understanding of decision-making processes. This engagement fosters acceptance and autonomy among healthcare practitioners, thereby augmenting their participation and dedication toward disinvestment decisions.

"…for engagement between the decision-maker and the ground [clinical care providers], I expect the uptake would be faster and it will increase response. Secondly, this exercise would increase knowledge and awareness. […] It will increase involvement or autonomy of the health care deliverer." (PRGM02)

b. Criteria and considerations in the disinvestment process

The participants highlighted several key criteria as they reflected on the assessment process for disinvestment. These criteria included clinical effectiveness, safety issues, the cost and cost-effectiveness of a technology, and an examination of the technology's life cycle to determine its relevance and potential obsolescence.

"…the evidence on clinical effectiveness, which for me is the main [criteria]. Other than this and also budget, we should also consider the accessibility of the medications and also value. Does the medication give value to the clients." (CLIN03)

"For criteria for disinvestment, probably we do have to look at whether the technologies are already obsolete. […] If, let's say, you want to disinvest an old technology or product and then invest in some new technology, you probably have to look at your budget." (RSCH01)

The participants also emphasised the importance of patient preferences in considering individuals' values and willingness to accept the intervention by sharing experience on the cervical screening programme that was implemented:

"Another reason is because of the... I'm not sure whether it's value-based or patient's preference, because HPV DNA is less invasive when compared to Pap smear. So, with those two factors, that's why we are moving towards using HPV DNA rather than Pap smear." (CLIN03)

While explicit criteria are important, the source of evidence supporting disinvestment decisions is equally indispensable. These sources of evidence include clinical practice guidelines, published scientific studies, and real-world data pertaining to the use of technologies or services. In addition, colloquial evidence such as expert opinions can both serve as valuable sources and prompt reassessment of health technologies, particularly when new information emerges from conferences or scientific meetings.

> *"We should also look into the national guidelines, literature, expert opinions, and others before we want to discontinue or continue with it. Sometimes they [clinicians] are also responsible for reviewing Clinical Practice Guidelines, and they attend conferences overseas. So certain things that they get from there are like, 'This [practice] may no longer be feasible'. Therefore, they would like to stop it, and they will give us the suggestion." (HOSP01)*

c. Wise spending of resources

Participants expressed strong support for the disinvestment process, emphasising its critical role in ensuring optimal use of limited resources. They assert confidence in the benefits of such initiatives, especially in promoting more efficient resource allocation within healthcare. Recognising the reality of constrained resources, the participants perceive disinvestment as an opportunity to redirect resources towards investment in high-value technology, replacing the LVC. They also dismiss objections based on increased workload or administrative demands, arguing that these challenges are minor compared to the significant advantages disinvestment can offer.

> *"I do not see a very big resistance to no longer practice what you have done 50 years ago, because it's no longer relevant! I don't think anybody would be very resistant towards disinvesting it. With that money, you can redirect somewhere where it gives a higher impact." (HOSP01)*

5.6.5 Theme 2: Disinvestment as 'a justifiable way of cutting budget'

This theme encapsulates the apprehensions and scepticism surrounding disinvestment in healthcare, frequently misconstrued as a mere justification for budget cuts or rationing, instead of a strategic initiative to boost efficiency through the reallocation of funds to higher-value interventions. The complex nature of disinvestment, which requires specialised skills and expertise, may intensify resistance among healthcare providers and the general public. Some respondents articulated concerns that the removal of care or treatment would cause significant harm, especially to vulnerable or disadvantaged groups. During the interviews, we occasionally observed emotional language and prolonged pauses, particularly when informants recounted unfavourable experiences related to managing challenging scenarios in decision-making.

a. Equity issues in underserved population

Participants expressed worries regarding equity among the underserved population by giving examples of rare diseases:

> *"Oh, this one is very hard! Let's just talk about rare diseases. Just the costs. That's huge! And if you were to talk about the amount of money that we're spending in Malaysia. We know we cannot give even the bare minimum. What we can do now is service some of the people living with rare diseases, but that's not even all. And now, we want to take away things from them?" (PRGM01)*

b. Unfamiliar and complex process

The participants viewed their unfamiliarity with the disinvestment process as a significant challenge for stakeholders, highlighting the absence of clear guidance as a critical concern.

> *"I think disinvestment is something that we are not very familiar with in our Malaysian settings and in my hospital setting, definitely. And we don't really know the cut-off. The guidelines… hmm… I'm not sure whether there's a national guideline for disinvestment." (CLIN04)*

Adding to that, there are insufficient skills and expertise in the country to execute the disinvestment process and manage disinvestment decisions due to a lack of experience in the field.

> *"My concern is this… we are still at a very infantile stage of setting this whole thing up. One of the biggest issues that I would think is, do we actually have enough experts? People with, you know, experience with disinvestment to actually look and customise that to our local population." (RSCH03)*

Moreover, participants believed that a lack of experience and the complexity of decision-making in disinvestment will inevitably hinder the process of gaining political will and acceptability among stakeholders:

> *"Do we have the political appetite to make this difficult decision? That's one. And the other thing is, do we have the skill set in our country to take the local context into consideration, as I mentioned earlier, when making the decision? Because the decision cannot be just purely on technical grounds." (PRGM01)*

c. Conflict on evidence versus expectation

One participant recounted a prior experience in reconciling the ethical obligations of a clinician with fulfilling patients' expectations regarding medication. Despite robust evidence showing a lack of benefit, there is apprehension that disinvestment could lead to patient resistance, as patients have become accustomed to certain medications and may expect continued access.

> *"For example, the use of medication Neurobion in treating neuropathy. Even though there is no evidence [to show its effectiveness], but it is very difficult to disinvest, because our patients' expectation is that, they need to be given some medication to treat their illness." (CLIN03)*

d. Perceived threats to authority

Concerns were also expressed about the perception of the disinvestment process as a criticism of decisions made by previous healthcare authorities. This view evokes discomfort or defensiveness, as it may suggest that previous decisions were misguided or inefficient. Such interpretations foster a protective stance among stakeholders, who feel their professional autonomy and credibility are being challenged or questioned.

> *"…sometimes colleagues or staff may feel like resistance to change, particularly if reassessment or disinvestment perceived as criticism on any previous decision, or reduction in authority if someone were to give a decision on that." (CLIN04)*

Moreover, participants worried that the public or patient community could react negatively and place blame on healthcare authorities, particularly the Ministry of Health, for perceived reductions in services or care. This fear of public blame appeared to exacerbate hesitance toward disinvestment, as it placed the Ministry of Health in a vulnerable position where their decisions could face scrutiny or resistance from both internal and external stakeholders.

> *"Whenever you try to take something out, people will start voicing out. People will be against it. People will start judging or blaming the ministry [Ministry of Health]. We don't want that." (PRGM05)*

5.6.6 Theme 3: Challenges and barriers towards disinvestment initiatives

This important theme highlighted several systemic challenges, practical barriers, and emotional disappointment among healthcare professionals that may impede stakeholder acceptance of disinvestment initiatives. Systemic issues such as inadequate planning, restrictions on investing in innovative technology, lack of funding, and bureaucratic challenges raise concerns about the system's readiness and ability to manage disinvestment in a way that leads to significant improvement. These barriers are causing delays in technology adoption and impeding changes in clinical practice.

Consequently, stakeholders expressed doubts about the effectiveness of the disinvestment process in eliminating obsolete or low-value practices by replacing them with better alternatives or technologies. This uncertainty also contributes to apprehension and personal frustration among healthcare professionals, fostering hesitancy to shift from experience-based to evidence-based practices in the context of LVC de-implementation. Table 5-2 presents the illustrative quotes associated with each subtheme, highlighting the barriers and challenges.

Table 5-2: Example of quotes on barriers towards disinvestment initiatives

Subthemes	Example quotations
1. Systemic barriers	
1.1. Poor planning and implementation	*"One of the biggest hurdles from that process would be the implementation part. We do see very good policies, or a very good new method being introduced into the system. But along the way, implementation does not always turn out as good as expected. […] these transform into additional workload for the people who are involved." (RSCH03)*
1.2. Lack of funding to adopt high-value technology	*"…they just assume that the government will give the budget that can cover 200 cases. I'm speaking about IVF only. […] If you look at the amount of budget received by each centre, there's no way they can accommodate 200 cases!" (CLIN02)*
1.3. Restriction to invest in innovative technology	*"We can't do a lot of things with that kind of restrictive policy. […] With that restrictive policy and the law, we feel that if we want to advance into new things [innovative technologies], sometimes are very limited." (PRGM06)*
2. Practical barriers	
2.1. Delay in technology adoption or change of practice	*"When it comes to ART [artificial reproductive treatment] services, Malaysia is the pioneers in the Southeast Asia. But now we are being left behind by other countries, for example, Vietnam, Thailand, Singapore even more." (CLIN02)*
2.2. Outdated technology still being used	*"It is sad for me now, because we see that even though we have been doing this for quite some time now, but it is very hard to say that we are growing. All of our colleagues that left the public sector, they manage to [grow] professionally, because they are able to use all the technologies that I mentioned." (CLIN02)*

Subthemes	Example quotations
3. Care provider's apprehension	
3.1. Healthcare professionals' frustration	*"Some of my clinicians are frustrated, you know. If let's say they stop something, and then they want to start something else. Like, they want to give new medication to the patients, they have to apply for permission… I think they are getting frustrated. It's more of bureaucratic red tape that we need to get rid of, some of it." (HOSP01)*
3.2. Unsure of benefit *3.3. Lack of knowledge / awareness*	*"They [healthcare professionals] will resist it, but it depends on how much they know about disinvestment. If we are in business operation, and we can say disinvestment is something that will benefit us, then it is good. But now, we don't really know how it will benefit us. If we don't know, how can we accept it?" (HOSP04)*
3.4. Experience-based vs evidence-based *3.5. Reluctant to change*	*"Sometimes for the very senior doctors, they rely on their experience. They have their own preference. For example, during COVID on the usage of steroids, they have different way [of managing patients] based on their experience, even we have guidelines [recommending oppositely]. They won't follow." (HOSP04)*

5.6.7 Theme 4: Strategies for value assessment and effective implementation

This theme explores potential strategies to enhance the acceptance and operationalisation of disinvestment initiatives in the Malaysian healthcare system. Among the subthemes identified from the KII were suggestions to increase stakeholder acceptance through knowledge transfer, integrating change management strategies, including equity as one of the criteria for assessment, and looking into factors that can assist transitioning from LVC to high-value care.

a. Awareness, acceptance and knowledge transfer

Educating stakeholders emerged as a critical component of successfully implementing disinvestment initiatives in healthcare. Before proceeding to disinvest services deemed to bring comparatively less value, clear and transparent communication is pivotal to increase understanding and build trust. Clinicians, as key implementers, often need clarity on the rationale behind disinvestment decisions to align their practice with the initiative's objectives. A participant shared previous experience dealing with clinicians on reassessing drug lists and stated that:

> *"The doctor is actually the agent of the patient, meaning that they accept what the doctor accepts. […] We have to tell them that this kind of routine exercise [disinvestment] is actually for a greater good. It's not for one perspective. We actually want to maximise what we have [resources and budget allocation]." (RSCH02)*

Other stakeholders that should be involved are the patients and the public. Building trust through open and transparent communication between doctors and patients can empower them to actively participate in their care and align their expectations with the broader goals of achieving value-based care. This approach offers an informed decision-making process for the patients, thereby enhancing their acceptance of disinvestment initiatives.

"We have to educate them [patients] because they have the right to know why we decide on this. We have to respect their rights and their needs. […] They need to have access to care, and they need the information." (HOSP02)

b. Change management strategies for disinvestment

In planning for disinvestment, incorporating a robust change management strategy is essential, as the process inherently involves taking back services or resources previously provided. It is an action that is far more challenging than introducing new technologies. Disinvestment often triggers both emotional and pragmatic responses, as stakeholders, including clinicians and patients, may perceive it as a loss rather than a strategic shift toward value-based care. Change management strategy was specifically mentioned as a practical way to introduce disinvestment:

"Well, anything new is always difficult. You need your change management strategies to be in place. And you need to manage it in a step-wise manner as you go. Identify your champions, start with those champions, do with the smaller scope. Start with something very specific, and once you can show that it works or it can work well in one, then you start expanding it further." (PRGM01)

Participants also emphasised that strong leadership is indispensable to driving disinvestment initiatives, ideally starting with a top-down approach or as a policy-driven effort. Framing the process as part of a quality improvement initiative can make it more appealing and acceptable to key stakeholders.

"Since this is a top-down approach versus a self-initiated bottom-up approach, there is a difference in terms of support. Once it's a top-down approach, there's more support. […] That is also the main reason that you can bring to your specialists and the consultants." (RSCH02)

The participants underscored the significance of adaptable disinvestment implementation on a case-by-case basis, promoting localised decisions that consider facility readiness and the local context. While a centralised policy on disinvestment might help in standardisation, a blanket rule allowing all levels to implement disinvestment decisions independently could lead to variability in care quality.

> *"It is very difficult to have one-size-fits-all kind of decision, because a lot of decision that we make, whether it is at the national level, at a regional level, or at a state level, it should be customised to whatever that is needed by the local population. Whatever that's needed or that's important for one state might not be necessarily important, or as needed in another state." (RSCH03)*

c. Equity as criteria for assessment

Equity emerged as a key consideration in disinvestment decision-making, with participants emphasising the need to protect vulnerable populations and those with rare diseases. Some advocated for the inclusion of specific criteria to address emotional and sensitive issues, while others emphasised the importance of setting boundaries or safeguards to prevent disproportionate impact on these groups. However, they also acknowledged that disinvestment should not entirely exclude these underserved groups, but recommend a transparent, rationale-driven approach to assess interventions that may be ineffective or of limited benefit.

> *"We need to make sure that there are mitigating safeguards for the vulnerable population, by having exclusions and so on. Yes, there is a concern that it affects the vulnerable population. But as long as there are safeguards, then it should be implemented." (PRGM03)*

> *"We need to include assessment on equity as a criterion, because disinvestment is supposed to be transparent, and it's supposed to be non-judgemental and also unbiased. If the evidence, the utilisation and also the budget support that disinvestment [decision], I think we need to do that even though it involves the vulnerable groups." (CLIN03)*

d. Transitioning from low-value to high-value care

Transitioning from low-value to high-value care requires a comprehensive approach that considers healthcare system readiness, improvements in health financing mechanisms, and the acceptability of decisions for patients and the public. Beyond maximising benefits, participants suggested that the initiative should prioritise equitable access to better-quality care, with a focus on providing life-saving and higher-value interventions supported by sustainable government funding, to ensure a smooth transition.

> *"I think if we want to take away low-value care, we must provide the option of how to improve it. You can either bring, for example, the fairest way is we support the cardiac centre for all the 147 [public] hospitals, that will be equity. […] The other way, which is a faster way is, maybe there could be a system of care." (CLIN01)*

Some participants suggested that Malaysia transition from the current healthcare financing model to a more sustainable system. However, it was highlighted that while different countries may have different financing models, their functions can align through strategic purchasing, a financing function that operates similarly regardless of the broader funding model.

> *"…people have an understanding of models of financing. But we should be moving towards functions of our financing [system]. So yes, you were correct in saying that Vietnam has social health insurance and Malaysia has tax-funded. But when it comes to functions, both Vietnam and Malaysia, which is what we are trying to do right now, can have in terms of functioning, strategic purchasing. The functions of purchasing are no different [between Malaysia and Vietnam]." (PRGM03)*

e. Monitoring and evaluation of health technologies implementation

Additionally, monitoring and reassessment should be embedded as part of the health technology management process to guarantee that the care that we provide remains effective and relevant over time. A number of participants agreed that routine monitoring allows for evidence-based adjustments as new data emerge or technologies evolve, enabling timely decisions to discontinue outdated procedures, medications, or methods. This approach bridges the gap between evidence and clinical practice, ensuring that healthcare delivery aligns with current standards and technology advancements.

> *"If you make it [disinvestment activities] a routine, then it may be easier for colleagues or the staff to accept that whatever drugs come in, even the new drugs, they may be substituted for further reassessment along the way, although it has probably been included in this CPG later. […] If you make it a regular assessment, it will be more acceptable to staff and colleagues." (PRGM04)*

> *"I think it should be done routinely. […] We have new drugs, new technology, new procedures, and new methods coming in that will surpass the previous method, the previous medications. At the end of the day, I think we all have one thing in common, which is patient safety and well-being." (HOSP03)*

5.7 Discussion

The current study employed qualitative methods to explore Malaysian stakeholder perspectives on the disinvestment of low-value care and ineffective interventions. Four major themes were identified on how disinvestment was viewed by key healthcare stakeholders in Malaysia, including systemic and practical barriers, as well as apprehensions by care providers towards the process. Overall, the majority of the respondents were keen on advancing into this challenging process, taking into consideration the positive perceptions in terms of how HTA was previously conducted in Malaysia, i.e., using a systematic, transparent, and comprehensive approach involving the key stakeholders. However, some participants were sceptical towards the successful implementation of this idea due to their belief that the Malaysian healthcare system is not ready in terms of the availability of skilled personnel and their fear that this process would jeopardise access to care as well as treatment options for the underserved populations.

Although participants expressed a range of opinions about the disinvestment process, they were unanimous in supporting the inclusion of equity as a key component in decision-making for the de-implementation of LVC. This perspective is particularly significant, as it differs with earlier online survey findings that ranked equity or fairness as the least important element (130). We hypothesise that most healthcare stakeholders in Malaysia may have found it challenging to fully understand the rationale for prioritising equity due to the complexity of disinvestment and its relative unfamiliarity.

a. Stakeholder's perceptions and engagement

Stakeholders frequently viewed disinvestment as a possible threat to established authority, largely due to a lack of clarity around the concept. There is a widespread misconception about the true nature of disinvestment. Our study found that some perceived disinvestment as a way to 'unload the excess baggage' in the current system by stopping the available treatments or reducing investment in healthcare

resources. This misconception frames disinvestment as a one-dimensional approach focused solely on withholding funds rather than as a method of reallocating resources to maximise value and efficiency. Misinterpretation of the disinvestment agenda causes scepticism about the motives behind the de-implementation of care, which obscures stakeholders' acceptance (126, 134).

Continuous awareness and education can gradually shift stakeholders' perceptions of disinvestment initiatives. A longitudinal study examining disinvestment programs in two hospitals found that staff initially viewed disinvestment negatively, associating it with a sense of 'loss' in providing quality care (135). Over time, however, their perspective evolved, and they began to see disinvestment as an opportunity to reallocate resources more effectively and improve care delivery. Ultimately, they accepted the initiative and developed an increased appreciation for evidence-based practices (135). This example demonstrates that showcasing clearly the benefits of disinvestment is vital to nurturing positive behavioural change and encouraging a more supportive approach among stakeholders.

Clinical care providers sometimes face pressure to offer certain treatments, even if they suspect the intervention is low-value, due to patient expectations (59). Our participants also expressed this sentiment when asked about the challenge of changing practice. The removal of an established practice can undermine clinicians' sense of autonomy and may be interpreted as a critique of their professional judgement or a lack of trust in their expertise, which may cause resistance (108, 136). Acknowledging the sub-optimal status of a long-established patient practice can be difficult, as it fundamentally challenges the foundation of their clinical decision-making. Furthermore, due to the historical precedence of some legacy items and the lack of recent evaluation, LVC tends to be based on habit, which further contributes to the sustainment of the practice (137). Identifying inefficient care can be complex, as some interventions may be effective for certain populations but not for others, leading to uncertainty among healthcare providers. To address this complexity, the

identification of LVC must be carried out transparently, grounded on the most up-to-date evidence, and using both top-down and bottom-up approaches.

b. Change management strategy

Having a well-planned change management strategy is pivotal to not only increase stakeholders' acceptance but also ensure proper execution of the proposed disinvestment initiatives, as discussed during several interviews. This is paramount, as any policy or guidelines alone without a complementary strategic plan for implementation are unlikely to succeed and may yield unforeseen outcomes (11). Applying change management models with sufficient flexibility to suit the specific context and empowering local change agents can effectively complement and enhance improvement and implementation outcomes (138). Moreover, strong leadership is fundamental in helping to build trust and align stakeholders around the shared goals of the initiative. This also emphasises the significant role of support from system leaders holding key positions in public service administration, in particular, whose influence is instrumental in reducing resistance and fostering acceptance of these changes (139).

In the context of disinvestment in Malaysia, understanding the enablers and challenges would give some reflection on how best to start implementing it. According to the respondents' perspectives, inadequate planning of implementation strategies can result in stakeholder frustration, further compounded by insufficient funding to support the adoption of innovative technologies. From the outset, there is often uncertainty about the potential benefits of undertaking the disinvestment process. To address this, the initial step could involve identifying champions among stakeholders, such as clinicians committed to value-based practices and influential leaders from administrative groups. These champions can help introduce and advocate for the plan, desensitise it, and ease concerns among implementers before advancing to the more complex stages of the process. This is mainly because disinvestment is not merely the reverse process of implementing a service; it involves a sense of loss and may be perceived as a threat by those providing the services (135).

Policymakers are encouraged to enhance transparency and consistency in disinvestment decision-making to build support and trust among stakeholders (123). Equally important is the need to monitor and evaluate the outcomes of disinvestment decisions to assess whether the program has achieved its intended objectives. These impacts can be measured using real-world data, such as claims records, updates to clinical guidelines, or surveys capturing public perspectives (67). Furthermore, our study highlighted the critical need for skilled personnel with proper training to carry out disinvestment assessments effectively. This involves not only improving their knowledge and technical competencies but also fostering collaboration with other professionals and researchers to address complex issues, particularly in ethical and social domains (140).

c. Equity and protecting underserved population

One of the key insights from our study is the emphasis on preserving equity in disinvestment decision-making, a topic that has been underestimated in previous research. The majority of the participants agreed that safeguarding vulnerable populations is essential because people suffering from rare diseases, for instance, are already in a disadvantaged position at the starting point of their illness, and this should not be overlooked. Policies that are tailored to their unique needs are crucial, as policymakers often assume they understand what these populations require, which may not align with their actual needs. Hence, including equity components and mitigation strategies in the decision-making process is vital to addressing their specific concerns and avoiding misrepresenting their priorities.

The majority of participants emphasised that while addressing equity and the needs of underserved populations is complex, these are critical components that must be prioritised in the disinvestment process for healthcare services. Our findings identified three key elements to ensuring equity for disadvantaged or vulnerable groups: the availability of alternative services, accessibility across different levels of care and geographic regions, and the establishment of safeguards to protect these

groups from inequitable outcomes. These priorities highlight the importance of a framework that explicitly places equity at the core of disinvestment decisions. Failing to ensure the availability, accessibility, and acceptability of essential healthcare services for disadvantaged groups could compromise the quality of care, undermining the principles of universal health coverage (141).

d. Strengths and limitations

Our study stands out as the first to explore healthcare stakeholders' perceptions of disinvestment initiatives in Malaysia through in-depth interviews. A key strength of this research is the diversity of participants, representing various professional roles across multiple levels of the healthcare system in the country. This included budget holders and programme managers at the national, ministerial, and state levels, as well as hospital management. Additionally, we recruited clinical care providers, including a senior clinical consultant in a public hospital, a primary care doctor, a hospital pharmacist, and allied health professional working in a centre with high-cost technologies. These participants brought a wealth of experience, highlighting central issues such as delays in technology adoption, despite Malaysia's historical leadership in specialised services like artificial reproductive treatment. The richness and diversity of the information are invaluable in influencing stakeholder acceptance, addressing challenges, and laying the groundwork for developing a comprehensive healthcare disinvestment framework tailored to the Malaysian context. Moreover, we included researchers with extensive experience in health services research, including conducting reassessments of medications listed in the national formulary. This is vital in identifying components for evidence generation and performing advanced technical analyses. By linking evidence on disinvestment with clinical practice recommendations, the approach ensures that practices remain contemporary and aligned with the latest evidence.

Yet, we also acknowledge several limitations in this study. We conducted all interviews online, which limited our ability to observe non-verbal cues like gestures and facial expressions, especially when some participants chose not to use their

cameras. We encountered a few technical issues during the interviews, including poor audio quality and intermittent internet connectivity. Despite these challenges, all interviews proceeded as planned. On the positive side, digital interviews offered significant advantages for both researchers and participants, enabling participation from their respective workplaces (9) and facilitating data collection across geographical boundaries. In consistent with previous studies, Zoom emerged as a practical tool for qualitative data collection due to its user-friendly interface, cost-effective, robust data management features, and reliable security options (142, 143).

Second, we recruited the participants through purposive sampling, based on responses from an online survey, targeting individuals with a strong interest in resource allocation and value-based healthcare. While this approach ensured the inclusion of experienced and knowledgeable participants, it may have excluded perspectives from other healthcare providers, such as nurses, biotechnologists, and junior doctors, who may hold different views or face unique challenges. Additionally, the use of snowball sampling, which relies on recommendations from professional networks, likely favoured respondents with extensive experience and familiarity with the healthcare system. Consequently, this method may not fully represent the diversity of all healthcare stakeholders in Malaysia, and the potential for selection bias cannot be entirely ruled out.

5.8 Conclusion

In this study, we found that Malaysian healthcare stakeholders viewed disinvestment initiatives both optimistically as a catalyst for efficient resource allocation and sceptically as a justification for budget reductions in healthcare. The main challenges identified were apprehensions about the negative repercussions of disinvestment and concerns about the Malaysian healthcare system's readiness to effectively implement the process. We explored potential strategies for value-based assessment and effective implementation to overcome the identified barriers. Promoting a culture of accountability and collaboration among stakeholders is essential to improving the acceptance and successful implementation of disinvestment activities. By addressing central elements such as criteria for assessment of disinvestment candidates, change management in implementing the initiatives, equity in underserved groups, transparency, and evidence-based decision-making; these strategies facilitate a more sustainable and patient-centred approach to healthcare resource reallocation through disinvestment initiatives.

Chapter 6: Value of de-implementation and decision-making framework for healthcare disinvestment

6.1 Background

In Chapter 3, I explored three primary approaches to the disinvestment process, drawing on published literature and case studies that utilised tools such as PBMA and HTA, with or without economic evaluation methods like CUA. The chapter also introduced MCDA as a potential tool for supporting disinvestment decision-making. Building on this, the online survey and interviews in Chapters 4 and 5 emphasised that decision-making about disinvestment necessitates meticulous consideration of the local context to improve acceptance and legitimacy among key stakeholders. Moreover, evaluating disinvestment candidates involves addressing multiple criteria and navigating complex considerations, particularly when deciding whether to stop, remove, or reallocate resources from low-value or obsolete practices.

This chapter integrates the application of MCDA as a decision-making framework, informed by stakeholders' views, to facilitate the healthcare disinvestment process. It begins with stakeholder identification and is followed by the introduction of the concept of the "value of de-implementation" as guiding criteria for assessing disinvestment candidates. The chapter then details the steps involved in the value measurement process, including defining the criteria, eliciting criteria weights, measuring performance, establishing scoring functions, and conducting an overall value assessment to provide recommendations for disinvestment candidates.

The development of the framework is the result of extensive discussions between my PhD supervisory team and Assist. Prof. Dr. Sitaporn Youngkong, an expert in MCDA and priority setting in health, HTA, and health policy research. She earned her PhD from Radboud University in 2012 with the thesis on MCDA for priority setting of health interventions in Thailand. Her expertise is evidenced by her significant contributions at national and international levels, including guidance on using MCDA to support HTA

agencies in setting healthcare priorities (88). Another contributor to this chapter is Dr. Nicola McMeekin, a research associate at HEHTA, University of Glasgow, specialised in developing conceptual models for economic evaluations. Her PhD introduced a novel role for these models in analysing clinical trial data under uncertainty. Notably, her widely cited work on creating robust guidance for methodological framework development (144) has been instrumental in shaping this chapter. To reflect the collaborative efforts behind this work, the terms ‘we’ and ‘our’ are used throughout the chapter.

6.2 Stakeholder involvement in value assessment for disinvestment

In any MCDA exercise or activity, the first step is to identify and assemble suitable panel members. Traditionally, HTA agencies lead the decision-making on health technologies at the national level. In Malaysia, for example, this process is coordinated by MaHTAS under the MOH. In the context of implementing this framework in the Malaysian healthcare system, the stakeholder involvement in this chapter is described based on the process conventionally practiced by the MOH Malaysia. These exercises typically involve two distinct groups of panelists: **the technical group** and **the multidisciplinary advisory panel**.

The technical group includes HTA reviewers, analysts, health system researchers, health economists, information specialists, and clinical content experts such as the clinicians or family physicians. This group provides the technical input necessary to assess and prioritise potential disinvestment candidates based on predefined criteria. Members may be drawn from HTA agencies, research institutions, academia or universities, hospitals as well as researchers in health informatics. They are tasked with performing detailed analyses and compiling findings to guide the decision-making process. In contexts where an established HTA agency exists, its reviewers or researchers often play dual roles as project coordinators and technical contributors. The technical group’s assessments typically compiled in a technical report or a presentation package, which serves as the foundation for subsequent deliberations.

The second group is the multidisciplinary advisory panel, which plays a central role in decision-making throughout the MCDA process (145). This panel comprises senior experts with substantial decision-making experience, such as consultants and senior clinicians, heads of department, programme managers, public health leaders and resource managers. While technical expertise is important, familiarity with evidence-based decision-making is a distinct advantage. To ensure alignment and comprehension, the technical coordinators may organise briefing sessions for expert panel members to provide an overview of the disinvestment process. These sessions outline the objectives, steps involved, and the expected outcomes from the MCDA framework.

While the advisory panel members should be constant throughout the MCDA exercise, when appropriate and necessary, the panel can bring in topic-specific experts to advise the decision-making panel (i.e., the second group above). For instance, during the assessment of the potential disinvestment of cancer therapies, the panel may invite specialists such as clinical oncologists, pharmacists with expertise in cancer care, and palliative care physicians to provide additional input, ensuring the consideration of relevant perspectives. Additionally, to uphold the integrity of the process and minimise bias, all members of both the technical group and expert panel should declare any potential conflicts of interest.

In summary, the composition and preparation of these two groups are pivotal for the success of the MCDA process. While the technical group ensures a robust analytical foundation, the multidisciplinary advisory panel brings critical insights and contextual expertise to inform fair and evidence-based decision-making. Moreover, involving stakeholders in the decision-making process empowers them and ensures that their perspectives are integrated into the final outcome.

6.3 Value of de-implementation

Within assessment of health technologies for reimbursement purposes, decision-makers requires the analysis of different dimensions that define the direct and indirect consequences of implementing, using or re-evaluating a technology in comparison with others. Evidence-based decision-making in healthcare often incorporates broader considerations, such as affordability, feasibility, and acceptability, which may require contextualisation through deliberative processes. These dimensions often encompass health benefits (e.g., safety and effectiveness), economic, organisational, ethical, legal, environmental, and social aspects (61, 140).

In healthcare disinvestment, balancing technical and economic efficiency with equity considerations are important (Chapter 5). Attention has also been directed toward managing the tensions between the quality of supporting evidence, stakeholder expectations, patient demands, and the healthcare system's readiness to implement recommendations. Although some indicators exist to measure individual components, quantifying and integrating these domains to evaluate the overall implementation of different programmes remains challenging. This difficulty arises from the diverse range of outcomes generated by assessments, which are often not directly comparable across interventions or settings.

Inspired by the evolution of the ISPOR Value Flower (146) and builds on insights from our scoping review, mixed-method study with healthcare stakeholders, and expert consultations, this thesis introduces a novel approach to synthesising quantitative and qualitative data within an MCDA framework to assess and evaluate healthcare disinvestment candidates. A key innovation lies in the application of MCDA to integrate five carefully identified domains: **health impact, equity, enablers for disinvestment, system readiness,** and **economic impact** (Figure 6-1). Each will be weighted by stakeholder's preferences and further aggregated into a comprehensive estimate of total benefit or value, except for economic impact. This approach represents a significant potential in operationalising the "value of de-

implementation", providing a structured and transparent method to guide disinvestment decisions in healthcare.

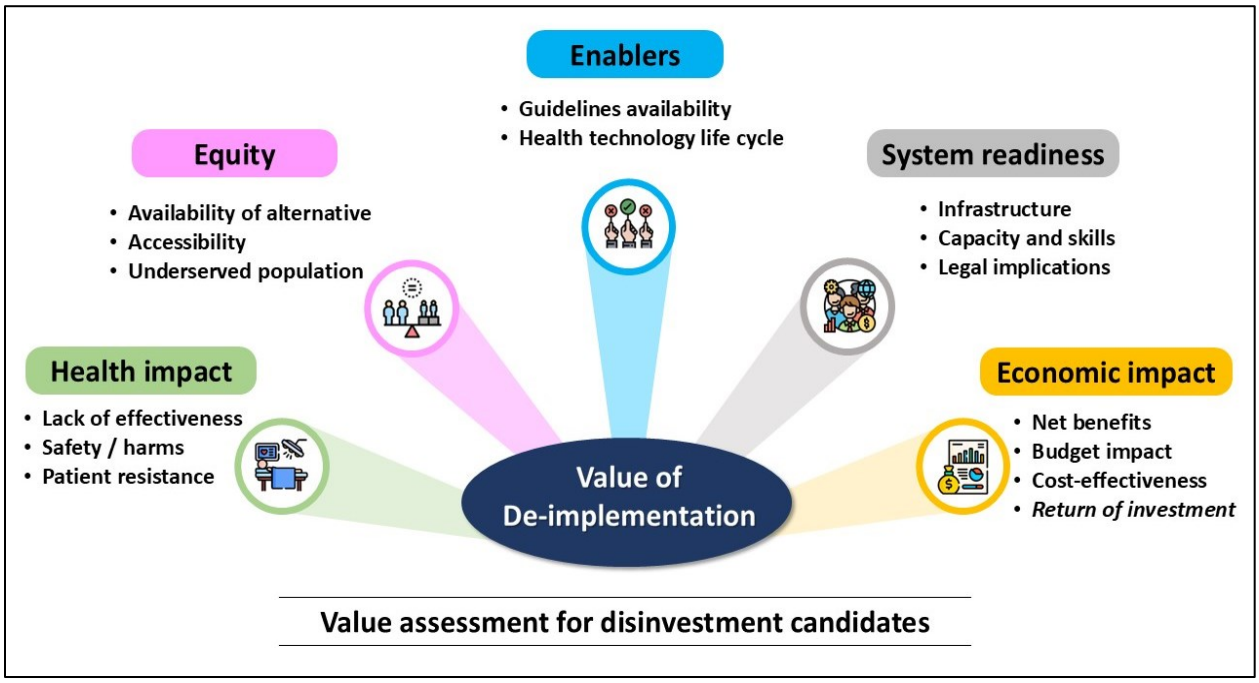


Figure 6-1: Components of value assessment for disinvestment decision-making

6.2.1 Health impact

We identified three key components to assess the health impact of interventions in a disinvestment context:

i. ***Lack of effectiveness***: this component evaluates the clinical efficacy of interventions, considering factors such as impact on quality of life, diagnostic accuracy, disease prevention, and other relevant clinical outcomes.

ii. ***Safety or harmful effects:*** assesses the safety profile of interventions, including adverse events, potential harm, and overall risk-benefit ratio.

iii. ***Patient reluctance and resistance***: this component evaluates the acceptability and tolerability of interventions from the perspective of both patients and the public. It considers factors such as patient satisfaction, adherence rates, and potential barriers to implementation.

The performance of these components will be assessed primarily based on recent evidence from various sources, including RCTs, systematic reviews, meta-analyses, observational studies, qualitative studies, survey and patient-reported outcomes research, local studies and real-world evidence (RWE) derived from administrative data or registries. For safety profiles, the incidence reporting and adverse event notifications by the Malaysian National Pharmaceutical Regulatory Authority are also considered.

6.2.2 Equity

Three key characteristics that highlight equity concerns in disinvestment decisions, identified through literature review and stakeholder interviews, are as follows:

i. ***Availability of alternative:*** this attribute assesses the presence of alternative interventions or care delivery models that can replace the candidate intervention, such as different technologies or alternative care delivery approaches (e.g., frequency, route of administration, screening interval).
ii. ***Accessibility of care:*** it evaluates the accessibility of care at various levels of the healthcare system if the candidate intervention is disinvested. It considers factors such as the need for specialist referral, geographical disparities in access (e.g., urban vs. rural), and potential barriers to care.
iii. ***Underserved population:*** this component emphasises the ethical implications of disinvestment on vulnerable or disadvantaged populations, such as individuals with rare diseases, the elderly, children, or patients with advanced disease requiring palliative care. It considers the risk for increased health disparities and the acceptability of disinvestment decisions in these groups.

Similar to the health impact assessment, a variety of sources, including health system research and health economic studies, can provide the evidence to inform equity considerations. Expert opinions and colloquial evidence are also considered to assess the extent of service accessibility and availability.

6.2.3 Enablers for disinvestment

Enablers for disinvestment refer to factors that support the implementation of alternatives or facilitate the execution of disinvestment decisions. Two key enablers we have identified are:

i. ***Availability of guidance / guidelines:*** this factor facilitates the transition required for a change in practice. The presence of local guidance, clinical protocols or other adaptable frameworks tailored to the local context can significantly ease the process of de-implementing LVC and implementing a more effective alternative.

ii. ***Health technology life cycle:*** this attribute evaluates the stage of adoption or diffusion of the assessed candidate or technology within the healthcare system. It also considers the utilisation patterns of the technology or intervention to assess local consumption levels and the obsolescence of the health technology.

The availability of guidelines can be verified through established guideline developers within the country, such as the Ministry of Health and the Academy of Medicine for Malaysian evidence-based CPGs and other guidance. The technical group can also explore international guidelines from the Guideline International Network's (GIN) library, via their website at https://g-i-n.net/international-guidelines-library.

6.2.4 System readiness

The system readiness domain evaluates the healthcare system's preparedness and its potential impact on implementing disinvestment decisions. This includes assessing the feasibility of de-implementing the candidate and adopting an alternative as a replacement. It considers perspectives from both payers and care providers, the additional capabilities and training that might be required, and the willingness to accept potential risks, such as public protests or legal challenges, associated with disinvestment decisions. Three key attributes of the system readiness domain are:

i. ***Infrastructure readiness:*** this attribute assesses whether the existing facilities are prepared to support the disinvestment decision. For example, facilities equipped with digital systems may enable the replacement of X-ray films, facilitating the transition.

ii. ***Capacity and skills:*** this criterion examines the availability and readiness of human resources, opportunities for skills upgrading, and clinicians' willingness to adapt to changes in practice. It also considers whether specialised training is necessary to implement alternative care.

iii. ***Legal implications:*** this component evaluates the likelihood of legal challenges or public protests arising from disinvestment decisions, drawing from evidence in similar settings or countries. For instance, if there is a high risk of lawsuits due to controversial issues, the candidate may be unsuitable for disinvestment.

6.2.5 Economic impact

Based on studies and engagements with Malaysian healthcare stakeholders, the ***economic impact*** in assessing disinvestment candidates should encompass several key factors. These include the cost of the intervention, its affordability to payers as reflected in the budget impact, evidence of cost-effectiveness, potential cost savings if the candidate is removed from practice, return on investment (either retrospectively or through forecasting), and the cost of alternative replacements, if available. For interventions that affect a wider population, ***net monetary benefits (NMB)*** can provide a comprehensive measure of economic impact. For instance, in a colorectal cancer screening programme, net benefits can be demonstrated through early detection and treatment outcomes, such as cost savings from reduced advanced-stage cancer treatments, increased productivity, improved patient quality of life, and lives saved. ***Opportunity cost***, defined as the potential benefit forgone if the programme is disinvested, can be expressed in terms of the loss of additional cases detected, the loss of disease prevention outcomes, or the loss of incremental QALY gained.

Information on economic impact can be sourced from published studies, such as economic evaluations or budget impact analyses, with a preference for local studies to ensure contextual relevance. In cases where sufficient data and information are available for primary analysis by the technical group, conducting a ***cost-consequence analysis*** or a ***financial impact analysis*** would yield more robust and actionable insights. These analyses provide the advisory panel with clearer and more relevant evidence to support informed decision-making.

In this framework, the economic impact is included as part of the overall value assessment but is excluded from the MCDA performance scoring exercise. This decision is based on the high possibility of double-counting or overlapping with other domains, particularly those related to health impact (e.g., CEA, CUA or budget impact analysis, which inherently account for clinical effectiveness) and system readiness (which may involve additional resources required to implement an alternative if the candidate is disinvested). The rationale for excluding economic impact from the MCDA performance scoring is supported by our consultations with the MCDA expert and publications on MCDA methodologies highlighted these considerations in applying the frameworks for priority setting for investment and HTA context (88, 147, 148).

For instance, Claxton et al. (2015) contended that costs and ICERs are not suitable for direct inclusion in MCDA models, as they do not constitute inherent attributes of a benefit (148). Despite that, cost information remains crucial for understanding the resource implications and potential trade-offs associated with different decision alternatives. In addition, Baltussen et al. (2019) emphasised that MCDA requires respondents to assign values and weights to cost-effectiveness relative to other criteria. This process, however, is challenging for individuals as they may not be aware of budgetary constraints or the opportunity costs of alternative resource allocations. To address this limitation, they propose using a “cost-per-value” allocation rule whereby this approach ranks technologies based on their cost-per-value ratio, prioritising those with the lowest ratios (88).

Wilson et al. (2022) compared MCDA and CEA methods for prioritising knee osteoarthritis interventions and they found significant discrepancies in how these methods weigh intervention attributes and make trade-offs. This suggests that directly incorporating cost into MCDA value calculations may not be optimal. Instead, they propose focusing on the net benefits from non-economic criteria of interventions in the MCDA model and subsequently evaluating their cost-related attributes, such as budget impact or cost-effectiveness, separately. This approach ensures that resource allocation framework takes into account the comparison of the MCDA value score with the economic impact of the interventions that being assessed (147).

In the context of incorporating the “value of de-implementation” within the disinvestment decision-making framework using MCDA, the economic impact remains a critical component of the deliberation process. The information and evidence pertaining to the economic impact of each candidate intervention should be presented to the advisory panel for a comprehensive assessment of overall value during deliberation. This ensures that the panel can consider the economic implications during decision-making and rank the assessed interventions based on the **NMB-per-score** for each candidate.

6.4 Elicitation of criteria weights

In MCDA, the priority setting process considers criteria weights agreed collaboratively ahead of time. From the online survey, the rank of criteria chose by the respondents was based on direct rating. However, due to some modification to the components and definitions of the criteria as included in the value of de-implementation framework, the criteria weights will be determined by the panel members when the objective and the initial briefing is provided. The criteria weightage will then be used consistently throughout the project to assess the performance of the candidates, as recommended by ISPOR MCDA Good Practice Task Force (92).

There are various methods in eliciting the criteria weightage. A review of weightage found that the simple multi-attribute rating technique (SMART) method combined with “swing weighting” approaches are the most popular and feasible methods for MCDA in low- and middle-income countries (149). The choice of a weighting method depends on the decision-making context, resource availability, and feasibility. Examples of weighting methods trade-off with high complexity are discrete choice experiment (DCE) and potentially all pairwise rankings of all possible alternatives (PAPRIKA). While more complex methods may reduce bias, they demand greater resources and impose higher participant burden (149). Each method has strengths and weaknesses, and factors such as resource constraints, complexity, and practicality should guide the selection. Given the multi-stakeholder nature of the decision-making process, the SMART approach is considered an appropriate method for eliciting criteria weights. Its simplicity, flexibility in assigning both absolute and relative weights, and its successful application in previous MCDA-based priority-setting exercises for rare diseases in Malaysia make it a suitable choice (150).

The SMART method assigns weights and scores to criteria based on their relative importance and performance, usually on a 0-100 scale (151). The most important criterion is given a score of 100, and the least important criterion is given a score of 0 (or a low score relative to others), and weights for the criteria are calculated from ratios of the points. On another note, a rank-based weight elicitation method can also be used in a condition where criteria are ranked with two priorities that could be of equal rank, as reported in an MCDA exercise in evaluating health services research (152). In this scenario, the formula for SMART rank-based weighting is as follows:

$$W_i = \frac{n - R_i + 1}{\sum_{j=1}^{n}(n - R_j + 1)}$$

- R_i is the rank of criterion ***i***
- ***n*** is the total number of criteria

If rank is mutually exclusive, i.e., the criteria has no equal ranking, the SMART Exploiting Ranks (SMARTER) ranking sum formula can be used (153). The ***m*** criteria are ranked in order of their importance. The most important criterion gets a value of 1, the second-most important criterion gets a value of 2, and so on down to a value of ***m*** for the least important criterion. Weights for the criteria are calculated using the formula (151):

$$w_i = \frac{1}{m}\sum_{j=i}^{m}\frac{1}{j}$$

- w_i: weight assigned to criterion ***I***,
- ***m***: total number of criteria,
- ***i***: rank of the criterion (1 for the most important, ***m*** for the least important).

6.5 Performance matrix and scoring functions

Information on how alternatives perform with respect to each criterion can be compiled into a "performance matrix", usually illustrated in a table, using various methods, such as expert assessments, rapid literature reviews, comprehensive systematic reviews, or modeling exercises (151). The level of detail and effort required for data collection depends on factors such as the availability of evidence, the nature of the decision problem, and practical considerations like resource constraints (87). As stated before, MCDA allows for the integration of both quantitative and qualitative data, as well as subjective judgments in cases where more robust evidence is lacking, alongside traditional scientific data within a single framework. Therefore, scores are typically generated by establishing rules or functions that convert performance measurements into a standardised scoring system. These scores differ from performance measurements in two key ways. First, they often translate performance metrics, which may use different units for each criterion, into a common scale, such as 0 to 100. Second, scores reflect the relative importance or preferences for changes in performance within a criterion, ensuring that equivalent changes on the scoring scale (e.g., 1-5 or 10-20) are equally valued (87, 92).

For decision-making framework on disinvestment process using value of de-implementation that we developed, the performance matrix is built from the scoping and literature reviews, online survey and interviews with Malaysian healthcare stakeholders, as well as discussion among the supervisory team and an MCDA expert with vast experience in the process. Using the example from MCDA tool for health services administrators by Blythe 2019 (152), we decided to use a compositional method in eliciting stakeholders' preference for criteria performance by point allocation system. We set the total performance score for each domain at 6, and each component within a domain is assigned a score, ranging from 0 to 2 for health impact, equity, and system readiness; and from 1 to 3 for enablers. A maximum score for a domain indicates that the candidate fully meets the overall performance requirements for the criteria to be considered for de-implementation. The performance matrices for the four criteria are shown in Table 6-1 to Table 6-4.

The average score for each domain is then normalised using linear transformation method where higher value is preferred (benefit criterion) (152, 154). To keep the score between 0 to 10, the formula use is:

$$K_{domain} = K_{max} \times [K_{ave} / \text{highest score}]$$

- K_{domain}: scaled domain score
- K_{max}:10 maximum score for each candidate
- K_{ave}: average score from the panel's scoring

Table 6-1: Performance matrix and score for domain 'Health impact'.

Components	Score			Score range
	0	1	2	
i. Lack of effectiveness • quality of life, clinical outcome indicator • diagnostic accuracy • disease prevented	Evidence on lack of effectiveness not available; evidence of improvement present (statistically significant)	Evidence on lack of effectiveness present (not significant); evidence of improvement present (not statistically significant)	Evidence on lack of effectiveness available (statistically significant); or evidence of inferiority compared to other alternative(s)	**0-2**
ii. Safety / harmful effects	No evidence of harmful effects or minimal harm (statistically significant)	Evidence of safety / harmful effects but not statistically significant; or similar safety profile with alternative(s)	Presence of concerning safety issues / harmful effects (statistically significant)	**0-2**
iii. Patient reluctance or resistance	No evidence of resistance from patient / public; acceptance and satisfaction from patient	Mixed evidence on patients' preferences (in terms of resistance and acceptance)	Evidence of reluctance to accept intervention / resistance to intervention	**0-2**
Total score for domain 'Health impact'				**0-6**

Table 6-2: Performance matrix and score for domain 'Equity'.

Components	Score			Score range
	0	1	2	
i. Availability of alternative - to replace candidate, either different health technology or different ways of care being provided (e.g., frequency, route)	There is no alternative intervention or technology to replace candidate	Alternative technology is available but assessment is needed to approve its use in healthcare system (e.g., HTA)	Presence of comparable or better alternative with proven evidence	**0-2**
ii. Accessibility of care - services can be accessed at any level of provision if candidate is being disinvested - geographical health disparities (urban vs rural)	Serious concern on accessibility of treatment or care if candidate is disinvested; or presence of geographical health disparities	Some concern on accessibility of care if candidate is disinvested	No issue on accessibility at any level of care or location if candidate is disinvested	**0-2**
iii. Under-served population (e.g., intervention involves disadvantaged group, rare diseases, end-of-life care)	Presence of ethical concern involving disadvantaged group that can cause refusal to accept disinvestment decision	-	No serious ethical concern involving disadvantaged group; or mitigation strategy is available to protect the under-served group	**0-2**
Total score for domain 'Equity				**0-6**

Table 6-3: Performance matrix and score for domain 'Enablers'.

Components	Score			Score range
	1	2	3	
i. Availability of guidance - presence of local guidelines or other suitable guidelines to support change in practice	No guidelines to support change in practice if candidate is disinvested	Guidelines available from other countries, but adaptation is needed for local practice	Guidance / guideline is readily available to assist change in practice; or existing guideline needs updating	**1-3**
ii. Health technology life cycle - level of adoption or diffusion into health care - utilisation of technology / service (consumption)	Technology is just being introduced, or majority of patients still using the intervention	Technology is still in use by some proportion of patients; or utilisation of technology is reducing after adoption into system (under-use)	Technology is not being used anymore (obsolete)	**1-3**
Total score for domain 'Enablers'				**2-6**

Table 6-4: Performance matrix and score for domain 'System readiness'.

Components	Score			Score range
	0	1	2	
i. Infrastructure readiness - assesses whether the existing facilities are prepared to support the disinvestment decision. (e.g., facilities equipped with digital system to replace usage of X-ray film)	Facilities are not ready to support disinvestment decision; major upgrading is needed	Some upgrading in infrastructure is needed to support disinvestment decision	Facilities are available and ready to be utilised if candidate is disinvested	**0-2**
ii. Capacity and skills - human resources, skills upgrading or training, and clinicians' willingness to adapt to changes in practice	Change in practice requires specialised training; or difficult to explain to patients on the reason to change practice	Change in practice requires training; communicating the change in practice with patients is needed	Alternative technology is familiar to care provider and/or communicating the change in practice is feasible	**0-2**
iii. Legal implications - possibility of legal issues or public protests arising from disinvestment decisions drawing from evidence in similar settings or countries	High possibility of legal issues if candidate is disinvested	Presence of public protests from other country	Low possibility of legal issues / public protest if candidate is disinvested	**0-2**
Total score for domain 'Equity				**0-6**

6.6 Domain scoring and overall value assessment

The scores for all domains are aggregated to produce a single index score for each intervention. This should be represented on a scale that is straightforward, intuitive, and credible (145). The final score for each candidate is calculated using a simple weighted sum method by multiplying the domain scores with the weights and summing them across all criteria using the additive model (92):

$$v_j = \sum_{i=1}^{n} S_{ij} \times W_i$$

- v_j: overall value of intervention j,
- S_{ij}: score for intervention j on criterion i,
- W_i: weight attached to criterion i.

Candidates can then be ranked based on their combined scores, with the advisory panel reviewing and validating the results through discussion and deliberation. Once the agreed scores are finalised, the NMB-per-score for each candidate can be plotted on an XY-plane (example in Figure 6-2). This visualisation of the graph aids in identifying the candidates most likely to undergo disinvestment, underscoring the importance of de-implementation in the decision-making process. Should the panel find the ranking unsatisfactory, they can revisit and refine any stage of the process until they deem the results reliable and reach a consensus (145).

When evaluating the value of implementation for investment, services that offer the greatest benefits at the lowest costs logically represent the most efficient use of resources. Priority should therefore be given to these services to maximise the overall benefits for the community. However, the proposed disinvestment framework for decision-making could use NMB as a representation of the candidates' economic performance. Theoretically, disinvestment is more likely to occur for the intervention with the highest de-implementation score and lowest NMB. Within the NMB-per-score allocation rule, candidates being assessed are rank ordered based on the NMB-per-score ratio. Therefore, the candidates with the lowest ratios (i.e., those closest to the bottom-right of the graph) are considered priorities for de-implementation.

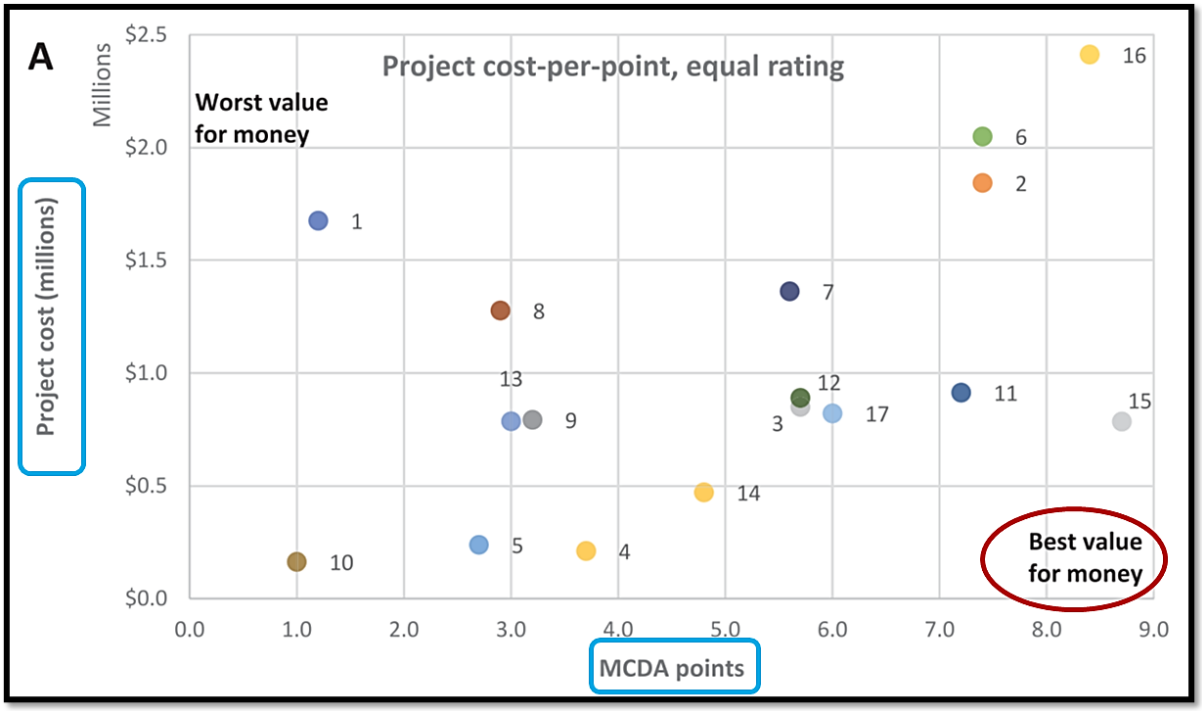


Figure 6-2: Example of MCDA cost-per-point on a cost-effectiveness plane. Circles represent the interventions being assessed. *(source: Fig. 3A in Blythe 2022 (155), permission obtained under Creative Commons Attribution 4.0 International License).*

6.7 Discussion

This chapter has demonstrated the development of an MCDA framework designed for conducting comprehensive evaluations of disinvestment candidates, tailored to specific settings and predefined objectives. The decision-making framework enables the integration and comparison of performance and healthcare outcomes using a mixed-methods approach, with the added potential of incorporating stakeholder preference-based weightings to inform policy decisions. Similar to the process of developing a methodological framework (144), the approach is divided into three phases: (a) identifying data to inform the decision-making framework, (b) developing the MCDA framework, and (c) validating, testing, and refining the decision-making framework.

We introduce the value of de-implementation to guide both the technical group and expert advisory, which comprised of health impact, economic impact, equity considerations, enablers for disinvestment and system readiness. These five domains facilitate the technical group in a structured manner to search for evidence on disinvestment candidates, and allow for fair comparison between the candidates being assessed. The framework also assists decision-makers in organising and simplifying the extensive information needed for effective and justifiable decision-making. Priority setting naturally involves managing complex and often challenging-to-interpret information, which may be used in various ways to reflect the interests of different stakeholders (145). By structuring the priority-setting process effectively, decision-makers can approach decisions with greater confidence, ensure their actions are transparent, and account for all relevant factors.

This framework not only includes information about the assessed candidates but also considers the broader impacts of decision to disinvest or de-implement LVC, through information under the domains equity and system readiness. Highlighting the challenges and barriers on implementation of an intervention is crucial, as decision-makers must understand not only the costs and benefits of a new or alternative

intervention but also the practical difficulties involved in its implementation (156). Similarly, this information is equally critical for de-implementation decisions, as disinvesting in one intervention often leads to a shift in practice toward implementing an alternative. In transitioning from LVC to higher-value care, the aim is not only to deliver care that provides greater value but also to ensure that this transition results in meaningful improvements in the quality of care while maintaining equity in healthcare delivery. It is a critical component of this process, and its inclusion as a distinct domain in our framework represents a novel contribution to the field of healthcare disinvestment research. The equity domain ensures that decisions to disinvest in LVC consider the availability of suitable alternatives, which must not be compromised to safeguard patient care. It also addresses accessibility concerns across different levels of healthcare delivery and geographical disparities in health services. This aspect is particularly important in contexts where healthcare access varies between urban and rural regions, as observed in several states in Malaysia such as Sabah and Sarawak.

Additionally, the framework incorporates stakeholder perspectives, especially regarding the potential impact on vulnerable groups. In the interview conducted, stakeholders expressed valid concerns when disinvestment decisions risk disproportionately affecting populations with limited access to healthcare. Disinvestment is already an emotive issue, and it becomes even more complex if safeguards or mitigation measures are not in place to protect these groups. Ensuring that equity considerations are embedded in the process helps build trust and provides a foundation for fair and responsible decision-making. This approach reinforces the ethical imperative to prioritise the needs of disadvantaged populations while transitioning to more effective and efficient care delivery systems.

To date, MCDA has not been explicitly applied in the context of healthcare disinvestment. Most technical analyses and decision-making processes in disinvestment rely on approaches such as HTA and PBMA. While valuable, these methods have limitations in integrating qualitative and quantitative evidence into a

single outcome for comparison—something MCDA is well-suited to achieve. However, the MCDA approach is built on a key assumption that the criteria must be mutually exclusive to avoid double counting and collectively exhaustive to ensure all relevant factors are considered (92). The construction of an appropriate model is therefore a critical task, as it must reflect the stated preferences of stakeholders while recognising that different models may or may not be applicable or generalisable to various priority-setting contexts (1). This adaptability is essential to ensure the priority-setting process remains relevant to local decision-makers and their organisational contexts. It is equally pivotal to emphasise that MCDA is a tool designed to support, not replace, decision-making. The ultimate responsibility for decisions rests with decision-makers, not the tool itself (87). Stakeholders must acknowledge that although MCDA offers a transparent and methodical framework for making informed decisions in accordance with specific priorities and values, there remains an opportunity for discussion and deliberation.

The main challenge that should be expected in assessing disinvestment opportunities lies in the difficulty of obtaining evidence on the lack of effectiveness and understanding patients' preferences. As a result, a wider range of evidence types is being utilised, extending beyond the traditional gold-standard RCTs and peer-reviewed observational studies, to include expert opinions and patient perspectives (93). This approach acknowledges the complexity of disinvestment decisions, which require diverse insights to ensure balanced and comprehensive evaluations. However, it is essential to maintain the rigour of evidence-based decision-making throughout this process. Accepting low-quality or insufficient evidence risks undermining the credibility and effectiveness of disinvestment efforts. To address these challenges, real-world data (RWD) and RWE offer significant potential, particularly in evaluating technologies across their life cycle. By providing insights into the actual performance of interventions in clinical practice, RWD and RWE can complement conventional evidence, offering a more nuanced understanding of the impact of disinvestment on healthcare outcomes, patient preferences, and system sustainability.

There are several limitations with the MCDA framework that we proposed. The criteria and domains within this framework were primarily developed based on data collected through surveys and interviews with Malaysian healthcare stakeholders, as detailed in the performance matrix. Consequently, the generalisability of this framework to other countries is uncertain. However, we believe the domains are relevant to settings with similar healthcare system with Malaysia, as the framework also incorporates insights from a literature review, which included studies from countries with established disinvestment processes. Another limitation is the potential for double-counting criteria, which can affect the results. Despite explicit attention to this issue, analysts must exercise careful attention to ensure accurate and objective application of the framework (152). Although this tool offers valuable guidance for decision-making, it does not serve as a prescriptive mandate and cannot immediately address healthcare disinvestment challenges. Its effectiveness is heavily dependent on the quality and comprehensiveness of the input data. There is a risk of misrepresentation if findings are selectively interpreted or manipulated, potentially distorting the true nature of an intervention and undermining the tool's credibility. These limitations highlight the importance of transparency, robust data, and vigilant analysis in applying this framework effectively.

This proposed framework for de-implementation represents a significant step forward but is not without its limitations. While the scope of this PhD thesis necessitated certain assumptions and practical decisions, there remains considerable potential for further development and refinement. For instance, future work in decision-making for disinvestment could explore whether incorporating methods such as Discrete Choice Experiments (DCE) might add meaningful value to the framework, particularly in capturing stakeholder preferences more robustly. Additionally, the domains within the framework could benefit from further adjustment, either by tweaking existing domains or introducing new ones based on emerging evidence or stakeholder feedback. These areas, though beyond the scope of this study, are critical for enhancing the framework's applicability and robustness in diverse contexts.

6.8 Conclusion

In conclusion, this chapter discussed the development of an MCDA framework tailored for disinvestment decision-making in healthcare. Grounded in findings from a survey and interviews with Malaysian healthcare stakeholders, alongside insights from a scoping review of the literature, the framework introduces the concept of the value of de-implementation—a novel approach for systematically evaluating the feasibility and impact of withdrawing LVC. The framework is structured around five key domains: **health impact, equity considerations, enablers for disinvestment, system readiness,** and **economic impact**. The first four domains are incorporated into the MCDA scoring system to facilitate transparent and evidence-based prioritisation of disinvestment candidates. The economic impact, while integral to the overall value assessment, is treated separately to provide a comprehensive evaluation without influencing the MCDA scoring directly. This separation ensures that economic considerations are factored into the decision-making process while maintaining the objectivity of the scoring system.

By offering a structured and adaptable tool, this framework has the potential to guide policymakers and healthcare decision-makers in navigating the complex process of disinvestment. However, its practical application and effectiveness need to be validated through pilot testing in real-world settings. Such testing will help refine the framework and confirm its suitability for broader use, particularly in healthcare systems with similar characteristics to Malaysia. Future work could explore incorporating methods like DCE to better capture stakeholder preferences and refining the framework's domains by adjusting existing ones or introducing new domain based on emerging evidence and feedback.

Chapter 7: Implementation of disinvestment initiatives in Malaysia

7.1 Foreword

This chapter begins by detailing the initial three steps of the disinvestment process: identifying and prioritising potential candidates for disinvestment, followed by assessing the impact of the identified candidates in the form of two case studies. Figure 7-1 summarises the first three steps of disinvestment process that have been used by other agencies or countries as per my findings in the previous scoping review (Chapter 2) (105).

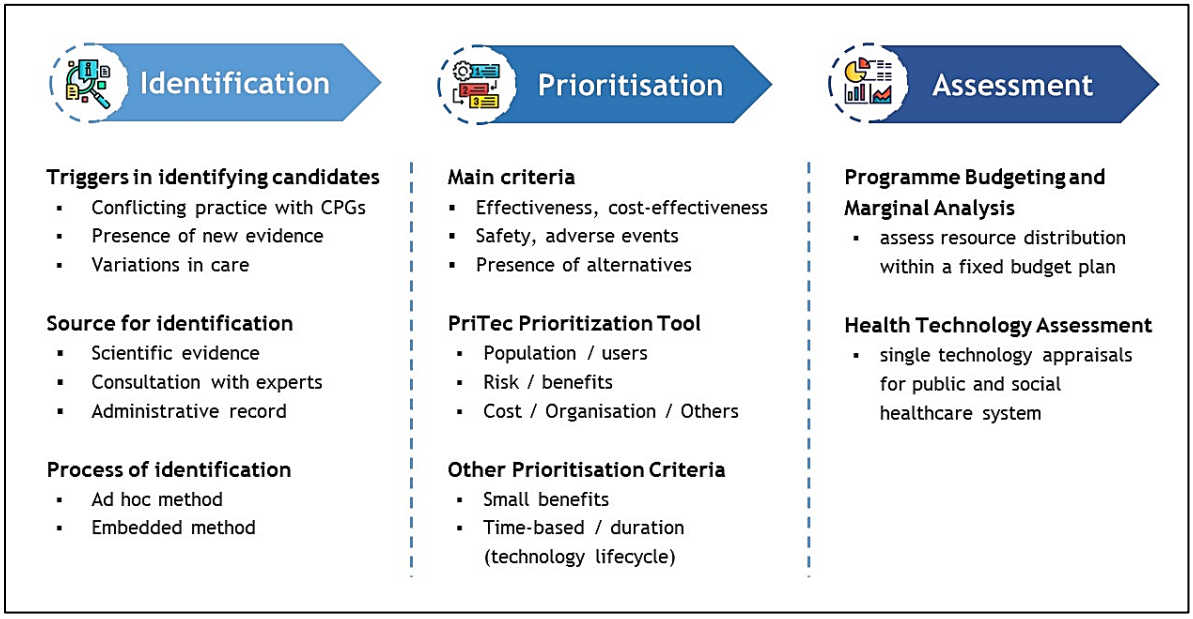


Figure 7-1: Identification, prioritisation and assessment for disinvestment (105).

Identification of candidates for disinvestment is the most important and challenging step as it deals with the way organisations manage a variety of existing technologies with questionable value, which leads to possible inefficient and inappropriate use of resources (13). To address a notable gap in research on healthcare disinvestment in LMIC, I concentrate on conducting case studies within the context of Malaysia. The case studies will offer valuable insights into addressing the distinct challenges and

barriers to implementing disinvestment initiatives in Malaysia as a continuation of previous stakeholder engagement (Chapters 4 and 5). This priority is both strategic and necessary for my research in developing recommendations that are practical and feasible for the Malaysian healthcare system.

For both case studies, I employed different triggers and sources to identify the potential candidates for disinvestment. The first case study was proposed by a clinical specialist (bottom-up), highlighted the existence of possibly obsolete medication in the Malaysian national formulary that is indicated for the treatment of advanced renal cell carcinoma. Meanwhile, the second case study was identified proactively (top-down) by assessing the recommendations from various evidence-based Clinical Practice Guidelines (CPG) available in the MOH Malaysia. These approaches to identifying disinvestment candidates are proposed in the national HTA programme for medical devices in Italy (15).

The latter section in this chapter focuses on piloting the decision-making framework developed in Chapter 6 using the two case studies. The workshop was conducted with Malaysian healthcare stakeholders in September 2024 aimed at evaluating the feasibility and acceptability of using MCDA for disinvestment. The chapter concludes by presenting the findings from the stakeholder deliberation process during the workshop and discussing the broader implications for implementing the framework.

7.2 Case study 1: Interferon-alpha-2a as systemic treatment for advanced renal cell carcinoma in Malaysia

7.2.1 Background

As front-line decision makers on the utilisation of health technologies in treating patients, clinicians form their perspectives on the safety and effectiveness of technologies based on their hands-on professional experience in real-world settings. Most of the time, they actively engage in treatment optimisation within their professional networks in response to emerging evidence, especially on safety issues and the ineffectiveness of medication (28). The delivery of LVC is influenced by both individual factors and broader systemic components, which emphasise the need for strategic efforts across different levels in the healthcare system to reduce such practices (108).

Recognising the crucial role of clinicians in informing the candidates or practice that warrants assessment for disinvestment, this case study was initiated following an early dialogue with a practicing Oncologist in one of the public hospitals in Malaysia. It was observed that the medication interferon (IFN)-alpha-2a, previously used to treat advanced renal cell carcinoma (RCC), had not been utilised in clinical practice for a considerable duration. Notwithstanding its possible obsolescence, Malaysia's national formulary continues to list and formally endorsed IFN-alpha-2a as a treatment option for advanced RCC. Highlighting the need for a more dynamic approach to reassessment of the clinically relevant cancer treatment, this case study presents a critical opportunity for healthcare disinvestment and the use of real-world evidence, especially in the context of formulary de-listing to optimise resource allocation.

This case study exemplifies a bottom-up approach to identifying LVC, entailing a clinical care provider requesting the initiation of the disinvestment process. Consequently, early engagement and proactive communication with stakeholders,

including clinicians, facilitate data-driven and evidence-based decision-making in providing high-value care for both patients and society as a whole.

7.2.2 Case study background

Kidney cancer is the sixth most common cancer in men and the tenth in women, accounting for 5% and 3% of all oncological diagnoses, respectively (157). Renal cell carcinoma is the most common type of kidney cancer with the predominant histological subtype is clear cell RCC, followed by papillary and chromophobe RCC (158). Although the highest incidence rates of RCC are found in North America as well as Northern and Eastern Europe, the incidence of kidney cancer continues to rise in many Asian countries, particularly China, Japan and India with the standardised incidence rates of 5.2 to 8 per 100,000 population (159). Based on the recent GLOBOCAN data, the estimated number of new cases in 2020 was 431,288 globally and the highest proportion is from Asia (36.3%) followed by Europe with 32.1% (160). Along with the increasing incidence, the number of deaths due to kidney cancer is also estimated to increase by 1.1% each year (161). From the projection of mortality rates, it is estimated that globally, the number of deaths will increase from 179,000 in 2020 to 301,000 in 2040 (160).

In Malaysia, the five-year database of National Cancer Registry 2012-2016 reported a 40% increase in the number of new cases of RCC in men compared to the previous report of the same duration, accounting for an incidence rate of 2.5 percent from 1.9 percent (162). The age-standardised incidence rate was highest in Indian men ethnicity with 2.2 per 100,000 population (162).

a. Available guidelines on treatment of advanced renal cell carcinoma

There are various guidelines for the treatment and management of patients with RCC available (163-166) which are critical for standardising screening, diagnosis, treatment approaches and follow-up plans to improve clinical outcomes. One of the widely used guidelines, the European Society for Medical Oncology (ESMO) guidelines for the diagnosis, treatment and follow-up of patients with RCC was published in 2019 (166) and recently, the oncology societies in Asian countries adapted the recommendations in the guidelines to suit local practices (159).

b. Systemic treatment in advanced renal cell carcinoma

While surgery is the primary treatment for local and locoregional kidney cancer, systemic therapy is required for advanced, unresectable and metastatic diseases (163, 164, 166). For the treatment of advanced and metastatic RCC, various immunotherapeutic agents have been developed, including immune checkpoint inhibitors (ICI), cytokines such as IFN-alpha and interleukin, adoptive T-cell therapies, and vaccines (158). However, immunotherapy's non-curative outcomes highlighted the need for a more effective and targeted treatment for these conditions. Subsequently, modern targeted therapies were introduced and proven to significantly improved the prognosis of patients with advanced and metastatic RCC (161, 167). Targeted therapies, among others, include tyrosine kinase inhibitors (TKI), angiogenesis inhibitors like vascular endothelial growth factor (VEGF) and its receptor (VEGFR), and mechanistic target of rapamycin (mTOR) inhibitors.

c. Treatment landscape for advanced renal cell carcinoma

Over the last three decades, the therapeutic landscape for advanced RCC has shifted dramatically from non-specific therapy with broad-acting cytokines to specific regimens, which directly target the cancer, the tumour microenvironment, or both. Prior to 2005, treatment options for advanced RCC were largely restricted to immunotherapies, particularly cytokine therapies such as IFN-alpha and interleukin-2, used as monotherapy (168, 169). These immunotherapies were the first-line treatment and represented the earliest available option for advanced RCC. However,

these treatments had numerous adverse effects and were only effective in about 12% of patients, offering partial or complete remission to a small subset of trial participants (170). As a result, progress in cancer therapy research led to the introduction of targeted therapies after 2005 in some European countries. These TKI, such as sunitinib and pazopanib, greatly improved the chances of survival for advanced and metastatic RCC patients, increasing the median length of survival and lowering the risk of death (161, 169, 171).

Further advances in newer immunotherapy combinations have largely displaced targeted therapies as first-line treatment. New combinations of an ICI and a VEGFR-TKI, such as pembrolizumab/axitinib, avelumab/axitinib, and nivolumab/ cabozantinib, became available, demonstrating significant benefit over older standard of care (163-165, 171). According to a recent Cochrane systematic review and meta-analysis, the combination of pembrolizumab/axitinib (HR 0.73, 95% confidence interval (CI) 0.50 to 1.07) and nivolumab/ipilimumab (HR 0.69, 95% CI 0.69 to 1.00) possibly reduce the risk of mortality across groups compared to sunitinib, respectively (172).

The superiority of newer treatments like VEGFR-TKI agents and mTOR inhibitors has limited the use of IFN-alpha (173). A 20-year retrospective cohort study that looked back at how systemic treatments for advanced RCC has changed over time found that overall survival did not improve during the IFN-alpha era from 2000 to 2005 (171). However, the introduction of VEGFR-TKIs led to an improvement in five-year survival rates. Specifically, the absolute five-year survival rates were 7% for patients receiving first-line IFN-alpha, 21% for those treated with VEGFR-TKIs, and 36% for those receiving ICIs (171). In the ESMO guideline, IFN-alpha is only recommended in combination with bevacizumab (166). However, this combination was excluded from the most recent adapted ESMO guidelines for Asian countries (159). Therefore, IFN-alpha may be considered an obsolete treatment for advanced RCC in view of its limited recommendation in the recent international guidelines.

d. Clinical practice on advanced renal cell carcinoma in Malaysia

There are no specific CPG on management of kidney cancer in Malaysia. The MOH Malaysia developed a standardised cancer protocol for systemic therapy in the treatment of solid tumours, encompassing chemotherapy and targeted therapies (174). This treatment protocol is designed to be used locally considering patient suitability and appropriateness for the Malaysian healthcare system.

In this protocol, systemic therapy for RCC is only considered in the setting of metastatic disease with criteria-based stratification of favourable to intermediate-risk groups of patients. The first line treatments for this condition are oral sunitinib 37.5–50 mg daily dose for 4 weeks and 2 weeks off, or oral pazopanib 800 mg daily continuously. Due to high cost and limited favourable outcomes, second-line treatment of these regimes is not recommended. The protocol also mentioned IFN-alpha as another systemic therapy, previously used either as monotherapy or in combination with other drugs at a relatively high dose (9-18 MIU 3 times per week). However, the relative benefits are very small with considerably high toxicities; hence, the eligible patients need to be carefully selected. IFN-alpha as monotherapy is no longer considered the standard treatment of choice due to its limited benefits (174).

Apart from sunitinib and pazopanib, IFN-alpha is still listed in the Malaysian Ministry of Health Medicines Formulary for the indication of advanced RCC (175). This contradicts with the guidance provided in the Systemic Therapy Protocol, as well as the most recent adapted ESMO guidelines for Pan-Asian countries, which listed the combination of axitinib + pembrolizumab as the most recommended regime for excellent, intermediate, and poor risk advanced RCC (159).

7.2.3 Aims of the case study

The aim of this case study is two-fold. First, it seeks to identify the prescribing patterns and use of systemic therapies for advanced RCC in two oncology centres in Malaysia. By reviewing this data, it can provide a clear picture of current treatment practices locally. Following this, the study explores stakeholders' perspectives on

utilising RWE in decision-making regarding disinvestment. These insights were gathered through stakeholder interviews (Chapter 5), which were conducted after obtaining the prescribing pattern data to better understand how RWE can inform decisions on delisting obsolete therapies.

7.2.4 Compliance with ethical standards

All patient data in the prescribing pattern research were de-identified following the Declaration of Helsinki and Malaysian Good Clinical Practice Guidelines (176). The study was exempted from full review by the Malaysian NMRR (NMRR-ID-22-01081-HSF [IIR]), while ethical approvals for the KIIs were granted by the Malaysian Medical Research Ethics Committee (NMRR-ID-22-02570-6PR [IIR]) and the University of Glasgow MVLS Ethics Committee (ID 200220048).

7.2.5 Methods

a. Study design and data source for prescribing pattern

This is a cross-sectional study of administrative databases, namely electronic records of prescription systems from two public hospitals with cancer services in Malaysia, the National Cancer Institute and Hospital Sultan Ismail. The Pharmacy Department of each hospital manages the electronic prescription system, and only authorised personnel with permission from the Hospital Director can access them. The prescription for these therapies comprises a detailed treatment plan to be completed by the Oncologists, specifying the indication for use, the medication name, the dosage regimen, and the quantity of packages to be administered based on the treatment duration.

b. Study population and data collection

The study includes all patients diagnosed with advanced and metastatic RCC at these two hospitals who had received any form of systemic therapy at least once. A field researcher in each hospital extracted the anonymised prescription data for adult patients (aged 18 and older) with a diagnosis of advanced or metastatic RCC from January 2015 to December 2021. Data collection was conducted from 1 June 2022 to

30 September 2022. These prescription data were reviewed and compiled in an Excel workbook (Microsoft Corporation). Additional information for analysis includes alterations in dosage, either reduced, optimised, or augmented dose, along with medication substitutions throughout the treatment course. Prescription data for paediatric patients (under 18) with RCC who received systemic therapy at the same hospitals were excluded from the study. Two field researchers, both clinical pharmacists working in the hospitals, conducted the data collection. As the primary researcher, I received the de-identified prescription data for analysis.

c. Prescription data analysis

De-identified data for users of TKI and VEGFR-TKI therapies were centrally aggregated and subjected to a quality check. Any missing information related to diagnosis or treatment dosage was verified with field researchers. Descriptive analyses, such as means, medians, and proportions, were conducted to assess prescribing patterns. The units of analysis were the number of patients, their age, and the prescriptions they received.

d. Key informant interviews

To gather stakeholders' perspectives on the use of RWE in decisions regarding the delisting of obsolete medication, prescribing pattern results were presented as a clinical vignette during KII conducted from March to May 2023. The participants were Malaysian healthcare stakeholders, and the primary goal of the interviews was to explore their perceptions on the disinvestment initiative and its implementation. Detailed methods for the KII are provided in Chapter 5, and the interview transcripts were assessed using thematic analysis with Atlas.ti software.

7.2.6 Results

a. Prescribing pattern for systemic therapy

Overall, 318 patients diagnosed with Stage IV RCC were included in the study, with 206 patients from the National Cancer Institute (NCI) and 112 from Hospital Sultan Ismail (HSI) (Table 7-1). The mean age of the cohort was 59.4 years (range 36-82),

with the majority of patients falling in the 60-69 age group (45.8%), followed by the 50-59 age group (29.8%). A total of 526 prescriptions were recorded, with 404 prescriptions issued at NCI and 122 at HSI. As shown in Figure 7-2, pazopanib was the most frequently prescribed drug, accounting for 390 prescriptions (74.1% of the total), followed by sunitinib with 108 prescriptions (20.5%). Additionally, two medications were prescribed off-label, as they were not listed in the Malaysian medicine formulary for the indication of advanced RCC. The medications, axitinib and everolimus, constituted for 5.3% of the overall prescriptions. Notably, no prescriptions for IFN-alpha were documented for the treatment of advanced RCC in either hospital during the study period (2015-2021).

Table 7-1: Demographic of study population, frequency and proportion of systemic therapy prescriptions in two hospitals for year 2015-2021.

Variables	Number	%
Total number of patients	318	100.0
National Cancer Institute (NCI)	206	64.7
Hospital Sultan Ismail (HSI)	112	35.3
Age ± SD (mean, years)	59.4	9.3 (SD)
Age category at initiation of systemic therapy (years)		
<40	13	4.0
40-49	36	11.2
50-59	95	29.8
60-69	146	45.8
≥70	29	9.2

Prescription based on types	Total (%)	NCI (%)	HSI (%)
Number of prescriptions (% from total)	526 (100.0)	404 (76.8)	122 (23.2)
Pazopanib	390 (74.1)	298 (76.4)	92 (23.6)
Sunitinib	108 (20.5)	85 (78.7)	23 (21.3)
Everolimus	21 (4.0)	21 (100)	0 (0)
Axitinib	7 (1.3)	0 (0)	7 (100)
Changes in prescription			
Pazopanib	84 (21.5)	62	22
Reduced dose	30	19	11
Augmented / optimised dose	45	34	11
Pazopanib → Sunitinib	6	6	0
Pazopanib → Everolimus	3	3	0
Sunitinib	10 (9.3)	4	6
Reduced dose	2	0	2
Augmented / optimised dose	4	0	4
Sunitinib → Pazopanib	4	4	0
Everolimus (reduced dose)	1 (4.8)	1	0

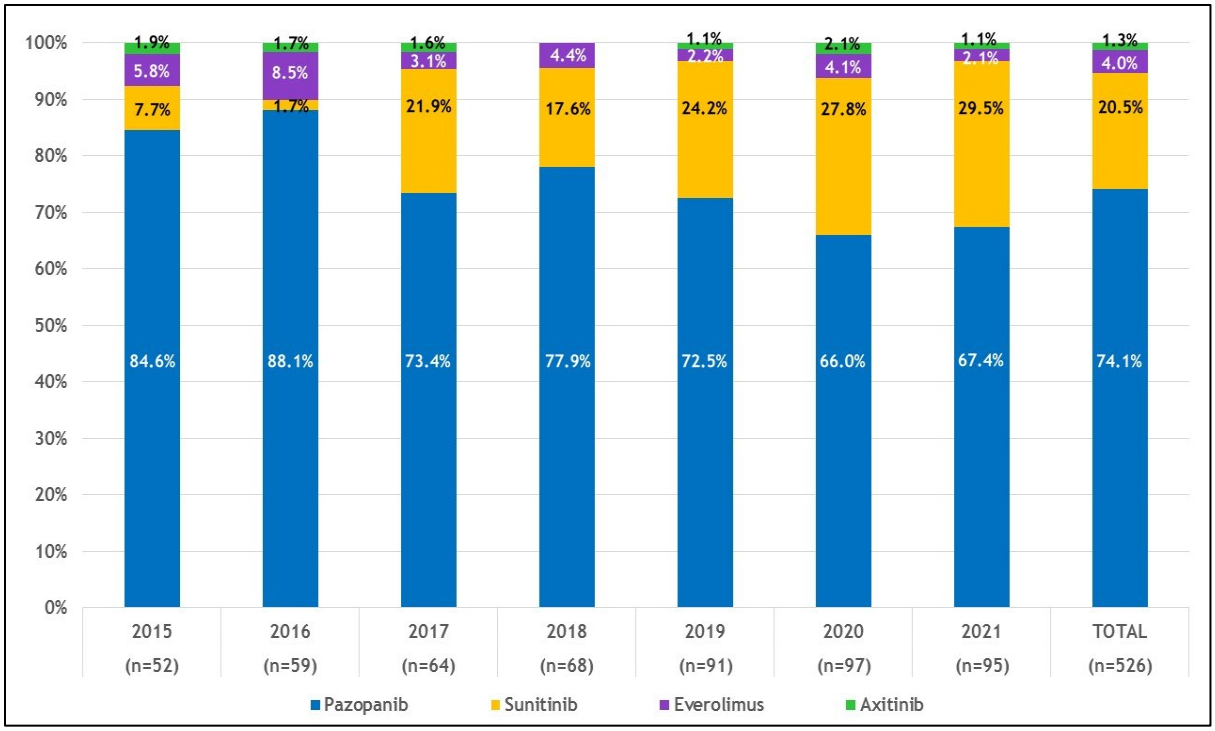


Figure 7-2: Proportion of tyrosine kinase inhibitor prescriptions for advanced renal cell carcinoma patients, by years and total for 7 years.

The majority of prescription alterations occurred among patients receiving pazopanib (21.54%), primarily due to dose augmentations for treatment optimisation. Of these prescriptions, 10% stated the reason for dose reduction was due to intolerance to side effects, with other causes unspecified. Additionally, three patients were switched from pazopanib to everolimus due to a lack of response to the initial treatment. Among patients receiving sunitinib, 9.3% of prescriptions were modified, mainly for treatment optimisation or a switch to pazopanib, although the reasons for the switch were not specified.

b. Key informant interviews on using real-world evidence for decision-making

A clinical vignette was created as one of the questions for the KII informed by the findings from the prescribing pattern study (Table 7-2). The interview question posed to the participants was: ***"In the absence of robust data, such as published***

evidence or data collected for clinical trials, would you be confident enough to use real-world evidence for delisting or disinvestment purposes?"

Table 7-2: Clinical vignette used in the key informant interviews

It was alerted by one of the Oncologists that Interferon-alpha-2a is one of the chemotherapy drugs listed in the Malaysian MOH Medicine Formulary with the indication for advanced RCC but it has not been used in clinical practice for quite some time. Other drugs that included in the formulary for the same indication are Pazopanib and Sunitinib, which are stated in the systemic protocol for cancer treatment as the first-line therapy for advanced RCC. A retrospective data in two cancer centres in the country were collected and analysed to investigate the prescribing pattern of these chemotherapy drugs in patients with advanced RCC. Using the prescription data from year 2015–2021, it was found that Interferon-alpha-2a has not being used for this indication in the two centres. Hence, it is suggested to be de-listed from national formulary for the indication of advanced RCC. From the data, Pazopanib is the most prescribed treatment for advanced RCC patients followed by Sunitinib. Apart from that, two other drugs were identified to be used off-label, namely Axitinib and Everolimus. However, the number of prescriptions for these two drugs is less than 10% of the total patients in both hospitals due to its cost and not being listed in the formulary for the specific indication.

As the characteristics of the interview participants were outlined earlier in Chapter 5, this section specifically focuses on the findings from the KII on the stakeholders' perceptions of using RWE in making judgements related to delisting of obsolete medications and disinvestment decisions. It also examines the key challenges and considerations in utilising RWE for healthcare decision-making.

c. Findings from key informant interviews

Two overarching themes emerged regarding stakeholders' attitudes toward the use of RWE. The first theme reflects scepticism, with several participants expressing doubts about the reliability of RWD, citing concerns with the way it was collected and analysed. In contrast, the second theme highlights a more optimistic view, wherein participants regard RWD as a valuable complement to existing evidence, considering it sufficient for making prompt decisions when supported by proper analysis. This demonstrates the practicality and potential of RWD to generate evidence in healthcare decision-making.

Theme 1: "Can we trust the data? I am not convinced."

i. Doubt on data integrity and credibility

Our interviews highlighted that some stakeholders expressed concerns about the trustworthiness of RWE, even when it was published in high-impact journals. They identified this as a key barrier to using such evidence in disinvestment decisions. For instance, one researcher specifically raised doubts about the robustness of data collection and monitoring processes:

> *"Even data that published in the very high impact journal might not be necessarily the holy grail. There is so much commercial interest… When we talk about real-world evidence, it comes down to how robust the data source, how stringent the process is from collection of patients [information] to data monitoring. I guess that is only one part of the puzzle." (RSCH03)*

Meanwhile, another participant, a hospital administrator, mentioned about the analysis of RWD:

> *"For me, without proper analysis, I won't rely on or trust the real-world data, actually. As we know, something like that [real-world data] is actually very low in the hierarchy of evidence-based medicine." (RSCH03)*

Although RWD can provide valuable insights such as information on prescribing patterns and utilisation of medications, making decisions without a more convincing source of evidence can still be challenging. The data will need to comply to at least some achievable minimum standard in terms of the quality, especially on the process of data collection, completeness and its analysis. These concerns are discussed below.

ii. Uncertainty on the amount and internal validity of real-world data

Another key challenge in making informed disinvestment decisions is the ambiguity of data quantity, which may hinder its effective use. In the context of disinvestment, where decisions to remove or restrict medications and services carry substantial clinical and policy implications, stakeholders are often wary of relying on inadequate or incomplete data. This uncertainty not only challenges the confidence in disinvestment outcomes but may also discourage decision-makers from undertaking such actions without robust and reliable RWD to support the justification.

> *"I would say no. Not only in this case. I think in whatever diseases, especially in rare diseases or when the drugs used are relatively new [for listing purposes]." (PRGM02)*

Another participant concurred, emphasising that robust clinical trial evidence is crucial in deciding whether a medication should be removed from the formulary. Therefore, relying just on RWE for disinvestment decision is insufficient.

> *"I find this question is very tricky to answer. Hmmm... Honestly, I would like to have robust data before I decide. I mean, for me to suggest for disinvestment of any medications. Especially if the medication is, in this case, it's a cancer treatment. So, in my opinion, I would like to gather more data, more clinical trials, more retrospective studies before I suggest this medication to be delisted or disinvested." (CLIN03)*

iii. Fear of legal implications if conflicting with clinical guidelines

Stakeholder hesitation to utilise RWD for disinvestment decisions sometimes arises from apprehensions over possible legal consequences, particularly when RWD contradicts existing evidence-based guidelines. Even with substantial RWD support, decision-makers fear that excluding medications from national formularies or benefits packages could expose healthcare providers and institutions to legal action if the CPG continues to recommend these treatments. Based on previous experience, a respondent highlighted the concern by referring to the international example:

> *"Hmm... not really (laugh). I think, even with the robust data, it's a huge challenge to remove services or drugs from the list. We must see whether it is listed in the CPG or not. I heard from our colleagues [from other country] when I went to a [international] workshop, they have been sued by the patient because they didn't provide the drug that is still listed in the CPG!" (PRGM05)*

The reluctance among stakeholders to fully endorse disinvestment is amplified by cases where patients have filed lawsuits against healthcare organisations for failing to supply medications listed in CPGs but omitted from public benefits, as conflicting evidence between RWE and CPGs may create a legal liability they are unwilling to risk. This highlights the critical importance of regularly reviewing and updating CPGs to align with new evidence, whether derived from RWE or other sources, to minimise conflicts and legal risks.

Theme 2: Complementary role of RWD in supporting adaptive decisions

i. Reversible decision with monitoring system

The respondents emphasised that decision-making can be flexible, which enables the possibility of reviewing and amending disinvestment choices when continuous monitoring of RWD is in place. Real-world evidence is considered sufficient for making judgements that are both practical and timely, especially when a thorough

monitoring system allows for further reconsiderations of those decisions over time. An optimistic perspective on using RWD was expressed, as follows:

> *"That's an easy YES for me. You know why? Because you can always revert on your decision. It's not like a fixing stone. You could use your real-world evidence and then you can still monitor it over time. And if you have a good enough monitoring system, you are able [to reassess] like in two or three years. And if it's true enough, nobody is using it, so I would be confident to de-list it. I don't think whatever decision you made is not reversible. So, in this case, it is reversible." (PRGM01)*

ii. Quantum and quality of real-world data

Overall, the interview participants emphasised the importance of improving the quality of RWD to provide more reliable and actionable insights in healthcare decision-making. Several critical areas for improvement were suggested. These included the development of surrogate endpoints to enable a more meaningful evaluation of impacts and outcomes, as well as the volume of data available, which should reflect its validity for decision-making and its generalisability for the local population.

> *"As long as you are confident in terms of the actual quality of the real-world data systems, as it were. You are collecting the data that you are supposed to collect, and it is accurate. Yeah, I'll be confident to use." (PRGM01)*

> *"It also depends on whether the sample size or the quantum of the data. Is it big enough to confer to the population? If it's big enough, I'll be more confident to use them as evidence in making decision." (PRGM04)*

There is also a need for standardised data collection methods in databases or registries to ensure consistency and comparability across outcome measures. By addressing these aspects, RWD has the potential to become a more robust basis for evidence generation, particularly in situations where properly conducted research, like RCT, is impractical due to financial constraints. In this context, RWE serves as complementary evidence and could further augment its impact on healthcare policymaking, particularly disinvestment decisions.

> *"We know that it is very expensive to do RCT, for example, to get robust evidence. But if the real-world evidence fulfils all the standard criteria, I probably will suggest that we can use those data for our decision-making… It can be part of complementary [evidence]. Even though RCT is always the gold standard, if real-world data is robust, let say the data collection is good enough, then we can use it." (RSCH01)*

iii. Making decision with precaution

Notwithstanding the issues with RWE, a participant shared experience on how challenging it was to make prompt and timely decisions as a policymaker in the situation where robust data is hardly available. In this context, safeguards are needed as a precaution that the decision is made within a limited availability of high-level evidence. To mitigate potential harm, specific safeguards should be established, and comprehensive analyses should be conducted.

> *"…I also consider other aspects where, if it's not easy to obtain robust data, decision needs to be made anyway. I wouldn't say I'm confident, but I would understand why we use other forms of information in making decision. In reality, policies need to be made… It might not be the most ideal way to come to a decision, but the least we could do is to make sure that the harm that may come from it is less evident by making sure that certain safeguards are put in, or certain levels of analysis are done." (PRGM03)*

iv. Cross-comparison with other country or region

Alongside mitigation strategies to ensure the quality and reliability of RWE, participants recommended cross-comparison between data collected in Malaysia and that from other countries, both regionally and internationally. Such comparisons could increase the acceptability of RWE among stakeholders and boost their confidence in using RWD for decision-making.

> *"Probably we'll have to do comparison of RWD across several countries or regions. More countries with examples will be better compared to if just one country." (PRGM04)*

> *"We must also analyse [real-world evidence] from other countries. Not only from one country, but a few countries. If we have the data from a few countries, and we know what the pros and cons are, then we can make decision confidently from there." (HOSP02)*

v. Real-world data as trigger for reassessment

Recognising the limitations of RWD, insights from prescribing patterns can serve as an important signal, especially when considering the disinvestment of outdated or obsolete technology. Such information may highlight low utilisation or limited clinical relevance, which can prompt decision-makers to investigate whether continued inclusion in the formulary is justified.

> *"While the results from the study involving the two sites is insufficient to disinvest from formulary, it is sufficient to trigger the policy- or decision-makers to relook at these drugs on whether to disinvest from formulary. The trigger will then go towards a national level evaluation on the need to delist the drug." (RSCH02)*

Overall, most participants with optimistic views agreed that RWD and RWE have the potential to inform healthcare decision-making in a timely and pragmatic manner, provided that appropriate safeguards are in place and data quality meets the required standards.

7.2.7 Discussion

This case study demonstrates a bottom-up approach to identifying candidates for disinvestment or reassessment in which the trigger to start reassessment was proposed by the clinical care provider. From the local clinical practice, based on real-world data of prescribing patterns in two hospitals with cancer services, it was shown that IFN-alpha-2a had not been used for treating advanced RCC. However, stakeholders are still contemplating disinvesting or delisting the medication from the national formulary list. Therefore, questions arise about the acceptable standard for evidence collected outside clinical trials and how to enhance the quality of RWD to make it relevant for decision-making. This section will cover the discussion around the bottom-up approach in identifying disinvestment candidates and using real-world evidence for disinvestment.

a. Bottom-up approach in identifying disinvestment candidates

Bottom-up approaches can markedly enhance the acceptance of recommendations, as they are advocated by the clinical community, which facilitates implementation within their own fraternity and practices (44). A prominent example is the Choosing Wisely programme, which has made remarkable progress by identifying areas of overuse through its lists and fostering comprehensive efforts to reduce overuse of LVC (49). One key strategy within Choosing Wisely initiatives is to actively involve patients and their families by providing education to enhance their understanding of the rationale behind the necessity, or lack thereof, of a specific intervention. However, these approaches lack enforced guidelines or formal resource reallocation, making their success heavily dependent on the voluntary commitment of clinicians and the cooperation of patients (177). As indicated in the responses above, clinicians prefer to

adhere to established guidance, emphasising that any changes to clinical practices or recommendations should be formally ‘endorsed’ to ensure credibility and acceptance.

Notably, sustaining these initiatives poses a challenge, as insufficient support may lead to clinicians’ disengagement. An integrated strategy that merges “light-touch” top-down policies such as capitated payment models that maintain clinician autonomy and ensure care accessibility, with concurrent bottom-up, flexible, and experimental local pilot programmes targeting various factors contributing to the use of LVC, is expected to be more appealing to stakeholders (13, 104). This approach minimises authoritative interventions from decision-makers while respecting clinicians’ professional autonomy.

Clinicians require adequate support to fully engage with and successfully execute disinvestment initiatives. Adding extra tasks to clinicians’ workloads without providing additional financial or human resources is unrealistic and could diminish their motivation (178), even though *pro bono* work is a recognised and expected part of their roles. Additionally, some healthcare personnel may perceive formal reassessment and disinvestment processes as unnecessary, believing that such practices or technologies will be phased out naturally over time, for instance, when newer techniques or more effective interventions become available. This passive strategy, however, presents significant concerns, especially on the timing and the data for such “natural” disinvestment. Procrastination in replacing or ceasing obsolete technology results in increased opportunity costs due to the continued wasteful consumption of resources. Furthermore, prolonged delays narrow the window of opportunity for timely investment in more efficient alternatives, ultimately hindering the healthcare system’s capacity to maximise value and improve patient care.

b. Using real-world evidence in decision-making for disinvestment

Real-world data can be categorised based on the types and source of data collection. Clinical data such as demographics, lab test results, care provider notes, radiology images and medication prescription are the most commonly used RWD in healthcare, among others (Figure 7-3) (179).

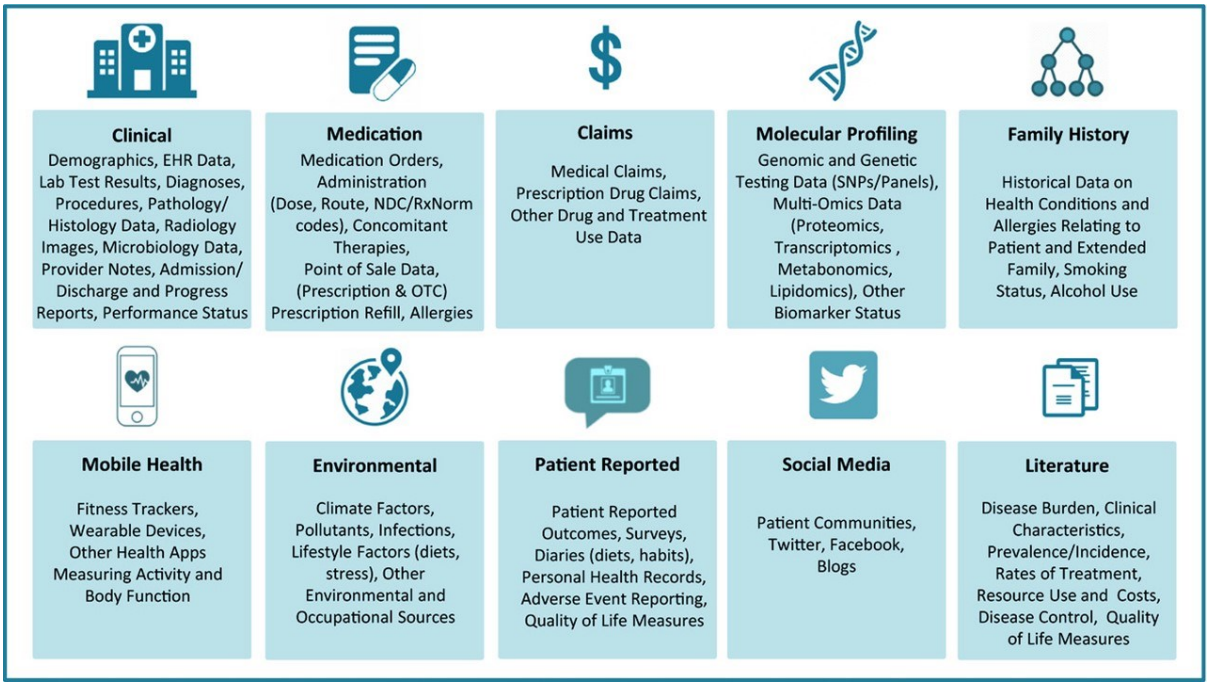


Figure 7-3: Types and source of real-world data. *(source: Fig. 1 in (179), permission obtained under Creative Commons CC-BY license)*

The NICE UK framework for RWE emphasises that the suitability of a data source depends on its characteristics relative to the research question, with each source having unique strengths and limitations (180). Combining or linking different types of RWD, such as patient demographics, medical history, health behaviours, and resource use; can enhance data quality and support broader research. Both national and international data collections are considered when making recommendations to ensure comprehensive evidence. In many circumstances, specific evidence to inform local decisions was not always available. To avoid decision-making paralysis in such situations, policymakers often turn to pragmatic data sources, such as administrative

records and service utilisation data, to develop actionable solutions (98). It provides insights into the efficacy and safety of therapies pragmatically, complementing traditional RCTs.

The inclusion of RWE in Malaysian decision-making has become increasingly evident, highlighting the need to generate RWE to inform the implementation of policy recommendations. In recent years, there has been an increasing recognition of the significance of RWE in facilitating HTA (181). Addressing the recognised limitations of RWE is essential to fully leveraging its potential and enhancing its impact on HTA. However, significant methodological challenges remain, and these must be resolved to fully realise its value. The application of RWE in disinvestment decisions presents unique challenges due to the complexity of healthcare systems and the potential consequences of removing the interventions from the services package that has been offered to the patients. These challenges are illustrated by Liu and Panagiotakos (2022), highlighting numerous opportunities for improvement and the need for greater efforts to fully harness the potential of RWD (Figure 7-4) (182). They are interconnected rather than isolated, for instance, data quality directly influences the performance of statistical and machine learning techniques. Meanwhile the selection of data sources, along with the cleaning and pre-processing steps, affects the reproducibility and replicability of results. Additionally, how information is shared and disseminated has implications for data privacy, as well as the explainability and interpretability of RWE (182).

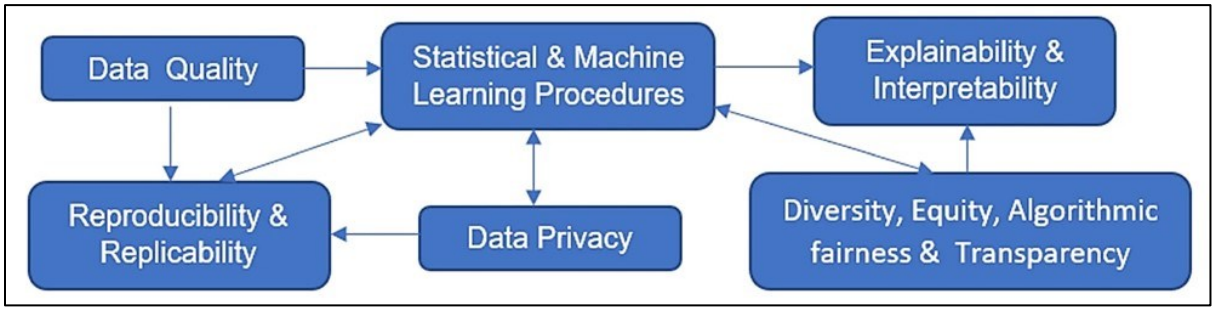


Figure 7-4: Challenges in real-world data and their relations. *(source: Fig. 2 in (182), permission obtained under Creative Commons CC-BY license.)*

7.2.8 Reflections from the case study

We included only two hospitals with a total of 318 patients in our analysis, which may not fully represent the situation across the entire country whereby 2,886 patients diagnosed with kidney cancer across all stages between 2017 and 2021 *(National Cancer Registry Department, pers. commun., 3rd January 2025)*. However, expanding the study to include more hospitals was not feasible due to time limitations, challenges in recruiting field researchers, and restricted access to data sources caused by privacy concerns (183). In addition, some hospitals are still using manual records for handling prescriptions; hence, there is the possibility of incomplete data entry in the medication prescription record. The participants have highlighted the need for standardised data collection methods within databases and registries to ensure consistency and comparability across outcome measures. By addressing these aspects, RWD can potentially become a more robust foundation for evidence generation, hence strengthening its role in guiding healthcare policy, including disinvestment decisions.

While the volume of data on the prescribing patterns may appear insufficient to justify delisting IFN-alpha-2a from the national formulary, it holds significant value for the purposes of this research. It provides critical insights into the key considerations and prerequisites for building confidence in disinvestment decisions. Smaller studies like this can serve as essential triggers for further data collection, driving the development of a more robust evidence base. Moreover, this data was not gathered with the immediate expectation of informing a decision but rather to deepen understanding of how RWD can support evidence-based decision-making in disinvestment processes.

During the KII, it became evident that some participants were unfamiliar with the concepts of RWD and RWE. Misunderstandings were common, with some believing that patient testimonials, public opinions, and expert viewpoints from healthcare professionals also constituted RWE. The lack of clarity about what qualifies as RWD or

RWE may contribute to hesitancy in accepting the disinvestment process. This observation highlights the critical need for education and knowledge transfer, underscoring the importance of equipping stakeholders with the necessary understanding to make informed decisions. For disinvestment initiatives to succeed, it is essential to ensure that stakeholders are well-prepared to navigate such decisions in real-world scenarios.

7.2.9 Conclusion

In this case study, which focuses on the use of IFN-alpha-2a for treating advanced RCC, the prescribing patterns of clinicians play a crucial role in determining the real-world practice of systemic therapy in Malaysia. This information is crucial not only for reassessing the least used drugs, likely due to their low value or tolerability, but also for identifying potentially higher-value treatment options that could potentially be listed in the national formulary or updated in the available clinical protocol. By utilising RWD obtained from prescription records and administrative data, healthcare decision-makers can make informed choices about whether to delist treatments that are no longer being used or offer benefits to the patients. Using RWE in disinvestment decisions has the potential to improve the efficiency of healthcare services, provided that the monitoring and evaluation systems are in place to amend the decisions, if necessary. However, it is essential to approach this process with caution, considering the limitations of RWD/RWE and engaging with stakeholders to ensure that decisions are informed, equitable, and aligned with the needs of patients.

7.3 Case study 2: Colorectal cancer screening programme in Malaysia

7.3.1 Background

Clinical Practice Guidelines are systematically developed statements with recommendations that assist healthcare practitioners in making informed decisions on the management for specific clinical conditions. Over time, these guidelines have proven to be essential in improving the quality of care and standardising treatment across various healthcare settings (184). Nevertheless, not all recommendations within CPGs consistently reflect the latest evidence of best practices or optimal use of resources, leading to the persistence of LVC which refers to interventions that provide little or no benefit, incur unnecessary costs, or even cause harm to the patient (185). Identifying such low-value practices within evidence-based CPGs is one of the suggested disinvestment or de-implementation processes (13, 34, 186). Reviewing the position statement and recommendations in the CPGs allows for further evaluation of any practice that conflicts or is inconsistent with the guideline recommendations (185).

In the Malaysian healthcare system, CPGs are predominantly developed by the MaHTAS, the Oral Health Division of the MOH and professional societies affiliated with the Academy of Medicine (187). The development of the CPG by MaHTAS is guided by globally recognised quality criteria outlined in the Appraisal of Guidelines, Research and Evaluation (AGREE II) instrument (188), ensuring adherence to international standards while considering local context and practices. The guideline development groups and review committee must incorporate relevant and multidisciplinary stakeholders to ensure the representation of all expertise groups, the identification and resolution of practical issues in CPG use, and the enhancement of shared responsibility and ownership in CPG implementation (187). Ideally, follow-up monitoring of the implementation of CPG recommendations should be conducted to assess the impact of these recommendations on changing the practice and improving the quality of healthcare.

This chapter explores the use of the Malaysian evidence-based CPGs as a primary source for identifying low-value care by reviewing the recommendations, followed by further analysis of the potential candidate for de-implementation or disinvestment. This could also provide a value-based assessment for improvement in practices when updating the CPG in the future.

7.3.2 Selection of CPGs for identification of recommendations

The list of published Malaysian CPGs was accessed from the MOH website (https://www.moh.gov.my/index.php/pages/view/3962?mid=1570), and forty-four guidelines across seventeen categories published from 2015 to 2021 were screened to assess suitability. I selected fifteen CPGs on conditions with a high disease burden in Malaysia as prospective candidates for review and proceeded to look for 'do-not-do' recommendations which advise against providing certain types of care or services in these CPGs. Additionally, any key statements or recommendations in the CPGs that may need to be re-evaluated due to contradicting current practice or the presence of recent international guidelines with updated evidence were also identified. Table 7-3 displays the title of the CPGs that were finalised for the purpose of identifying recommendations and key statements.

Table 7-3: List of Malaysian Clinical Practice Guidelines reviewed for 'do-not-do' recommendations and key statements for de-implementation.

No	Title of Clinical Practice Guidelines	Published year
1.	Management of Neonatal Jaundice	2015
2.	Management of Dengue Infection in Adults (Third Edition)	2015
3.	Management of Colorectal Carcinoma	2017
4.	Management of Diabetes in Pregnancy	2017
5.	Management of Atopic Eczema	2018
6.	Management of Chronic Kidney Disease (Second Edition)	2018
7.	Management of Hypertension (Fifth Edition)	2018
8.	Management of Acute ST Segment Elevation Myocardial Infarction (Fourth Edition)	2019
9.	Management of Breast Cancer	2019
10.	Management of Major Depressive Disorder (Second Edition)	2019
11.	Management of Rheumatoid Arthritis	2019
12.	Management of Type 2 Diabetes Mellitus (Sixth Edition)	2020
13.	Management of Ischaemic Stroke (Third Edition)	2020
14.	Management of Dengue in Children (Second Edition)	2020
15.	Management of Tuberculosis (Fourth Edition)	2021

From screening the CPGs, a total of seventeen 'do-not-do' recommendations were identified from nine CPGs as listed in Table 7-4. There are several key messages that mimicked 'do-not-do' statements, but since the statements are not supported with scientific evidence and/or mainly related to traditional and complementary medicine practices in Malaysia, I did not include them in the list.

Table 7-4: 'Do-not-do' recommendations identified from 15 Malaysian Clinical Practice Guidelines

CPG titles (year)	Recommendation and key statements
Management of Dengue Infection in Adults (2015)	1. Dengue patients with mild bleeding do not require blood transfusion.
	2. There is no role for routine prophylactic transfusion with platelets and plasma in dengue infection.
Management of Diabetes in Pregnancy (2017)	3. Vitamin C and E supplementation should not be given to prevent pre-eclampsia in women with diabetes.
Management of Atopic Eczema (2018)	4. Serum immunoglobulin E levels, skin prick test, patch test and skin biopsy, should not be used as diagnostic tools for atopic eczema.
Management of Chronic Kidney Disease [Second Edition] (2018)	5. Serum creatinine should not be used alone in the assessment of renal function.
	6. Aspirin should not be used as primary prevention of cardiovascular disease in chronic kidney disease.
Management of Acute ST Segment Elevation Myocardial Infarction [Fourth Edition)] (2019)	7. *Facilitated percutaneous intervention (PCI) is not recommended as it was associated with increased mortality and major bleeding. **a strategy of planned immediate PCI (<1 hour) after an initial pharmacologic regimen consisting of a reduced dose of a fibrinolytic agent, glycoprotein (GP) IIb/IIIa inhibitor or a combination of these agents*
Management of Breast Cancer (2019)	8. For patients with early breast cancer and asymptomatic, routine imaging screening for metastasis should not be performed.
	9. The use of PET or PET/CT scanning is not indicated in the staging of clinical stage I, II or operable III (T3N1) breast cancer. The recommendation against the use of PET scanning is supported by: • high false-negative rate in the detection of small lesions (<1 cm) and/or low grade • low sensitivity for detection of axillary nodal metastases • low prior probability of having detectable metastatic disease • high rate of false-positive scans

CPG titles (year)	Recommendation and key statements
Management of Ischaemic Stroke [Third Edition] (2020)	10. Aspirin therapy is not recommended for primary prevention of stroke in the elderly, diabetics, or other high-risk groups.
	11. After a cardioembolic stroke, parenteral anticoagulant therapy (heparin or low molecular weight heparin) is not recommended to prevent secondary stroke.
	12. In ischaemic stroke, elastic compression stocking should not be used.
	13. Routine shunting (without other surgical treatment) in patients with acute central venous thrombosis and impending brain herniation due to parenchymal lesions is not recommended to prevent death.
	14. Steroids in patients with acute central venous thrombosis without any co-existing inflammatory disease are not recommended to prevent death or to improve the functional outcome.
	15. Lateral flow urine lipoarabinomannan assay should not be used for the diagnosis of pulmonary tuberculosis in HIV-negative adults.
Management of Dengue in Children [Second Edition] (2020)	16. Do not prescribe acetylsalicylic acid (aspirin), ibuprofen or other non-steroidal anti-inflammatory agents or intramuscular injections, as these aggravate gastritis or bleeding.
Management of Tuberculosis [Fourth Edition] (2021)	17. Interferon gamma release assay (IGRA) cannot distinguish between LTBI and active TB. Thus, it should not be used to diagnose active TB.

7.3.3 Prioritisation

Table 7-5 lists four CPG recommendations and key statements identified from the review as potential technologies for disinvestment assessment. In prioritising which technology is suitable for further assessment, I reviewed the accompanying references to identify the evidence cited to support each recommendation. In addition, I verified with the relevant local databases or registries for the specific disease conditions, if available, along with publicly accessible national formulary listing, government documents on national strategic planning and policy reports pertaining to healthcare in Malaysia. For comparison, I searched international CPGs including the NICE guidelines and Scottish Intercollegiate Guidelines Network (SIGN), as well as recent publications on the topic to identify any new evidence that might justify a modification in clinical practice recommendations. Where applicable, I sought advice from Malaysian clinical specialists in the related area to gather their insights on local practices and detect any discrepancies between the CPG recommendations and the actual implementation in real-world settings.

In finalising the potential technologies for disinvestment assessment, I consulted my supervisors before deciding on the most suitable candidates for disinvestment evaluation. Collectively, we thoroughly examined and assessed each of the recommendations and key statements, taking into account the consequences and significance of each technology in relation to the case study. Through this deliberative approach, we critically assessed the strengths and limitations of each suggestion to ensure that the final selection was both robust and aligned with the overall objectives of the research. The reasons for not proceeding with further assessments of the other suggestions are outlined in Table 7-5.

Table 7-5: Recommendations and key statements from Malaysian Clinical Practice Guidelines (CPGs) as potential candidates for disinvestment evaluation.

Recommendations / key statements (Name of CPG & year)	Remarks
1. Screening of colorectal carcinoma (CRC) should be offered at age of 50 years and continues until age 75 years for average-risk population. If immunofaecal occult blood test (iFOBT) is negative, yearly test should be performed. *(Management of Colorectal Cancer, 2017)* (189)	• At public health clinics and private healthcare facilities, opportunistic screening for colorectal cancer is conducted every two years using iFOBT, with the condition that the test results are negative (190, 191). • There is a discrepancy between the recommendations in the CPG and the actual implementation in clinical practice. • **Conclusion: for further assessment.**
2. Mechanical bowel preparation: • should be performed in rectal carcinoma surgery. • may be performed in colon carcinoma surgery. *(Management of Colorectal Cancer, 2017)* (189)	• A Cochrane review that was included in the CPG concluded that there was no difference in post-operative complications between mechanical bowel preparation and no bowel preparation (192). • However, the expert members of the CPG agreed that bowel preparation resulted in lesser morbidity (based on consensus). Therefore, it was still recommended. • A recent systematic review and meta-analysis published in 2024 concurs with the previous Cochrane review and suggested to exclude mechanical bowel preparation from clinical practice (193). • Based on our discussion, a rigorous randomised controlled trial within Malaysia is needed to genuinely persuade the surgeons to change practice. • The cost of continuing to practise mechanical bowel preparation may not be too high and does not have a substantial impact on the allocation of resources. • **Conclusion: not suitable for assessment as case study.**

Recommendations / key statements (Name of CPG & year)	Remarks
3. Postpartum metformin therapy should be considered to prevent newly diagnosed diabetes in women with history of gestational diabetes mellitus (GDM). *(Management of Diabetes in Pregnancy, 2017)* (194)	• According to Ratner et al. (2008), starting metformin after birth in women with a history of GDM reduced the risk of diabetes mellitus by 50.4% (195). • A study published in 2016 showed that short-term metformin therapy does not affect weight, HbA1c or blood glucose values postpartum compared with insulin or diet-only treatments. Hence, women with GDM requiring no medication are least likely to develop impaired glucose tolerance or diabetes postpartum (196). • CPGs by NICE (197) and South Australia (198) did not recommend metformin therapy after birth as preventive measures from developing diabetes mellitus, while another guideline by the Qatar Ministry of Public Health suggested a conditional prescription of metformin, only if the patient is on medication during the antenatal period (199). • **Conclusion: consultation with clinicians is required (further elaboration in sub-section *7.3.10 Identifying disinvestment candidates through CPG*)**

7.3.4 Case study background

Prior to 2014, Malaysia did not have a nationwide screening programme for colorectal cancer (CRC), despite its high prevalence in the country (200). The first initiative to implement formal CRC screening programme started in 2011 whereby an HTA project was conducted by MaHTAS to evaluate the effectiveness and safety of immunofaecal occult blood test (iFOBT) as a screening modality for CRC following a proposed strategy in the National Cancer Control Blueprint 2008-2015 (201, 202). Based on the HTA recommendation, the iFOBT technique can be utilised in Malaysia as a screening test for CRC, and implementing a screening programme using this approach is beneficial in preventing advanced CRC and reducing mortality (203). However, a local economic assessment was not carried out at that time due to a lack of health economic experts in MaHTAS and Malaysia, in general.

Following the findings in a pilot study in 2013, nationwide implementation of CRC screening took place in 2014 as an opportunistic screening programme in a selected health clinics in Malaysia. This involved procuring iFOBT kits through a central national tender and distributing them to participating MOH health clinics (190). At these clinics, patients who met the initial selection criteria (average-risk, asymptomatic individuals aged 50 to 75 years) were invited for the screening test. The stool samples were sent for processing and the results will be informed to the patients within a timeframe of 1-2 weeks. In the event of a positive test result, the patient will be referred to a nearby hospital for colonoscopy, which will serve as a means of conducting a more thorough investigation and administering appropriate treatment. If the result is negative, the patient is recommended to have iFOBT testing every two years (190). The detailed patient pathway for opportunistic CRC screening using iFOBT is depicted in Figure 7-5.

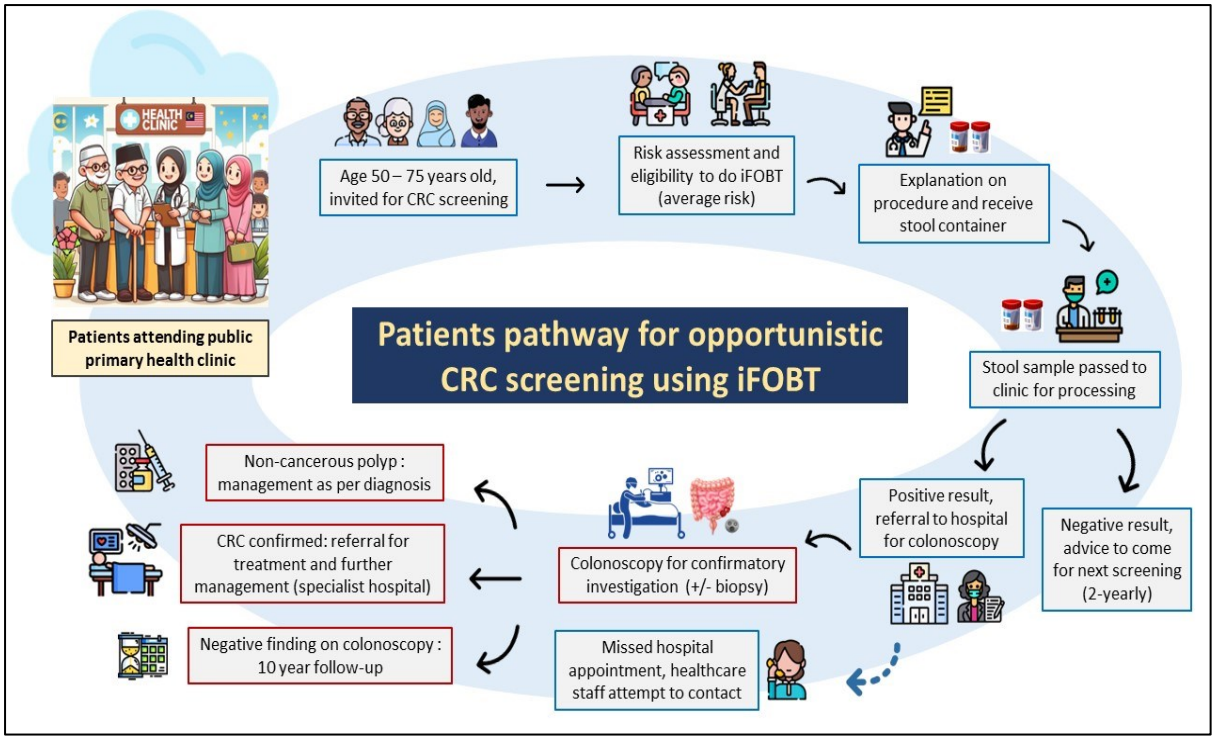


Figure 7-5: Clinical pathway for opportunistic colorectal cancer screening using immunofaecal occult blood test (iFOBT) in Malaysia

In 2016, a technology review (known as mini-HTA) with local economic and financial implications was conducted by MaHTAS to look into the cost-effectiveness of screening an asymptomatic population aged 50 to 65 years old for colorectal cancer using colonoscopy (204). This assessment was part of the efforts to strengthen and progressively expand the CRC screening services to all health clinics in Malaysia as outlined in the National Strategic Plan for Cancer Control Programme 2016-2020 (205). Two screening strategies were evaluated, namely i) primary screening with colonoscopy and ii) primary screening with iFOBT, followed by colonoscopy if iFOBT is positive (iFOBT+colonoscopy). The comparator was no screening programme. Using the decision-tree model, the assessments found that the combination of iFOBT+colonoscopy dominated colonoscopy by having a lower cost with a higher QALY. The estimated ICER of iFOBT+colonoscopy compared with no screening strategy at all was approximately MYR 9,400 (around GBP 1,650) per QALY gained. Using the age group of 50 to 65 years old as the target for population-based screening (around 3 million people), the resulted financial implications were estimated to be MYR 1 billion (GBP 175 million) for annual iFOBT and MYR 1.1 billion (GBP 193 million) for biennial iFOBT (204). Based on this

report, the CPG on Management of Colorectal Carcinoma that was published in 2017 recommended that screening of CRC should be offered at the age of 50 years and continues until age 75 years for average-risk population. The preferred screening modality is iFOBT, and if it is positive, colonoscopy is necessary. If iFOBT is negative, a yearly test should be performed (189).

However, on a national scale, the implementation of the CRC screening programme remains focused on opportunistic screening for individuals aged 50 to 75 with two-yearly iFOBT as outlined in the recent National Strategic Plan for Cancer Control Programme 2021-2025 (191). Hence, there is a discrepancy between the recommendation provided in the CPG and the actual implementation in clinical practice and national strategic policy. As no explanation was provided for why the implementation is contradicting the recommendations from both the CPG and the HTA, I inferred that the concern lies in the financial impact resulting from resource constraints and insufficient budget allocation for CRC screening.

To provide a broader perspective on how other countries implemented CRC screening programme, recommendations from international clinical guidelines were reviewed and summarised in Table 7-6. By analysing CRC screening strategies and guidelines from other countries, I seek to uncover not only which screening interval should be de-implemented but also guidance to enhance a more effective implementation strategy in Malaysia. From the review, four guidelines produced by the NICE, SIGN, Cancer Care Ontario, and Cancer Council Australia recommended for the screening using iFOBT to be repeated every 2 years for adults aged 50 to 74 years. Meanwhile, two guidelines by the US Preventive Services Task Force Recommendation Statement and the American Cancer Society recommended annual iFOBT among adults aged 50 years to 75 years or older.

In addition, an updated economic evaluation of the UK Bowel Cancer Screening Programme (UK-BCSP) using an existing School of Health and Related Research (ScHARR) state-transition bowel cancer screening model was published in 2022 with the aim to assist the UK National Screening Committee in determining how faecal immunochemical testing (FIT) could best be implemented while considering

constraints on endoscopy capacity (206). From the analysis, it was suggested that the UK-BCSP should maintain a two-yearly FIT screening interval for those between the ages of 50 and 74. As the endoscopy capacity increases, it is recommended to first to reduce the starting age for screening and thereafter adjusting the FIT threshold. These guidance can be applied to other CRC screening programmes facing comparable constraints in endoscopic resources (206).

Table 7-6: Recommendations from international guidelines on colorectal cancer screening using iFOBT or faecal immunochemical test (FIT).

Guidelines title	Country | Organisation	Year	Recommendation / statement	Screening interval
Bowel Screening Standards (from Clinical Practice Guidelines for Diagnosis and management of colorectal cancer)	Scotland | Scottish Intercollegiate Guidelines Network (SIGN)	2016	Everyone with a Community Health Index (CHI) number aged 50-74 years, is invited **every two years** to complete a home bowel screening test (also known as faecal immunochemical test).	Two-yearly
Colorectal Cancer Screening in Average Risk Populations: Evidence Summary	Canada | Cancer Care Ontario	2015 *(updated in January 2022)*	Average-risk individuals initiate screening with faecal immunochemical test (FIT) beginning at 50 years of age and ending at age 74. The test should be **repeated every 2 years**.	Two-yearly
Clinical Practice Guidelines for the Prevention, Early Detection and Management of Colorectal Cancer	Australia | Cancer Council Australia	2023	The recommended strategy for population screening in Australia, directed at those at average risk of colorectal cancer and without relevant symptoms, is immunochemical faecal occult blood testing **every 2 years**, starting at age 50 years and continuing to age 74 years.	Two-yearly

Guidelines title	Country | Organisation	Year	Recommendation / statement	Screening interval
Quantitative faecal immunochemical testing to guide colorectal cancer pathway referral in primary care (Diagnostic guidance, DG56) and UK Bowel Cancer Screening	United Kingdom | National Institute for Health and Care Excellence (NICE) and National Health Service (NHS)	2023	Quantitative faecal immunochemical testing (FIT) is recommended to guide referral for suspected colorectal cancer in adults, available to everyone aged 60 to 74 years. The programme is expanding to make it available to everyone aged 50 to 59 years. If negative, individual will be invited to do another screening test in **2 years** (if still be under 75 by then).	Two-yearly
Screening for Colorectal Cancer (Recommendation Statement)	United State of America | US Preventive Services Task Force	2021	The USPSTF recommends screening for CRC in all adults aged 50 to 75 years. Recommended screening strategies include high-sensitivity guaiac fecal occult blood test (HSgFOBT) or fecal immunochemical test (FIT) **every year.** *(Other modalities are also available.)*	Annually
Colorectal cancer screening for average-risk adults: guideline update from the American Cancer Society	United State of America | American Cancer Society	2018	The recommendation for regular screening in adults aged 50 years and older is a strong recommendation. Screening using FIT or guaiac-based faecal occult blood test **annually.**	Annually

7.3.5 Aims of the case study

This case study aims to evaluate the financial implications and the benefits of implementing the current practice of a biennial iFOBT compared to an annual iFOBT approach as indicated in the Malaysian CPG on the Management of Colorectal Cancer. The findings from this analysis will provide evidence-based information for the Malaysian healthcare stakeholders, enabling them to make informed decisions on the de-implementation of contradicting strategies for CRC screening using iFOBT. This is necessary to reduce the variation in clinical practice.

7.3.6 Methods

a. Study design and interventions

For this study using Microsoft Excel, I performed cost consequence analysis (CCA) and budget impact analysis (BIA) of opportunistic CRC screening programme using iFOBT for average-risk individuals aged 50 to 75 years with baseline mid-year population of 2023. The analyses were conducted for both two-yearly iFOBT (Strategy 1, current implementation) and annual screening using iFOBT (Strategy 2, recommendation in CPG). First, I estimate the population in each strategy at various stages of the screening pathways. Next, using the estimated population, I calculate the five-year costs and clinical outcomes for each strategy based on the data obtained from various sources. Finally, the five-year economic outcomes for both strategies are derived and compared to assess their relative outcomes and total costs.

b. Description of clinical pathway for opportunistic CRC screening

The clinical pathway for Strategy 1 (two-yearly iFOBT) is illustrated in Figure 7-5 previously. The difference between Strategy 1 and Strategy 2 is on the interval of repeat screening with iFOBT if the previous test is negative. In Strategy 2, the participant is counselled to attend the next screening in the subsequent year. Otherwise, the components in the care pathway are similar for both strategies.

c. Perspective and time horizon

The financial impact analysis was conducted over a period of 5 years from the perspectives of healthcare provider (the Ministry of Health Malaysia) and

participants or patients (travelling cost and time-off to attend screening programme, including colonoscopy).

d. Currency, price date and conversion

All unit costs were presented in local currency – the Malaysian Ringgit (MYR) and adjusted to financial year 2023 using Malaysia consumer price indexes. Malaysian Ringgit was also converted into British Pound Sterling (GBP) using the exchange rate for 2023 (GBP 1 = MYR 5.85), only in the result section.

e. Data sources for opportunistic CRC screening using iFOBT

The data about the population of Malaysia, both in total and broken down by age groups, was acquired from the Department of Statistics Malaysia (207). The projected population for the year 2023 was documented as 34,671,895, with 6,240,941 individuals falling between the age range of 50-75 years, accounting for 18% of the overall population (207). According to WorldData.info on population growth by country, the growth rate of the Malaysian population is estimated to be 1.2% annually (208).

Table 7-7 summarises the input parameters in estimating the population at each stage of the patient pathways for both strategies. Most of the parameters were obtained from 5-year evaluation study by Tamin et al. (2020), which examined the results of a government-led initiative on the use of iFOBT for CRC screening in public health clinics in Malaysia (190). It was reported that the screening uptake is constantly increase over the years, from 0.23% in 2014 to 0.68% in 2018 ($p<0.01$). Based on the estimation, it is assumed that in 2023, 0.87% of the eligible population agreed for CRC screening when they attended health clinics for other health conditions; and 9.21% of this proportion of tested participants would receive a positive iFOBT result. Only 55.9% of patients who had positive iFOBT availed for colonoscopy. Among those who underwent colonoscopy, CRC was detected in 4.04% of cases and 13.93% was found to have non-cancerous polyps, hence do not require subsequent iFOBT and will be managed and treated accordingly. For those diagnosed with CRC, 82.1% of the patients received treatment according to standard practice in the CPG (209).

In Strategy 2, it is assumed that if the initial iFOBT test results are negative, 43.5% of the average-risk population will opt out of the next screening schedule based on the reported preference by study participants for not to have an annual screening test (210). Hence, the population agreeing for a yearly iFOBT screening from Year 2 to 5 is estimated using the formula:

> ***Population (Year 2 to Year 5)*** *= 0.87% from target population + (56.5% from participants with negative iFOBT screening in previous year)*

f. Resources and cost input for financial impact estimation

The resources and unit costs for the analysis were derived from a published budget impact analysis by Ngan et al. (2020) in proposing a home-based iFOBT as an alternative screening strategy in Malaysia to the currently implemented opportunistic iFOBT screening in public health clinics (211). The total cost and resources for the healthcare provider comprised of:

i. the cost of providing iFOBT
ii. the cost of conveying a definitive diagnosis to positive iFOBT participants (along with explaining treatment plan or referral)
iii. the cost of following up positive iFOBT participants who missed/refused colonoscopy (after referral)
iv. colonoscopy cost (including polyps removal and/or biopsy if needed)
v. the cost of treatments for CRC

The total cost and resources for the participants / patients comprised of the costs for travelling to the health clinic or hospital, and the average loss of productivity due to time taken for screening activity (including undergoing colonoscopy). Treatment costs from patient's perspective is excluded because the standard treatment for CRC in Malaysia is covered by the MOH.

Table 7-8 outlines the resources and unit cost for healthcare providers and participants / patients for the opportunistic CRC screening programme.

Table 7-7: Input parameters used to estimate the population at each stage of the patient pathways for two-yearly and annual iFOBT in opportunistic colorectal cancer (CRC) screening.

Stage in pathway	Input value	Lower range	Upper range	Source
Total population (all ages) – baseline year 2023	34,671,895	-	-	DOSM 2023 (207)
Target population (aged 50-75) – annually	18%			DOSM 2023 (207)
Availed of / agreed for CRC screening (2023)	0.87%	0.70%	1.04%	Tamin 2020 (190)*
Receive iFOBT positive result	9.21%	7.37%	11.05%	Tamin 2020 (190)*
Agree for colonoscopy after positive iFOBT	55.09%	45.39%	59.70%	Tamin 2020 (190)
CRC detection after colonoscopy investigation	4.04%	3.23%	4.85%	Tamin 2020 (190)*
Polyp detection (non-cancerous) after colonoscopy	13.93%	-	-	Tamin 2020 (190)
Drop-out on next screening *(in annual strategy)*	43.50%	34.80%	52.20%	Bujang 2021 (210)
Patients with CRC receiving treatment	82.10%	65.68%	98.52%	Muhamad 2023 (209)*

** The lower and upper ranges were estimated from the data source by reducing and increasing 20% (+/-20%) from the reported values*

CRC = colorectal cancer; DOSM = Department of Statistics Malaysia; iFOBT = immunofaecal occult blood test

Table 7-8: Resources and unit cost for healthcare providers and participants for the opportunistic CRC screening programme using iFOBT.

Resources and unit cost	Price / cost	Lower range	Upper range	Source
Healthcare provider				
Performing screening (asking for symptoms, family history, referral) and taking sample	MYR5.58	MYR4.46	MYR6.70	Ngan 2023 (211)*
Processing stool specimens	MYR1.70	MYR1.36	MYR2.04	Ngan 2023 (211)*
Consumables – stool container, gloves, mask, etc.	MYR11.51	MYR9.21	MYR13.81	Ngan 2023 (211)*
Interpreting the test results	MYR2.79	MYR2.23	MYR3.35	Ngan 2023 (211)*
Provider cost of perfoming CRC screening with iFOBT (at public health clinics)	**MYR63.58**	**MYR50.86**	**MYR76.30**	Ngan 2023 (211)*
Conveying a definitive diagnosis to patients (along with explaining treatment plan or referral)	**MYR8.37**	**MYR6.70**	**MYR10.04**	Ngan 2023 (211)*
Following up participants who missed colonoscopy after a positive iFOBT (post-referral)	**MYR6.73**	**MYR5.38**	**MYR8.08**	Ngan 2023 (211)*
Colonoscopy (including polyps removal and/or biopsy if needed + anasthesia)	**MYR1,716.11**	**MYR1,372.88**	**MYR2,059.33**	Veettil 2021 (212)*
Treatments for CRC (regardless of disease stage)	**MYR10,686.58**	**MYR9,460.85**	**MYR13,241.69**	Malaysian DRG, 2020

Resources and unit cost	Price / cost	Lower range	Upper range	Source
Participants resource and cost				
Travelling cost per trip for screening (assuming the travel distance = 10km, travel time = 10 minutes)	MYR14.00	-	-	Ngan 2023 (211)
Average income monthly (median, by age group)	MYR2,957.00	MYR2,500.00	MYR3,400.00	DOSM 2023 (207)
Average income per day	MYR131.42	-	-	*Estimation*
Average income per hour	MYR5.48	-	-	*Estimation*
Time-off taken for screening activity (4 hours)	MYR21.90	-	-	Ngan 2023 (211)
Time-off taken for colonoscopy (1 day)	MYR131.42	-	-	*Personal communication*
Participant's cost for taking iFOBT screening	**MYR63.90**	-	-	
Participant's cost if iFOBT positive	**MYR14.00**	-	-	
Participant's cost if agreed for colonoscopy	**MYR145.42**	-	-	
TOTAL PARTICIPANT'S COST	**MYR223.33**	-	-	

**The lower and upper ranges were estimated from the data source by reducing and increasing 20% (+/-20%) from the reported values*

g. Assumptions for the analysis

The resource implications analysis includes the following assumptions:

- Based on a recent meta-analysis, the sensitivity and specificity of iFOBT were 0.86 and 0.85, respectively, regardless of the interval of the screening strategy and the cut-off threshold of the test (213).
- The clinical pathway from screening to treatment, follow-up (if positive), or repeat screening (if negative) is based on the Malaysian CPG (189).
- Gastroenterologists or surgeons perform colonoscopy procedures as day cases, incurring outpatient procedure costs in MOH.
- Participants required at least three visits to the clinic for an iFOBT test (receive a collection bottle, return the sample, and receive test results) and extra two visits if agreed for a colonoscopy, if iFOBT positive (214).

h. Outcomes of interest

The outcomes of interest from this analysis were screening participation rate, which reflects the uptake of screening, number of colonoscopies performed, CRC cases detection, resource and economic outcomes such as total cost for both strategies and incremental cost of screening per case detected. The net resource saving was calculated as the difference in total financial impact between the annual screening strategy and the current implementation of two-yearly CRC screening using iFOBT. The net monetary benefits are also estimated for both CRC screening strategies.

i. Uncertainty analyses

To address the uncertainty on the input parameters, one-way deterministic sensitivity analysis was performed to evaluate the impact of variations in the input value on the net resource implications. The input parameters used to estimate the number of persons at each stage of the screening process and the cost inputs were modified within a given range, as reported in the data sources, where available. In addition, the range of parameter variation for which there were no available data sources on dispersion was evaluated by decreasing and raising the value by 20% from the base case (211).

7.3.7 Results

a. Base-case analysis

Table 7-9 shows the estimated number of individuals at each stage of screening pathway for both strategies over the duration of 5 years. For the current practice of opportunistic CRC screening with two-yearly iFOBT (Strategy 1), the total cost for 5 years is MYR67,369,216 (GBP11,516,105), of which 54% (MYR36,100,616 / GBP6,171,045) accounted for the cost of providing opportunistic CRC screening to individuals who agreed for it (Table 7-10). Costs of providing colonoscopy to participants with positive iFOBT in Strategy 1 is MYR26,267,047 (GBP4,490,093), approximately 39% of the total cost for 5 years. The estimated CRC cases detected in current screening strategy is 570 cases, and the cost of providing treatment for 82% of CRC patients detected from this screening programme is MYR5,001,554 (GBP854,966), based on the input assumptions.

For Strategy 2 (opportunistic CRC screening with annual iFOBT), the total number of individuals in the target population age 50-75 years agreeing to undergo CRC screening is 63% higher compared with Strategy 1 over the duration of 5 years. Hence, the number of colonoscopies performed in annual strategy is 23,006 which is 63% higher than the current strategy. The 5-years financial impact for Strategy 2 is shown in Table 7-11. The estimated total cost in annual screening strategy is MYR109,841,227 (GBP18,776,278), 39% higher than Strategy 1. The total cost of colonoscopies performed in Strategy 2 is MYR42,826,751 (GBP7,320,812).

Table 7-12 highlights the comparison between the clinical and economic outcomes of both strategies. If annual CRC screening using iFOBT is being implemented, there are 63% of extra procedures performed (i.e., screening test and colonoscopy) compared with a two-yearly screening strategy. An additional 359 cases are detected in Strategy 2, making the incremental cost per one extra CRC case detected MYR118,178 (GBP20,201). Meanwhile, current implementation of two-yearly screening approximated 39% of net resource saving from the total cost of the 5-year screening programme (MYR42.5 million [GBP7.3 million]) and non-cash-releasing saving from performing colonoscopy (MYR16.6 million [GBP2.8 million]).

Table 7-9: Estimated population at each stage of pathway for CRC screening using iFOBT for Strategy 1 and Strategy 2

Strategy 1: CRC screening using iFOBT (two-yearly)	Year 1	Year 2	Year 3	Year 4	Year 5
Total population (all ages)	34,671,895	35,087,958	35,509,013	35,935,121	36,366,343
Target population (age 50-75 years)	6,240,941	6,315,832	6,391,622	6,468,322	6,545,942
Agree to take CRC screening	**54,296**	**54,948**	**55,607**	**56,274**	**56,950**
Receive positive iFOBT results	5,001	5,061	5,122	5,183	5,246
Undergo colonoscopy after positive iFOBT	**2,755**	**2,788**	**2,822**	**2,856**	**2,890**
Miss / refuse colonoscopy appointment	2,000	1,923	1,793	1,555	1,311
CRC detection after colonoscopy investigation	**111**	**113**	**114**	**115**	**117**
Polyp detection (non-cancerous) after colonoscopy + biopsy	384	388	393	398	403
Patients with CRC receiving / agree for treatment	91	92	94	95	96
Strategy 2: CRC screening using iFOBT (annually)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Total population (all ages)	34,671,895	35,087,958	35,509,013	35,935,121	36,366,343
Target population (age 50-75 years)	6,240,941	6,315,832	6,391,622	6,468,322	6,545,942
Agree to take CRC screening	**54,296**	**82,799**	**98,080**	**106,585**	**111,623**
Receive positive iFOBT results	5,001	7,627	9,034	9,818	10,282
Receive negative iFOBT results	49,295	75,173	89,046	96,768	101,342
Undergo colonoscopy after positive iFOBT	**2,755**	**4,202**	**4,977**	**5,408**	**5,664**
Miss / refuse colonoscopy appointment	2,246	3,425	4,057	4,409	4,617
CRC detection after colonoscopy investigation	**111**	**170**	**201**	**219**	**229**
Polyp detection (non-cancerous) after colonoscopy + biopsy	384	585	693	753	789
Patients with CRC receiving / agree for treatment	91	139	165	179	188

Table 7-10: Five-year resource impact and financial implications for Strategy 1

Strategy 1: CRC screening using iFOBT (two-yearly)		Year 1	Year 2	Year 3	Year 4	Year 5
Providing iFOBT to adults who agree for screening	Number of people	54,296	54,948	55,607	56,274	56,950
	Cost (MYR)	**6,921,914**	**7,004,977**	**7,089,037**	**7,174,105**	**7,260,194**
	Cost (GBP)	1,183,233	1,197,432	1,211,801	1,226,343	1,241,059
Conveying results and preparing referral for participants with positive iFOBT	Number of people	5,001	5,061	5,122	5,183	5,246
	Cost (MYR)	**111,877**	**113,220**	**114,578**	**115,953**	**117,345**
	Cost (GBP)	19,124	19,354	19,586	19,821	20,059
Providing colonoscopy to participants with positive iFOBT	Number of people	2,755	2,788	2,822	2,856	2,890
	Cost (MYR)	**5,128,931**	**5,190,377**	**5,252,662**	**5,315,694**	**5,379,482**
	Cost (GBP)	876,723	887,244	897,891	908,666	919,570
Following up participants with positive iFOBT who missed colonoscopy after referral	Number of people	2,246	2,273	2,300	2,328	2,356
	Cost (MYR)	**15,116**	**15,297**	**15,481**	**15,667**	**15,855**
	Cost (GBP)	2,584	2,615	2,646	2,678	2,710
CRC detection after colonoscopy investigation and biopsy	Number of people	111	113	114	115	117
	Cost (MYR)	**-**	**-**	**-**	**-**	**-**
	Cost (GBP)	-	-	-	-	-
Treatment for patients with confirmed CRC	Number of people	91	92	94	95	96
	Cost (MYR)	**976,590**	**988,309**	**1,000,168**	**1,012,170**	**1,024,316**
	Cost (GBP)	166,938	168,942	170,969	173,021	175,097
Total cost for Strategy 1 CRC screening using two-yearly iFOBT	**MYR**	**13,154,328**	**13,312,180**	**13,471,926**	**13,633,589**	**13,797,192**
	GBP	2,248,603	2,275,586	2,302,893	2,330,528	2,358,494
	MYR 67,369,216 for 5 years (GBP11,516,105)					

Table 7-11: Five-year resource impact and financial implications for Strategy 2

Strategy 2: CRC screening using iFOBT (annually)		Year 1	Year 2	Year 3	Year 4	Year 5
Providing iFOBT to adults who agree for screening	Number of people	54,296	82,799	98,080	106,585	111,623
	Cost (MYR)	**6,921,914**	**10,555,627**	**12,503,628**	**13,587,939**	**14,230,234**
	Cost (GBP)	1,183,233	1,804,381	2,137,372	2,322,725	2,432,519
Conveying results and preparing referral for participants with positive iFOBT	Number of people	5,001	7,627	9,034	9,818	10,282
	Cost (MYR)	**111,877**	**170,608**	**202,093**	**219,619**	**230,000**
	Cost (GBP)	19,124	29,164	34,546	37,542	39,316
Providing colonoscopy to participants with positive iFOBT	Number of people	2,755	4,202	4,977	5,408	5,664
	Cost (MYR)	**5,128,931**	**7,821,252**	**9,264,634**	**10,068,061**	**10,543,973**
	Cost (GBP)	876,723	1,339,966	1,583,698	1,721,036	1,802,389
Following up participants with positive iFOBT who missed colonoscopy after referral	Number of people	2,246	3,425	4,057	4,409	4,617
	Cost (MYR)	**15,116**	**23,051**	**27,305**	**29,673**	**31,076**
	Cost (GBP)	2,584	3,940	4,668	5,072	5,312
CRC detection after colonoscopy investigation and biopsy	Number of people	111	170	201	219	229
	Cost (MYR)	**-**	**-**	**-**	**-**	**-**
	Cost (GBP)	-	-	-	-	-
Treatment for patients with confirmed CRC	Number of people	91	139	165	179	188
	Cost (MYR)	**976,590**	**1,489,258**	**1,764,095**	**1,917,077**	**2,007,696**
	Cost (GBP)	166,938	254,574	301,555	327,705	343,196
Total cost for Strategy 1 CRC screening using two-yearly iFOBT	**MYR**	**13,154,328**	**20,059,796**	**23,761,756**	**25,822,369**	**27,042,979**
	GBP	2,248,603	3,429,025	4,061,839	4,414,080	4,622,731
	MYR 109,841,227 for 5 years (GBP18,776,278)					

Table 7-12: Comparison of clinical and economic outcomes (Strategy 1 and Strategy 2)

Outcomes comparison	Strategy 1 (two-yearly)	Strategy 2 (annually)	Differences and interpretations
1. Screening uptake	278,075	453,384	**175,309** additional people screened with annual iFOBT (63%)
2. Number of colonoscopies performed for iFOBT positive	14,110	23,006	**8,896** additional colonoscopies performed in annual screening (63%)
3. Number of CRC cases detected	570	929	**359** additional CRC cases detected in annual screening strategy (63%)
4. Total cost of screening in 5 years	MYR 67,369,216 *(GBP 11,516,105)*	MYR 109,841,227 *(GBP 18,776,278)*	**MYR 42,472,011** net resource saving in 2-yearly screening (39%) *[GBP 7,260,173]*
5. Incremental cost per one extra CRC case detected	MYR42,472,011 / 359		**MYR 118,178** additional cost per one extra CRC case detected *[GBP20,201]*
6. Cost of colonoscopies performed	MYR 26,267,047 *(GBP 4,490,093)*	MYR 42,826,751 *(GBP 7,320,812)*	**MYR 16,559,705** non-cash releasing saving from performing colonoscopy in 2-yearly screening strategy (39%) *[GBP 2,830,719]*

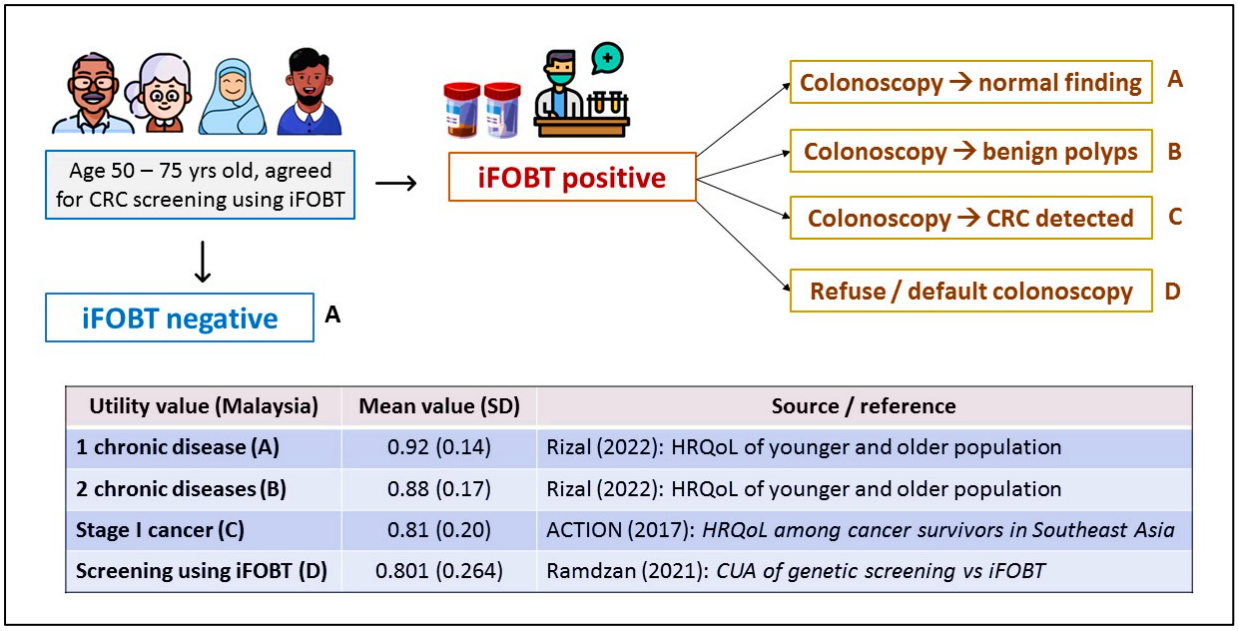
b. Net health benefit and net monetary benefit

To identify the strategy with the highest net benefit, a willingness to pay of MYR60,000 per QALYs was used as the value for the Malaysian population. This is approximately 1 GDP per capita for the country in 2023 and has been used as the cost-effectiveness threshold for HTA in Malaysia (26). For the net benefit of CRC screening using iFOBT for the two different intervals, the QALYs are calculated by multiplying the number of people in each pathway with the utility values of different outcomes after the target population receives the screening test. This calculation was used by Whyte et al. (2020) in estimating the NMB of different CRC screening strategies in the UK population (206).

Since there is no direct elicitation of preference from the population on the different interval of screening strategy, the utility value observed for people with cancer in the ACTION study, a longitudinal study in eight countries in Southeast Asia including Malaysia assessing the health-related quality of life (HRQoL) of cancer survivors, is used to represent the utility for those with early CRC detected from the screening programme (215). The utility values for those attending the clinic and having a negative iFOBT or non-cancerous polyp are obtained from a study on HRQoL for younger and older age group within the Malaysian population (216).

Figure 7-6 summarises the pathway and utility values used to estimate the QALYs for net monetary benefit analysis, and the comparison of QALYs calculations for Strategy 1 and Strategy 2 is outlined in Table 7-13. In this analysis, it is assumed that those attending the public clinic are having a type of chronic disease, and if the iFOBT is negative or the colonoscopy is normal, they have the same utility of 0.92 (group A1 and A2). Individuals with iFOBT positive and found to have benign or non-cancerous polyps are considered as having two chronic diseases with a utility value of 0.88 (group B). If the diagnosis of CRC is confirmed after colonoscopy investigation and diagnostic biopsy, the patients are assumed to have early stage of CRC (group C) with utility value of 0.81 as reported in the ACTION study (215).

However, if the individuals had positive iFOBT but refused further investigation with colonoscopy or defaulted referral for the procedure (group D), the utility value attached to this group is 0.801 (217).



Utility value (Malaysia)	Mean value (SD)	Source / reference
1 chronic disease (A)	0.92 (0.14)	Rizal (2022): HRQoL of younger and older population
2 chronic diseases (B)	0.88 (0.17)	Rizal (2022): HRQoL of younger and older population
Stage I cancer (C)	0.81 (0.20)	ACTION (2017): *HRQoL among cancer survivors in Southeast Asia*
Screening using iFOBT (D)	0.801 (0.264)	Ramdzan (2021): *CUA of genetic screening vs iFOBT*

Figure 7-6: Summary of pathways after CRC screening using iFOBT and the estimated utility values for each outcome.

Table 7-13: Comparison of quality-adjusted life-years (QALYs) calculation for Strategy 1 and Strategy 2 for 5 years

Strategy	*Pathway outcomes	Number of individuals in each pathway					Total people in each pathway	Utility	Total QALYs for population	Total QALYs (5 years)
		Year 1	Year 2	Year 3	Year 4	Year 5				
Strategy 1: Opportunistic CRC screening with iFOBT (two-yearly)	**A1**	49,295	49,887	50,485	51,091	51,704	252,462	0.92	232,265	**254,319**
	A2	2,260	2,287	2,315	2,342	2,371	11,575	0.92	10,649	
	B	384	388	393	398	403	1,966	0.88	1,730	
	C	111	113	114	115	117	570	0.81	462	
	D	2,246	2,273	2,300	2,328	2,371	11,575	0.801	9,214	
Strategy 2: Opportunistic CRC screening with iFOBT (annually)	**A1**	49,295	75,173	89,046	96,768	101,342	411,623	0.92	378,693	**414,651**
	A2	2,260	3,447	4,083	4,437	4,646	18,872	0.92	17,362	
	B	384	585	693	753	789	3,205	0.88	2,820	
	C	111	170	201	219	229	929	0.81	753	
	D	2,246	3,447	4,083	4,437	4,646	18,872	0.801	17,362	

Pathway outcomes:

A1 = Agree for screening + negative iFOBT

A2 = Positive iFOBT + colonoscopy, normal finding

B = Positive iFOBT + colonoscopy and biopsy, benign polyp(s)

C = Positive iFOBT + colonoscopy, colorectal cancer detected

D = Positive iFOBT, refuse or default colonoscopy investigation

Based on the number of individuals in each pathway outcome from the CRC screening programme for five years duration, Strategy 2 with annual repetition of iFOBT yielded a higher QALYs compared with the current implemented strategy (414,651 versus 254,319). This summed up to QALYs difference of 160,332. Since the incremental cost to implement the annual strategy is MYR42,472,011 based on the previous calculation, the ICER is MYR265 per QALY gained when comparing the annual strategy with the two-yearly strategy, as shown in Table 7-14.

In estimating the net benefit for each strategy, the formula used is:

Net benefit = (QALYs x λ) – total cost of the strategy
where, λ = willingness to pay (WTP) = MYR60,000

Meanwhile, the net monetary benefit (NMB) is calculated using this formula:

Net monetary benefit (NMB):
= ([difference in QALY, ΔE] x λ) – (difference in cost, ΔC)
= (ΔE x λ) - ΔC **where, λ = willingness to pay (WTP) = MYR60,000*

Based on the calculated QALYs, the net benefits for Strategy 1 are **MYR15.2 billion** (GBP2.6 billion) and Strategy 2 is **MYR24.7 billion** (GBP4.2 billion), respectively. Hence, the NMB for Strategy 2 in comparison with Strategy 1 is **MYR9.5 billion (GBP1.6 billion).** Based on this estimate, conducting CRC screening using iFOBT and repeating it every year if the previous test is negative yields a higher net monetary benefit than repeating the test every two years.

Table 7-14: Comparison of QALY, net health benefit and net monetary benefits between Strategy 1 and Strategy 2

Outcomes comparison	Strategy 1 (two-yearly)	Strategy 2 (annually)	Differences and interpretations
1. QALY difference (incremental QALY)	254,319	414,651	**160,332 higher QALY** in annual strategy
2. Cost difference (incremental cost)	MYR 67,369,216 *(GBP 11,516,105)*	MYR 109,841,227 *(GBP 18,776,278)*	**MYR 42,472,011** higher cost in annual strategy *[GBP 7,260,173]*
3. Incremental cost-effectiveness ratio	MYR 42,472,011 / 160,332		**MYR 265 per QALY gained** *[GBP45]*
4. Net health benefit (NHB): **NHB = ΔE - (ΔC/λ)** *[λ = CE threshold = MYR60,000]*	**NHB = 159,624 (higher in annual screening)**		
5. Net monetary benefit (NMB): **NMB = (ΔE x λ) - ΔC** *[λ = CE threshold = MYR60,000]*	**MYR 15.2 billion** ***(GBP 2.6 billion)***	**MYR 24.7 billion** ***(GBP 4.2 billion)***	**MYR 9.5 billion higher net monetary benefit** in annual strategy *[GBP 1.6 billion]*

c. One-way sensitivity analysis

The tornado diagram in Figure 7-7 depicts the change to the net resource saving when assumptions on probabilities and cost inputs for the two CRC screening strategies were varied. It illustrates the results of multiple univariate sensitivity analyses on key parameters that have the greatest influence on net resource savings. The key parameters included in this uncertainty analysis are:

i. the probability of individuals agreeing to take CRC screening test
ii. the probability of receiving positive iFOBT results
iii. the probability of individuals with positive iFOBT undergoing colonoscopy
iv. the probability of CRC detection after colonoscopy
v. the proportion of patients with CRC receiving treatment
vi. cost of providing iFOBT to individuals who agree to take the screening test
vii. cost of performing colonoscopy in iFOBT positive
viii. treatment cost for CRC

As calculated, the base case net resource saving in performing two-yearly screening compared with annual screening is MYR42.5 million (GBP7.3 million). The net resource saving would increase to MYR50.8 million (GBP8.7 million) if there was a 20% increase in the probability of adults agreeing to participate in the CRC screening programme. The parameters that moderately influenced the net resource saving (MYR38.3 million to MYR45.5 million) are probability of receiving positive iFOBT results, probability of undergoing colonoscopy if iFOBT is positive, cost of providing iFOBT, and cost of colonoscopy. Meanwhile, three other parameters do not significantly influence the differences in net resource saving.

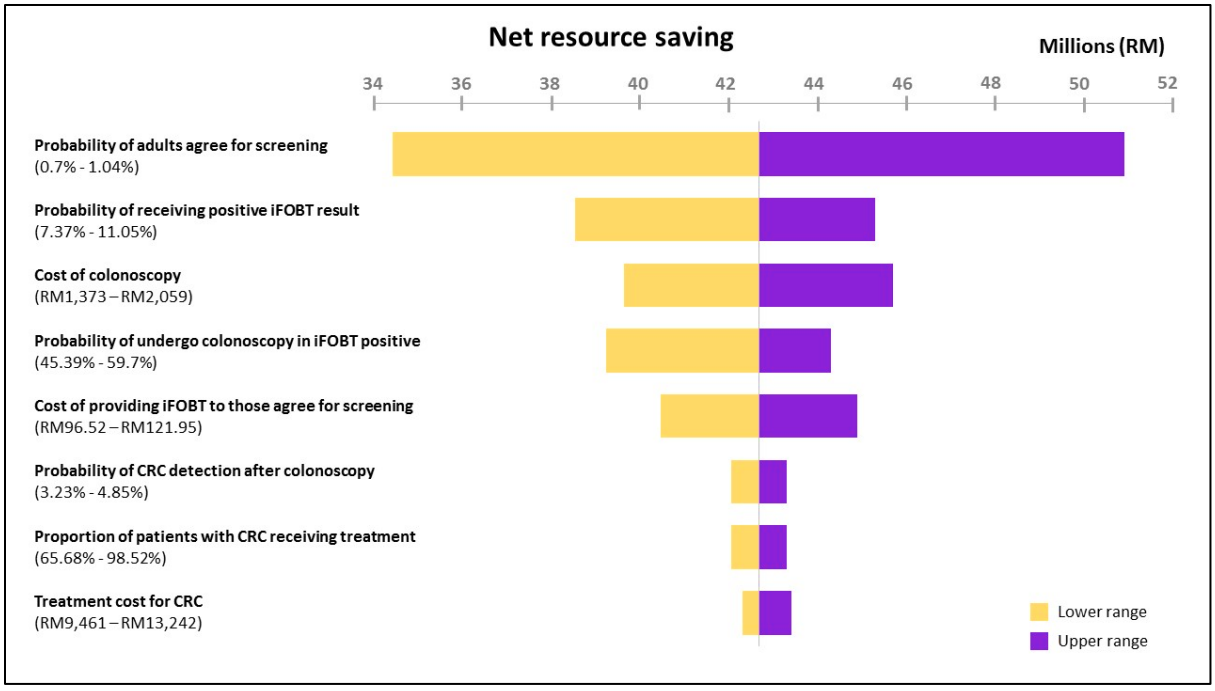


Figure 7-7: Tornado diagram of multiple univariate sensitivity analyses, *using* **k***ey parameters that influence the net resource saving in two strategies of CRC screening using iFOBT (two-yearly versus annually).*

7.3.8 Discussion on opportunistic CRC screening in Malaysia

In assessing the adoption of opportunistic CRC screening in Malaysia, I conducted cost consequence analysis and budget impact analysis for a five-year period. This diverges from the traditional evaluation in HTA, which typically utilises cost-effectiveness or cost-utility analyses to derive a singular value metric, such as the ICER, for decision-making regarding investments in new health technologies. However, in this case, the key issue that must be addressed transcends mere 'value for money'. The presence of conflicting guidelines and practices raises ethical concerns, as it may result in differing approaches within the public and private healthcare sectors in Malaysia. Moreover, from the evidence review and analysis of the implementation of the CRC screening programme in Malaysia, it is evident that the present opportunistic-based screening strategy is pragmatically sub-optimal, with less than 1% of screening uptake rate among the eligible population annually from 2014-2018 (190).

In this particular example, Strategy 1 (two-yearly) is cost-effective but Strategy 2 (annually), although more expensive to deliver, is more impactful in terms of net benefits. However, the return of investment for both strategies are almost similar, with ROI of 226.5 for Strategy 1 and 225.5 for Strategy 2, respectively. The advantage of using net benefits lies in its scalability to a population level, unlike the ICER, which is a ratio that provides no insight into the population size benefiting from an intervention. In many countries, including Malaysia, HTA decisions on reimbursement are often based on ICER. Strategy 2 would be deemed cost-effective compared to Strategy 1 when focusing solely on the ICER value at the individual level, without accounting for its population-level impact. However, in resource-limited settings or when designing benefits packages, budget impact should arguably be a key consideration in the decision-making process.

Based on the performance of CRC screening programme that was in place in Malaysia, the current strategy can be considered as “inefficient care”. This could be caused by inefficient organisation of programme implementation (218) due to resource constraints from the service provider side in terms of programme funding as well as readiness for colonoscopy services in the public healthcare facilities. Moreover, the infrequent promotion of screening by doctors in MOH primary health care facilities is also attributable to the substantial patient load, which limits their time and capacity (214). These factors collectively contribute to the underperformance of the screening programme. However, though sub-optimally implemented, CRC screening using iFOBT remains a critical component of the national healthcare strategy, and disinvestment from the government-funded program is not a viable option (219). The net benefit of CRC screening in terms of early detection, improved survival rates, and long-term cost-effectiveness, continues to justify its inclusion within public health initiatives (220).

In this situation, the argument remains in enhancing the uptake of whichever strategy is retained and prompts further critical questions: What would be the potential impact of full or optimum uptake, and what are the associated costs of achieving this?

Also, thinking along the line of opportunity cost, what are the expenses associated with abandoning the alternative strategy, if any? These enquiries segue into implementation science, which explores the costs and effectiveness of strategies for integrating interventions into and out of practice.

Moreover, before any consideration of de-implementation or adjusting the screening interval, several important factors must be taken into account, including the healthcare infrastructure and resource availability. The recent evidence from the UK Bowel Cancer Screening Programme does not support more frequent screening, as the existing intervals have demonstrated sufficient effectiveness in reducing the disease burden within a limited endoscopy capacity (206). Therefore, efforts should focus on improving implementation rather than scaling back or intensifying the current programme through a more frequent screening interval.

7.3.9 Limitations in analysis of CRC screening programme

There are several limitations in the case study analysis which need to be acknowledged. A notable limitation of this analysis is the lack of a publicly accessible CRC screening database in Malaysia. The input parameters for the case study are derived from outdated data spanning 2014-2018, which may not precisely reflect the current state of the screening programme. The last published paper on CRC screening, analysing performance for 2019-2020, provides only limited reporting on essential outcomes and underscores the influence of the COVID-19 epidemic on overall screening uptake (221). Additionally, cancer notification is not currently mandated by law in Malaysia, which raises the possibility of missed notifications or unreported cases, limiting the comprehensiveness of the analysis.

Another limitation of this case study is the inability to capture the psychosocial effects associated with CRC screening, such as patient anxiety and distress. The emotional and psychological elements significantly influence the screening experience; however, they are challenging to measure just through administrative or clinical data. Qualitative research involving patients or the public would provide a

deeper understanding of these issues, offering valuable insights into how individuals perceive and experience the screening process as well as the differences in the interval for subsequent iFOBT following a negative first test. Integrating evidence from such studies would enhance decision-making by ensuring that patient and public perspectives are considered in the evaluation and improvement of screening programmes.

Finally, the calculation of net health and net monetary benefits in this analysis is based on several assumptions, incorporating available utility values from published studies on health-related quality of life in the Malaysian general population (216), cost-effectiveness analysis comparing different CRC screening modalities (217) as well as a study on cancer survivors in Southeast Asia including CRC patients in Malaysia (215). While these sources provide valuable insights, they do not capture direct elicitation of preferences from the targeted population, which limits the ability to fully reflect the specific utility values of individuals undergoing screening. This lack of direct input may compromise the accuracy of the comparisons, as the analysis relies on generic assumptions rather than population-specific data, and potentially leading to less precise estimations of the benefits linked to each screening strategy. Another issue is the lack of uncertainty (e.g., absence of confidence intervals) in the QALY estimations presented in Tables 7-13 and 7-14. This omission could result in overconfidence in the findings and potentially lead to flawed decision-making, as the range of possible outcomes is not adequately addressed. Therefore, these results should be interpreted cautiously, taking into account the assumptions underlying the estimated values used in this model.

7.3.10 Identifying disinvestment candidates through CPG

Identifying potential candidates for disinvestment purposes is not without a challenge. Several approaches were highlighted by the Clinical Commissioning Groups within the UK NHS on how disinvestment opportunities were identified, including central influence by NICE or the NHS, benchmarking against national resources such as the *NHS Atlas of Variation in Healthcare* or the Quality, Innovation, Productivity and

Prevention (QIPP) programme, focusing high-volume elective procedures, and utilising 'soft intelligence' derived from individual observations (222). Despite numerous methods proposed for identifying disinvestment candidates in healthcare, none provide a systematic, reproducible process that can be routinely implemented in practice, as the approaches were characterised as *"non-sustainable, reliant on chance or not conducive to independently identifying local opportunities for disinvestment"* (222).

During the early stage of my PhD research, I encountered difficulty in selecting the suitable case studies due to differing perspectives and anticipations on the outcomes of the disinvestment process. The varying viewpoints made it challenging to align a specific example with the objectives of my research. Therefore, as a practical starting point in the identification process, it would be more effective to systematically develop a list of low-value care by identifying 'do-not-do' recommendations from existing evidence-based CPGs published in Malaysia. It is well established that the primary role of CPGs is to recommend effective treatments in most cases; hence, suggesting additional interventions aimed at improving patient outcomes. They are not typically considered a direct disinvestment strategy. However, the role of CPGs should extend beyond endorsing what should be done to also clarifying what should not be done, particularly in cases where interventions are found to offer limited or low value (80).

In the process of reviewing the recommendations in the CPG, I discovered that there were several recommendations and evidence statements in some CPGs that require further exploration because they conflict with current practice (i.e., in the case of CRC screening using iFOBT) as well as differing statements in terms of what evidence suggested and what actually the final recommendation was (i.e., mechanical bowel preparation before performing bowel surgery). There is also a risk of overtreatment; for example, the CPG Management of Diabetes in Pregnancy recommends postpartum metformin therapy to prevent newly diagnosed diabetes in women with a history of GDM (see Table 7-5).

Further discussion with Endocrinologist and Family Medicine Specialist (FMS) in the Ministry of Health Malaysia was initiated to explore the practicality of the recommendation on postpartum metformin therapy. In general, individuals who did not require medication will typically return to normal glycaemic levels in the postpartum period. The recommendation specifically applies to women with GDM who need a glucose-lowering medication (e.g., metformin, insulin injection, or both) during pregnancy. Therefore, doctors do not routinely prescribe metformin to women with a history of GDM to prevent diabetes. They only initiate it if there is evidence of impaired glucose tolerance (measured by fasting plasma glucose or HbA1c) after delivery, or if they have other pre-existing risk factors like polycystic ovarian syndrome, overweight or obesity, and physical inactivity. The Diabetes Prevention Program Outcomes Study (DPPOS), a landmark study, generally supports the use of metformin in conjunction with lifestyle interventions as the initial step to reduce the excess risk of incident diabetes (223). Therefore, the recommendation in the CPG Management of Diabetes in Pregnancy is still valid based on the available evidence as well as expert consultation with the specialists.

7.3.11 Conclusion

In conclusion, this case study utilised a top-down approach to identify LVC by utilising evidence-based CPG and contrasting conflicting recommendation within the CPG with the national strategic plan, which reflects the actual clinical practice. The analysis of the CRC screening programme, which makes use of different screening intervals, goes beyond the standard cost-effectiveness or cost-utility evaluations that are typically utilised in HTA for the purpose of determining the 'value for money' of new investments. Additionally, it underscores the complexity of decision-making, which is not simply 'black and white'. It involves balancing the potential improvements in implementing one strategy against the associated costs, as well as the implications of disinvesting from the alternative strategy. There is a transition towards implementation research, which will provide the option to improve or optimise existing practice by incorporating value-of-implementation analysis. What remains unexplored is the critical evaluation of these costs against the potential benefits, particularly the extent to which implementation might improve.

7.4 Pilot testing a decision-making framework for disinvestment: Insights from Malaysian healthcare stakeholders

7.4.1 Background

A workshop titled "Horizon Scanning and Disinvestment in Healthcare: Key Insights and Future Directions" was held on the 24th and 25th of September 2024, organised by MaHTAS in Putrajaya, Malaysia. The second day of the workshop was dedicated to the theme of healthcare disinvestment, with the primary objective of enhancing awareness among Malaysian healthcare stakeholders on disinvestment initiatives in the country. This also provided an opportunity for me to pilot a proposed decision-making framework guided by the concept of the value of de-implementation. The workshop successfully brought together 58 participants, representing a diverse range of stakeholders, including clinicians, pharmaceuticals and medical devices regulators, HTA reviewers, policymakers, and programme coordinators from the MOH Malaysia.

The disinvestment-focused sessions commenced with a series of lectures presented by me, which covered various components of my PhD research. These lectures included an introduction to healthcare disinvestment, followed by findings from the online survey and interviews conducted with Malaysian healthcare stakeholders. Additionally, I presented two case studies: one on the disinvestment of IFN-alpha-2a for treating advanced RCC, and the other on opportunistic CRC screening using iFOBT, comparing two different screening intervals. Following these presentations, I formally introduced the MCDA framework (Chapter 6) designed to support disinvestment decision-making.

To facilitate practical application of the framework, participants were divided into six groups, each assigned a facilitator from MaHTAS who also served as rapporteur. Each group received a summary of the case studies (Supplementary 7-1) and the performance matrix outlining the domains within the value of de-implementation framework. Participants were instructed that the CRC screening strategies were to be

assessed both individually and in comparison, to each other, resulting in three candidates for evaluation using the framework.

7.4.2 Ranking the criteria and eliciting the weights

The first exercise focused on determining the criteria ranking and eliciting weights for each domain within the framework. Each group represented a panel member, resulting in six mock advisory panel members. Initial discussions on criteria ranking took place within each group, and the outcomes were subsequently presented to all participants collectively. Health impact was unanimously ranked as the top priority across all groups. However, significant debates arose over the ranking of equity and system readiness.

Some participants argued that equity should be prioritised over system readiness and enablers to avoid issues related to disrupted patient care when alternatives are unavailable. They expressed concerns that reduced accessibility to healthcare services could undermine the country's commitment to universal health coverage. Conversely, some others advocated for giving system readiness equal or higher priority, emphasising the importance of ensuring a smooth transition in practice. This group highlighted that system readiness could minimise unintended consequences of disinvestment, such as resistance from healthcare staff, facility preparedness, and potential legal challenges stemming from poorly executed disinvestment decisions.

Following extensive discussion and justification from each group, the differing opinions were resolved through a majority vote. The majority agreed to rank equity higher than system readiness, recognising the significant consequences of neglecting equity considerations. Furthermore, it was argued that the sub-criteria within system readiness assess the impact of implementing disinvestment decisions, thus logically placing it after evaluating the availability and accessibility of alternative interventions. The final criteria ranking was as follows:

Rank 1: Health impact

Rank 2: Equity

Rank 3: System readiness

Rank 4: Enablers

While the SMART approach was initially considered due to its flexibility, the pilot exercise ultimately adopted the SMARTER method, with no tied ranks between criteria. The weights were calculated using the SMARTER formula, as follows:

1. *Health impact_weight* = $\frac{1}{4}(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4})$ = **0.5208**
2. *Equity_weight* = $\frac{1}{4}(\frac{1}{2} + \frac{1}{3} + \frac{1}{4})$ = **0.2708**
3. *System readiness_weight* = $\frac{1}{4}(\frac{1}{3} + \frac{1}{4})$ = **0.1458**
4. *Enabler_weight* = $\frac{1}{4}(\frac{1}{4})$ = **0.0625**

The group rankings, final consensus and weights is summarised in Table 7-15.

Table 7-15: Group rankings and final consensus on criteria, with elicited weightages for each domain.

	DOMAIN RANKING			
GROUPS	**Health impact**	**Equity**	**Enablers**	**System readiness**
Group 1	1	3	3	2
Group 2	1	1	3	2
Group 3	1	2	2	3
Group 4	1	2	3	2
Group 5	1	2	3	3
Group 6	1	2	3	4
FINAL CONSENSUS	**1**	**2**	**4**	**3**
Weightage	**0.5208**	**0.2708**	**0.0625**	**0.1458**

7.4.3 Scoring the candidates

For the group work, each facilitator was provided with a scoring sheet in an Excel file to guide the exercise (Supplementary 7-2). Participants were allocated 45 minutes to score the candidates based on the performance matrix for each domain. Following the group work, scores from all groups were aggregated by calculating the average score for each domain. These average scores were then normalised using linear transformation to ensure a consistent scale between 0 and 10. Subsequently, the predetermined domain weights (derived using the SMARTER method as described previously) were applied to the normalised domain scores to calculate weighted scores. Finally, an additive model was employed to sum the weighted domain scores, generating an overall score for each candidate as presented in Table 7-16.

Table 7-16: Overall weighted scores, total scores and NMB-per-score for disinvestment candidates assessed

	Weighted Score *(weight X domain score)*				Total score	Net monetary benefit (NMB)	NMB-per-score
Candidates	**HImp**	**Equity**	**Enabler**	**SysRed**			
CRC screening (two-yearly)	0.4596	2.3100	0.5417	1.2153	**4.5266**	MYR15.2 billion	**3.36**
CRC screening (annually)	1.3787	2.3100	0.5000	1.0532	**5.2420**	MYR24.8 billion	**4.73**
IFN-alpha-2a for advanced RCC	5.2083	2.7083	0.6250	1.4583	**10.000**	MYR0*	**0**

Notes: HImp=health impact; IFN=Interferon; RCC=renal cell carcinoma; SysRed=system readiness.
** The NMB for interferon-alpha is zero because the medication is assumed to no longer be used for treating advanced RCC, as it is considered obsolete.*

Based on the overall score, there was unanimous agreement on IFN-alpha-2a, indicating that the candidate should be delisted or removed as a treatment option for advanced RCC. For the CRC screening strategies, the annual screening strategy received a higher score compared to the current two-yearly implementation (Table 7-16), suggesting a preference for de-implementing the annual strategy based solely on

the matrix. However, when the NMB-per-score ratio is considered, the current two-yearly implementation exhibited a lower ratio compared to the annual strategy (3.36 vs. 4.73). This lower ratio indicates a higher likelihood for the current implementation to be de-implemented. This relationship is illustrated in Figure 7-8, where candidates plotted closer to the bottom right of the graph indicate a greater likelihood of disinvestment.

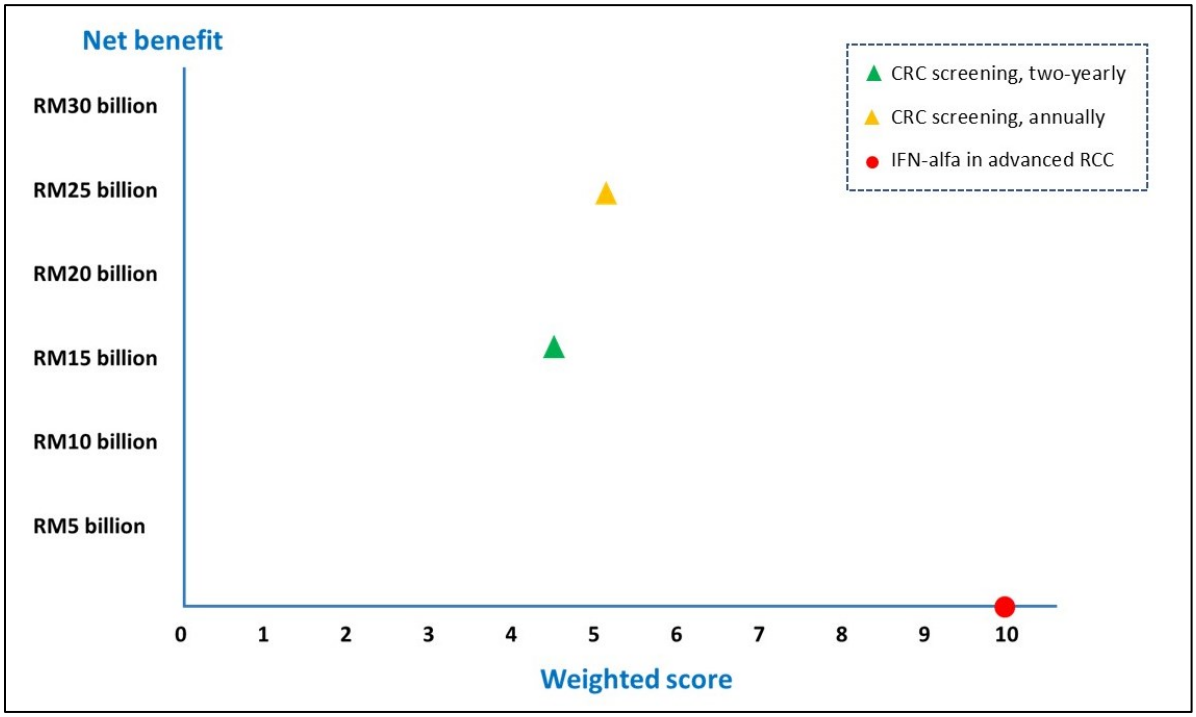


Figure 7-8: The Net Monetary Benefit (NMB)-per-score for the three candidates assessed during the pilot workshop. *Candidates positioned closer to the bottom-right are considered higher priorities for de-implementation.*

A sensitivity analysis was conducted to assess the robustness of the results under two scenarios: (a) equal ranking for equity and system readiness, and (b) equal weights assigned to all criteria. The results of these sensitivity analyses (detailed in Supplementary 7-3) demonstrated that neither scenario significantly altered the relative positions or priorities of the candidates for de-implementation. This indicates that the overall ranking and prioritisation of candidates remain consistent regardless of changes in the weighting or ranking assumptions.

7.4.4 Deliberation and decision-making

The participants engaged in a deliberation process to evaluate the MCDA framework's output during the final part of the workshop. A consensus was reached on several key points. For IFN-alpha-2a, the group unanimously agreed on the complete removal of the medication from the treatment regimen for advanced RCC. Additionally, the potential inclusion of axitinib as a treatment option for advanced RCC, currently used off-label, was highlighted. This recommendation aligns with other international guidelines that prioritise axitinib as a first-line treatment for advanced RCC (159, 163, 166). To ensure consistency with current best practices, the group also emphasised the need to update both the systemic protocol for cancer treatments and the MOH's national formulary to reflect the updated indications for IFN-alpha-2a.

Regarding the CRC screening programme using iFOBT, the participants were hesitant to de-implement the current two-yearly screening strategy, as it is already in place despite its sub-optimal implementation. While Strategy 2, a more intensive screening approach, offered higher NMB, its high implementation cost and potential resource constraints were identified as significant barriers. It was pointed out that the opportunity cost of implementing Strategy 2 could be better utilised to strengthen the implementation of the current Strategy 1. Furthermore, the CRC screening programme coordinator highlighted the ongoing challenges related to colonoscopy services in Malaysia, including long waiting times for follow-up colonoscopies and limited access to specialised personnel. The plan to expand colonoscopy services is underway, but financial constraints and resource limitations remain significant obstacles. In light of these challenges, the group concluded that the optimal strategy at the moment was to prioritise increasing awareness among the target population. By improving awareness and encouraging higher screening uptake, the net benefits of the programme can be enhanced.

The workshop concluded with a consensus to maintain the current biennial CRC screening interval while prioritising efforts to improve its implementation. Participants highlighted the need to update the CPG for the Management of Colorectal Carcinoma to align with these recommendations. They also stressed the importance of establishing robust monitoring and evaluation mechanisms for the enhanced implementation strategy to guide future resource allocation effectively. Recognising the value of these findings, the CRC screening programme coordinator from the Public Health Programme extended the invitation for me to present the workshop outcomes and contribute to the formulation of the next national cancer screening strategic plan for 2026-2030, scheduled for development in 2025.

7.4.5 Discussion

The workshop provided a valuable platform for participants to engage with the concept of disinvestment in healthcare and the application of MCDA as a decision-making tool. For many, this was their initial exposure to these topics, highlighting the need for broader dissemination of knowledge in this area. Participants suggested incorporating the framework into health policies to strengthen decision-making processes, emphasising the need for widespread awareness programmes, such as talks, roadshows, and continuous education sessions, to bridge the knowledge gap and clarify implementation pathways. As the national HTA agency, MaHTAS considering to incorporate a monitoring and re-evaluation component into the HTA recommendations to optimise resource allocation over time. While the framework was considered relevant across all decision-making levels, the participants also highlighted the significant challenge of acquiring the necessary expertise for comprehensive evidence searches and economic impact analyses.

After a few rounds of explanation, the participants accepted the exclusion of economic impact from the MCDA score, recognising the potential for double-counting. The visual representation of NMB-per-score on an XY-plane was found to be helpful in facilitating informed deliberation and decision-making, as well as in justifying decisions to either disinvest or re-strategise for improving the implementation and

value optimisation. Feedback on the scoring exercise using the performance matrix was positive, with participants noting its feasibility and clarity in providing a structured approach to the evaluation process. While the scoring system was considered easy to follow, some participants emphasised the need for more comprehensive evidence to support informed scoring decisions. This highlights the importance of exhaustive evidence searching and synthesis to ensure well-informed scoring. Regarding the scoring system itself, it was unanimously agreed that the current direct scoring system was preferred as it is more objective and easier to use compared to a range-based scale, which they perceived as more subjective and potentially challenging when assigning scores.

Some of the questions raised by workshop participants centered on health technology life cycle and management, particularly concerning obsolete technologies. One key question was about the specific time-frame or life cycle reference to determine when a medical device becomes obsolete. We suggested that such determinations should be made by regulatory body like the Medical Device Authority. Regarding the life cycle of health technologies assessed through HTA, we clarified that there is no universal rule of thumb for classifying technologies as obsolete in terms of years, as it varies by context. For instance, an MRI machine might be considered obsolete in a highly specialised facility but remain useful in a hospital that lacks advanced imaging capabilities. Therefore, the obsolescence of a health technology should not be determined solely by years or duration of its use.

Another question concerned the framework's applicability to different types of health technologies, such as disinvesting in pharmaceuticals versus public health programmes, among others. We explained that the framework is designed to be adaptable to various technologies, allowing decision-makers to select relevant criteria and domains based on their specific objectives. However, modifications to the scoring functions may be necessary to accommodate the unique characteristics of different technologies. This adaptability makes the framework versatile for diverse disinvestment scenarios.

A systematic review in LMICs found that cost-effectiveness and health benefits were the most commonly cited criteria for priority setting in public health resource allocation. It also highlighted a preference for different approaches, with MCDA more frequently applied in UMIC and the A4R framework in lower-income countries. Other factors such as legal, regulatory, ethical, and political considerations are frequently overlooked (4). What sets disinvestment apart in this context is its nuanced complexity. While cost-effectiveness and health impact remain critical, disinvestment requires an additional layer of considerations due to its unique nature, focusing on removing or scaling back the existing interventions that already in use. This entails evaluating not just economic and health outcomes, but also the implications of disinvesting and potential disruptions of implementation at the population level. In this process, MCDA serves as a valuable tool, allowing for the systematic incorporation of diverse criteria, such as system readiness and equity, to inform decision-making. Disinvestment, therefore, demands a more comprehensive and multifaceted approach compared to traditional priority-setting exercises.

The participants' reluctance to de-implement the current biennial CRC screening strategy reflects the inherent challenges of disinvestment. This hesitancy is expected, as removing or altering a programme already in force is often perceived as significantly harder than deciding against implementing it in the first place. This difficulty highlights why disinvestment is a distinct and complex process that requires careful consideration of its broader impact. In this case, the reluctance stems not only from the programme's existing integration into practice, but also from the perception that disinvesting from something entrenched in the system may disrupt services and fail to address the root causes of low screening uptake, namely sub-optimal implementation and inadequate public awareness. These underlying issues underscore the need for targeted improvements rather than complete withdrawal, ensuring the strategy fulfils its intended purpose.

Moreover, questions were raised about the consideration of alternative strategy, such as the annual screening interval, which is not formally practiced although it was stated in the CPG. Participants noted that disinvesting from an unimplemented strategy does not align with the proposed definition of disinvestment (5). This reflective discussion brought attention to the critical need for clarity in the objectives of disinvestment or de-implementation exercises. Without a well-defined aim, such exercises may struggle to achieve meaningful outcomes, as full or partial withdrawal of resources for certain candidates may not be demonstrable. Thus, it is crucial to establish clear objectives for any disinvestment or de-implementation exercise. This is to guide decisions and ensure that disinvestment efforts are aligned with achievable goals and the broader context of healthcare priorities.

7.4.6 Conclusion

The workshop provided a valuable platform to explore the concept of disinvestment and the application of MCDA as a decision-making tool. It facilitated in-depth engagement with the proposed framework, yielding valuable feedback on its usability and real-world applicability. Participants acknowledged the framework's relevance across different decision-making levels, its ability to integrate diverse criteria into a systematic process, and appreciated its adaptability to various health technologies. The exercise also highlighted key challenges, including the need for comprehensive evidence synthesis, technical expertise to carry out the analysis, and the complexity of addressing entrenched programmes. These insights are instrumental in refining the framework and demonstrating the potential of MCDA to support evidence-informed, transparent, and context-specific disinvestment decisions in Malaysia.

Chapter 8: Discussion and Conclusion

8.1 Introduction

This chapter begins with a general overview of the research project with a comprehensive synthesis of the work undertaken throughout the thesis. It then summarises the key findings from the main chapters, highlighting overarching themes that connect the research components. The discussion progresses to examine the implications of these findings for policy and practice while also identifying potential areas for future research. Finally, the chapter concludes with my personal reflections on the research journey, focusing on the insights gained and perspectives on implementing healthcare disinvestment initiatives in Malaysia.

8.2 General overview on the thesis

This thesis presents a comprehensive body of work on healthcare disinvestment initiatives, structured around five specific research objectives. These objectives include: assessing the global landscape of disinvestment implementation, analysing the methodological approaches employed in the disinvestment process, exploring stakeholder perspectives on such initiatives, proposing a priority-setting and decision-making framework using MCDA based on the value of de-implementation, and demonstrating the process of identifying and evaluating candidates for disinvestment within the Malaysian healthcare context.

The primary strength of this thesis lies in its comprehensive exploration of diverse topics within the research package. It addresses essential issues such as the challenges that hinder the success of disinvestment, the barriers to transforming these initiatives into effective programmes, and the integration of a vital component, the perspectives of key stakeholders. To enrich my thesis, I developed a framework grounded in stakeholder views and conducted pilot testing among Malaysian healthcare stakeholders. Addressing these components required a multi-method approach, which was crucial for gaining a nuanced understanding of disinvestment

initiatives. This approach, though challenging, has been rewarding, as it is driven by the primary question I sought to answer: “Are disinvestment initiatives worth implementing?” While the breadth of this research can feel overwhelming at times, it is necessary to achieve a holistic understanding of the topic.

My thesis highlights significant interest among stakeholders in leveraging the concept of disinvestment and embedding the value of de-implementation into health policy and HTA recommendations. When conducted rigorously, starting with robust identification of LVC and practices, followed by exhaustive analysis of viable alternatives, disinvestment activities can become a transformative avenue. This exercise enables resource reallocation and provide an opportunity to shift healthcare delivery from low-value to high-value care and further enhancing both efficiency and patient outcomes.

8.3 Summary of key findings

In this section, I summarise the key findings and contributions of the studies presented in this thesis, drawing from the main chapters outlined herein. Each chapter's objectives serve as a framework to highlight the specific components addressed, all of which contribute to the overarching theme of healthcare disinvestment initiatives.

8.3.1 Chapter 2: Scoping review of systematic reviews

Objective 1: To conduct a comprehensive scoping review to define the concepts and purpose of healthcare disinvestment, explore the methods employed, analyse the role of stakeholders, and identify the facilitators and challenges to its implementation.

In Chapter 2, I found that there was an increasing global focus on transparent and systematic resource allocation, highlighting the prioritisation of disinvestment initiatives despite their inherent complexities. While a variety of terms and concepts are associated with healthcare disinvestment, I believed that the overarching goals

remain consistent: to enable value-based decision-making and optimise resource use for maximum population health benefits and improved quality of care. The review also emphasised the critical role of stakeholder involvement in ensuring effective disinvestment processes, one of the important motivations behind the work that I conducted in Chapter 4 and 5 on mixed-method study.

I found that tools such as PBMA and HTA were commonly employed to evaluate disinvestment candidates. However, there was a notable lack of clarity regarding the technical dimensions and analytical processes needed to enhance their effectiveness in this context. The methodological approaches described in the reviewed articles largely mirrored the criteria used in HTA for investment or reimbursement decisions. Specific economic evaluations tailored for disinvestment were not suggested, although cost-effectiveness studies were recognised as valuable inputs for decision-making related to disinvestment of LVC.

Building on discussions about health technology management, I emphasised the potential of healthcare technology optimisation through continuous reassessment of these technologies across their life cycle. While not necessary for all, this approach offers a more systematic and proactive means of reallocating resources toward higher-value interventions, contributing to a more efficient and sustainable healthcare system.

This scoping review served as a cornerstone for my research project, shaping its direction and priorities. It highlighted critical aspects that required focused attention, including the importance of stakeholder involvement, the need for robust methodological frameworks for analysis, and the challenges surrounding the implementation of disinvestment initiatives. This comprehensive foundation not only informed the design and scope of my research but also underscored the interconnectedness of these elements in achieving plausible and sustainable disinvestment outcomes. In conclusion, the review offered a forward-looking

approach to refining and adapting disinvestment processes to address the complex demands of healthcare systems.

8.3.2 Chapter 3: Methodological approaches for disinvestment in healthcare

Objective 2: To examine the methodological approaches adopted by other countries and HTA agencies in implementing healthcare disinvestment initiatives.

In this chapter, I examined key methodological approaches to healthcare disinvestment, including HTA, PBMA, CUA, and MCDA, highlighting their strengths and limitations. I found that while HTA provides a strong evidence base for evidence-informed decision-making, particularly in assessing new technologies, it is often limited to single technology assessments for specific indications and does not directly engage with the decision-making process or consider the competing demands on limited resources. For CUA, it is useful for comparing interventions but may fall short in addressing important factors like equity, ethics, and stakeholder preferences, which are particularly relevant in Malaysia. It evaluates an intervention as a snapshot within a specific condition and at a particular point in time, without accounting for how disinvestment might influence a complex, interconnected system. This includes potential impacts on healthcare delivery, workforce reallocation, or future financial constraints. Consequently, effective disinvestment and rationing require a dynamic approach that captures resource flows and system-wide effects beyond QALY maximisation, an area where CUA falls short by design. Therefore, relying solely on CUA, without integrating HTA or other complementary approaches, is inadequate for making informed disinvestment decisions.

I discussed in the chapter on how PBMA offers a holistic and flexible framework for resource allocation, addressing both investment and disinvestment while promoting transparency, the qualities valued by Malaysian stakeholders. Lastly, I explained that although MCDA has not yet been widely explored for disinvestment, its flexibility in incorporating multiple criteria and its transparency make it a promising tool for

decision-making. The absence of a trialled MCDA process highlights the need for an appropriate and well-tested framework to be developed.

In the chapter, I also summarised several published case studies that utilised various methods for disinvestment, focusing on the criteria used for outcome measurement, decision-making, and the resulting decisions from these activities. There was also a discussion about combining multiple approaches for priority setting and resource allocation, involving both investment and disinvestment opportunities, as proposed by Mitton et al. (1) and Collins et al. (79). A limitation of this chapter is the lack of detailed discussion on the Accountability for Reasonableness (A4R), as its explicit use in disinvestment is still evolving and not widely understood by decision-makers. In practice, many components of A4R overlap with methodologies such as HTA, PBMA, and MCDA. For instance, disinvestment processes often incorporate elements like stakeholder consultations, public engagement, and transparent decision-making, even if these are not explicitly labelled as part of an A4R approach. Consequently, the application of A4R in disinvestment tends to be implicit rather than explicitly framed within its principles. Therefore, I focused the discussion on the four methodological approaches most commonly used to explore the potential for implementing a disinvestment framework in Malaysia.

8.3.3 Chapter 4 and 5: Online survey and key informant interviews with Malaysian healthcare stakeholders

Objective 3: To explore the perceptions, practices, and acceptance of Malaysian healthcare stakeholders toward disinvestment initiatives, including their views on the feasibility of implementing disinvestment frameworks in Malaysia.

Chapter 4 and 5 were designed as a mixed-method study to incorporate stakeholders' perspectives into my thesis. The online survey in Chapter 4 provided valuable insights into Malaysian healthcare stakeholders' perceptions of disinvestment. While small-scale and informal disinvestment activities were noted across various levels of care, a structured and systematic approach remains absent in the Malaysian health system.

Stakeholders emphasised the importance of specific criteria for disinvestment, including clinical and cost-effectiveness, the necessity and practicality of disinvesting an intervention, the health technology life cycle, and considerations of equity and fairness. Most stakeholders agreed on the need for a formal framework, developed with the involvement of key stakeholders, to guide the disinvestment process. Additionally, they highlighted the importance of training to facilitate acceptance and implementation.

Following the survey, the KII (Chapter 5) provided deeper insights into the stakeholders' perspectives on the initiatives. Participants expressed both optimisms, viewing disinvestment as a catalyst for efficient resource allocation, and scepticisms, fearing it might be used to justify budget cuts in healthcare. They emphasised the importance of fostering accountability and collaboration among stakeholders to enhance the acceptance and success of disinvestment activities. To address the challenges, proposed strategies include addressing critical elements such as robust change management processes, equity for underserved groups, transparency in decision-making, and reliance on evidence-based principles. Future research should focus on linking methodological analyses to disinvestment as part of resource allocation strategies and exploring ways to integrate equity into the assessment process, which commonly missed in priority setting exercise.

Data triangulation from this mixed-method study, combined with insights from the updated literature review, makes a significant contribution by offering a more comprehensive understanding of the challenges involved in implementing disinvestment initiatives (Supplementary 8-1). By integrating findings from both quantitative and qualitative perspectives, I gained deeper understanding on the phenomenon of disinvestment, particularly from the viewpoint of Malaysian healthcare stakeholders. One of the notable strengths of this approach is its ability to capture the complexity and nuances of stakeholder perspectives, which are often missed in studies relying solely on quantitative methods. The inclusion of qualitative insights allows for a richer exploration of contextual factors, such as organisational

culture, political will, and stakeholder apprehension, which are critical in developing disinvestment frameworks.

Although mixed-method studies are not commonly employed in HTA research, this study demonstrates their value in bridging the gap between empirical evidence and the practical realities of policy development. By combining the strengths of both approaches, this study not only identifies key barriers and facilitators but also provides actionable insights that can inform the design and implementation of sustainable and equitable disinvestment initiatives. This highlights the importance of using diverse research tools to address complex healthcare challenges.

8.3.4 Chapter 6: Value of de-implementation and decision-making framework

Objective 4: To develop a criteria-based framework for priority setting and decision-making process regarding the disinvestment of low-value health technologies and practices.

In Chapter 6, I presented a novel contribution of my thesis, the decision-making framework based on the value of de-implementation concept. It incorporates five key domains, **health impact, equity considerations, enablers for disinvestment, system readiness,** and **economic impact**; with the first four integrated into the MCDA scoring system for transparent prioritisation. Economic impact is considered separately for a comprehensive evaluation. The framework offers a structured tool for policymakers, but requires further validation through pilot testing in real-world settings. While the method employed, MCDA, is not inherently novel, the unique contribution of this work lies in its exhaustive approach to defining the criteria and domains within the context of the value of de-implementation. This was achieved through a rigorous triangulation of data and insights from multiple sources, including a comprehensive literature and scoping review, an online survey, stakeholder interviews and consultation with the methodological experts. By integrating these diverse perspectives, the resulting framework is not only grounded in evidence but also tailored to be more contextual and relevant for practical decision-making in healthcare disinvestment. This is the

main strength of the proposed approach, and I believe that this will enhance the applicability and robustness of the framework, which are important to attract the stakeholders in utilising it.

The MCDA framework I propose serves as both a strength and a weakness in the decision-making process; a true double-edged sword. Its strength lies in providing a structured, transparent, and evidence-based approach to prioritising disinvestment candidates by combining multiple sources of information to come out with agreed decisions. The effectiveness of this framework is critically dependent on the quality and completeness of the data used. Incomplete, biased, or inaccurate data can significantly distort the results and lead to erroneous decisions, subsequently compromising the credibility of the tool. Therefore, I recommend the users or prospective researchers interested in implementing the framework engage in deliberative discussions with stakeholders and decision-makers first regarding the appropriateness of the approach, especially in aligning with the objectives of the intended disinvestment activities.

8.3.5 Chapter 7: Implementing disinvestment process

Objective 5: To illustrate the analytical process of identifying and assessing candidates for disinvestment through evidence synthesis and value-based evaluation.

Chapter 7 is a substantial chapter, encompassing three interconnected components in one: the identification and prioritisation of disinvestment candidates, the assessment of their impact through two case studies, and the piloting of the decision-making framework developed in Chapter 6. This ‘three-in-one’ approach provides a comprehensive exploration of the disinvestment process, from conceptualisation to practical application. In this chapter, I illustrated the implementation of disinvestment exercise by exploring the initial three steps of the process: identifying and prioritising potential candidates, followed by assessing their impact through two case studies. The identification of candidates is a crucial yet challenging step, as it

addresses the performance of existing technologies with questionable value, which can lead to inefficient resource use.

The case studies employed different approaches to identify disinvestment candidates. The first, triggered bottom-up by a clinical specialist, identified an obsolete medication in the national formulary used for advanced RCC. Despite initial challenges in justifying the value of this case study, given that it might be perceived as a relatively trivial example for thorough assessment, I used this practical case to highlight how stakeholders perceive the minimal availability or lack of robust data in supporting decision-making. This discussion naturally led to the role of RWD and RWE, topics that have been receiving significant attention within the HTA community.

From stakeholder interviews, I observed varying levels of confidence in using RWE, particularly administrative data such as prescribing patterns for potentially obsolete medications. Stakeholders with greater exposure to high-level decision-making, such as at the national level, expressed more comfort and confidence in utilising these observational data. Conversely, those with less experience at higher decision-making levels were more likely to advocate for discontinuing or limiting the use of a medication only when strong and compelling evidence unequivocally demonstrated its lack of benefit. This disparity may stem from the inherent ambiguity of certain evidence, which makes it challenging to definitively classify a practice as LVC (108). In such situations, stakeholders often opted for a more cautious approach, advocating for the gathering of more robust evidence before proceeding with de-implementation efforts. This view accentuates the importance of high-quality data and evidence in facilitating effective and confident disinvestment decisions.

The second, a top-down approach, was derived from reviewing the evidence-based recommendations in the CPGs issued by the MOH Malaysia. The analysis of the CRC screening programme, which evaluates different screening intervals, went beyond traditional CEA or CUA typically used in HTA to determine the value of new investments. It highlights the nuanced nature of decision-making, which is rarely

straightforward, acknowledging that choosing to de-implement one approach requires weighing the costs and benefits not only of that approach but also of the alternative strategy replacing it. I also discussed the emerging shift toward implementation research, focusing on improving or optimising current practices through value-of-implementation analysis. However, a critical gap remains in thoroughly evaluating these costs relative to potential benefits, particularly in terms of how much implementation might enhance outcomes.

When discussing the approaches and evidence used in the two case studies, it is crucial to acknowledge that CPGs are predominantly informed by evidence on clinical effectiveness and safety, typically derived from RCTs, which are widely regarded as the gold standard for evaluating these outcomes. In addition, RWD and RWE serve a complementary role by offering valuable insights into the practical use of interventions, patterns of care, and potential safety signals within real-world settings. While RWD and RWE can help bridge evidence gaps and facilitate the implementation of guidelines, decisions regarding clinical effectiveness and safety must be grounded in robust, high-quality evidence as their foundation. Therefore, incorporating multiple data sources and maintaining a rigorous focus on evidence quality are fundamental to ensuring sound, evidence-based healthcare decision-making.

In this chapter, I reported the application of the decision-making framework developed in Chapter 6, evaluating its feasibility and acceptability through a stakeholder workshop. This workshop provided valuable deliberation on the framework's application, concluding with findings that inform the broader implications for implementing disinvestment in Malaysia. The constraint in this pilot testing was the limited number of candidates evaluated for disinvestment, comprising merely three interventions. Inclusion of other candidates would enhance the value and insightfulness of portraying the complexities inherent in decision-making around healthcare disinvestment.

Introducing MCDA as the decision-making approach in this pilot workshop provided several significant advantages. Firstly, MCDA emphasised the importance of clearly understanding each domain and its sub-domains to evaluate the performance of disinvestment candidate effectively. The detailed descriptions of sub-domains and the scoring framework in the performance matrix offered a clear and systematic guide to the advisory panel or the decision-makers, enabling them to assign scores in a more objective and consistent manner.

Secondly, the inherent flexibility of MCDA to integrate both quantitative and qualitative information into the performance matrix streamlined the decision-making process. This approach allowed panel members to consider a comprehensive range of evidence holistically, rather than focusing solely on statistical significance, which is a common limitation in traditional HTA. By accommodating diverse types of data, MCDA supported more informed and balanced evaluations.

Thirdly, MCDA's capacity to rank criteria based on stakeholder preferences introduced a tailored, transparent, and context-sensitive approach to decision-making. Unlike methods that apply equal weightage to all criteria, such as those often used in HTA and PBMA, MCDA acknowledged that not all criteria hold equal importance in real-world scenarios. By assigning weights aligned with stakeholder values, MCDA ensured that critical factors had a proportionate influence on the outcome, making the process both pragmatic and stakeholder-driven.

Lastly, relying solely on CUA and HTA to evaluate the CRC screening programme could lead to a decision to disinvest the current practice of two-yearly screening intervals. This is because the annual screening strategy demonstrated higher QALYs gained and was found to be cost-effective compared to the current practice. However, without conducting a BIA to assess the financial feasibility of implementing the annual strategy and highlighting the opportunity costs associated with this choice through CCA, the decision risks being overly dependent on the cost-effectiveness threshold alone. As a result, important discussions on refining and improving the currently

implemented screening strategy may be overlooked. These four features collectively demonstrate how MCDA enhances the rigour, transparency, and adaptability of decision-making, making it a valuable tool in this pilot framework.

8.4 Contributions to the research on healthcare disinvestment

In the context of previous disinvestment efforts that have been proposed in the Italian national health system and implemented in countries such as Spain, Brazil, Canada, South Korea, Australia, and the UK, these efforts often faced challenges such as limited stakeholder engagement, a lack of transparency in decision-making, and an over-reliance on technical tools like HTA and CUA. While tools like PBMA have been utilised, their application varied, often depending on the specific context or healthcare priorities of the region. Unlike earlier efforts, this PhD thesis proposes a framework utilising the MCDA approach designed primarily for implementation at the national level, with flexibility for adaptation to the meso- and micro-level of healthcare decision-making. As MCDA is underpinned by the robust methodological foundation of Multi-Attribute Utility Theory, this framework formalises how overall value is derived from trade-offs across multiple domains. Its strength lies in explicitly recognising marginal decisions, such as disinvestment, as a means to free up limited resources, thereby embodying the principle of opportunity cost and supporting value-based reallocation. In addition, the framework was designed to include a health technology life cycle component, which has not been widely discussed in previous initiatives. This dual focus ensures that the framework is both broad enough for systemic use and targeted enough to address the need for health technology management.

One of the key differences in this approach is the engagement of stakeholders early in the planning phase, aimed at raising awareness about disinvestment, gathering opinions on its implementation, and ensuring stakeholders are closely involved throughout the decision-making process. The MCDA framework, developed through this thesis, not only incorporates a diversity of perspectives but also enhances the acceptability and feasibility of disinvestment decisions. Furthermore, this thesis

emphasises the importance of creating a transparent evaluation process, where the criteria, their rankings, and the decision outcomes are explicitly communicated. This directly addresses a common critique of previous disinvestment efforts, namely the lack of clarity and understanding among stakeholders.

This framework includes equity as one of its criteria, systematically evaluating the potential impacts of disinvestment decisions on vulnerable and underserved populations. By explicitly incorporating equity into the decision-making process, the framework acknowledges the need to safeguard access to essential healthcare services for disadvantaged groups and to prevent decisions that could exacerbate existing health disparities. This approach goes beyond traditional technical assessments by recognising that the social and ethical implications of disinvestment are just as critical as clinical and economic considerations. Furthermore, the framework evaluates the broader impact of disinvestment decisions, not only in terms of cost savings or efficiency but also in the assessment of healthcare system readiness in implementing the recommendations to disinvest LVC.

As a contribution to the new knowledge on healthcare disinvestment, this thesis would be highlighted as an example of leveraging MCDA for national-level decision-making while addressing challenges such as equity and the impact of disinvestment decisions. It demonstrates the value of combining robust technical tools with meaningful stakeholder engagement to improve transparency and decision acceptability. The application of this framework in the pilot study showcased its potential success in evaluating and improving CRC screening programme in Malaysia, indicating its adaptability and relevance across different healthcare priorities.

This thesis also embraces the principles of knowledge translation by actively engaging stakeholders throughout the research process, integrating real-world case studies, and providing actionable recommendations to guide future disinvestment efforts. Knowledge translation has emerged as a critical field within health systems, focusing on closing the persistent gap between evidence-based recommendations on ***what***

should be done, and the realities of clinical practice of ***what is actually being done***. This field provides both theoretical and practical frameworks to support the movement of research into actionable policy and practice, making it particularly relevant to disinvestment and de-implementation initiatives (118). The synergy between knowledge translation and HTR lies in their shared goal of improving the value of healthcare through the reduction of LVC (224).

In the Malaysian context, where disinvestment remains a relatively novel policy concept, early and meaningful stakeholder engagement is crucial to build system readiness and consensus for change. Knowledge translation plays a central role in this process, not just by disseminating evidence, but by engaging stakeholders, enhancing capacity, and guiding change. Effective knowledge translation models must address system complexity, behavioural resistance, and the need for sustained involvement (225); challenges that are particularly relevant in Malaysia's multi-layered decision-making environment. This is evident in my case studies: the review of CRC screening showed that alignment across guidelines, strategy, and frontline delivery helped avoid pushback, while the delisting of an obsolete renal cancer drug was driven by clinician-led recognition and RWD, supported by informal knowledge translation efforts. These cases demonstrate how it can bridge evidence, stakeholder values, and system action, making it integral to the success of disinvestment initiatives in Malaysia.

8.5 Implications and recommendations for policy and practice

This thesis has shown that there are demands for integrating disinvestment initiatives into prioritisation and resource allocation and it is continuously evolving. Framing disinvestment as a policy-driven initiative provides a guidance for sustainable healthcare transformation, by balancing budgetary needs with long-term health outcomes through assessment of economic impact. The rising pressure to optimise healthcare budgets and redirect resources toward high-value interventions has provided a significant impetus for disinvestment initiatives.

Effective de-implementation initiatives will likely require strategies or components that are delivered from both top-down and bottom-up perspectives, and necessitate active engagement from all stakeholders to reduce LVC (11). When designing such initiatives, it is important to appreciate that any strategy or component is unlikely to be effective across all quality, safety and financing problems in general. Evidence shows that even frequently used components, like audit and feedback, academic detailing and policy interventions work some of the time but none work all the time (11). The observed effects are often modest and it is not always clear why the modest change occurred.

In reality, disinvestment does not seek to decrease the cost of treatments or services in terms of price to produce said treatment or service; rather, its aim is to reduce the overall budget through the removal or reduction of ineffective or less effective services or programmes. To meet budgetary constraints, an organisation may first decide to engage in cost-saving measures, and if such measures are not enough, then disinvestment activities as per the proposed definition could be introduced. However, disinvestment may also be applied as a first response to budget cuts independent of cost-saving efforts, or be used to free up resources that can then be reinvested into existing programmes or new initiatives.

To integrate disinvestment into health policy, it aligns seamlessly with the principles of health policy implementation. Reflecting on the overall outcomes and findings of this thesis, I have structured these principles into six key elements, conveniently represented by the letters A-B-C-D-E-F. These elements are not listed in order of priority but are intended to guide a comprehensive discussion on understanding and applying the concept.

i. A for Awareness.

Regardless of a nation's wealth or how large an organisation is, healthcare resources can never be deemed unlimited, as the demand for new investments in technologies and innovations continue to grow indefinitely. There must be a mutual awareness that

LVC that provides no net benefit in specific clinical scenarios, represents one of the most pressing challenges in healthcare. It not only drives up costs but also causes iatrogenic harm to patients and often hinders the delivery of high-value care. By establishing this awareness as a foundation, gaining acceptance from stakeholders becomes a less challenging task, creating the pathway for meaningful discussions and actions.

ii. B for Budget sensitivity.

Understanding the source and allocation of budgets or resources for healthcare services is crucial, particularly in relation to the level of governance, whether it is at the national, regional, or facility-based level. Knowing where the funding originates and how it is distributed provide discernment into the financial mechanisms driving healthcare delivery, while understanding how these funds are spent highlights potential inefficiencies or misallocations. This understanding allows for the identification of areas where resource reallocation could enhance efficiency, equity, and effectiveness in healthcare. Moreover, budget sensitivity fosters transparency and accountability, empowering stakeholders to make informed decisions that align with overarching policy goals and the needs of the population. In the context of disinvestment, this element ensures that limited resources are redirected from low-value or ineffective practices toward interventions that provide the greatest benefit.

iii. C for Cost of inaction and opportunity cost.

In disinvestment, it is important to highlight not just the cost savings from removing LVC but also the cost of inaction. Allowing clinicians to continue prescribing ineffective or minimally beneficial treatments risks patient safety, wastes resources, and prevents investment in higher-value care. Inaction perpetuates inefficiencies and missed opportunities to improve outcomes and reduce health inequities. By framing the discussion around both the opportunity costs and the potential harms of inaction, stakeholders can gain a clearer understanding of why disinvestment is not only a financial necessity but also an ethical and clinical obligations. Addressing both

opportunity costs and the risks of inaction provides a stronger, more urgent case for reallocating resources toward practices that deliver the greatest value.

iv. D for Data and evidence.

As the saying goes, *"Data is the electricity of the 21st century."* Without reliable data, even the most advanced technologies and analytical tools cannot support effective decision-making. In disinvestment, data and evidence are essential currencies that ensure recommendations are objective and credible. As stated before, RWD and RWE are particularly critical, allowing us to assess the actual performance of interventions in real clinical settings, highlighting areas where resources are being spent on low-value practices that may lack meaningful benefits. Strong evidence and the availability of viable alternatives play a role in helping healthcare professionals and policymakers make decisions and foster acceptance of disinvestment initiatives (114). Leveraging data and evidence ensures that decisions are grounded in objectivity and transparency, and focused on improving values in healthcare.

v. E for Engagement, empowerment, and enhancement.

Stakeholder involvement is a cornerstone of successful disinvestment implementation, serving as both a facilitator and a potential barrier. Meaningful engagement begins with including stakeholders from the earliest planning phases, ensuring the process is reasonable, transparent, and justifiable, with fair and open consultation. Continuous participation and clear communication of methods and decision-making processes are essential to build trust and promote partnership. Enhancement is achieved through knowledge transfer and shared decision-making, enabling stakeholders to make informed contributions and nurturing a deeper understanding of the rationale and benefits of disinvestment. A well-defined policy framework can further amplify these efforts by encouraging collaboration among healthcare providers, patients, and policymakers. This inclusive approach not only empowers stakeholders but also ensures that decisions are equitable and aligned with shared goals.

vi. F for Follow-up and impact monitoring.

Monitoring the implications of disinvestment decisions and evaluating the outcomes remain areas with limited documentation, likely due to underreporting. However, assessing the impact on patients and the public is critical to ensure that disinvestment decisions achieve their intended goals without unintended negative consequences. If outcomes prove unfavourable, there must be flexibility to reverse the decision or revisit the decision-making process and underlying analyses. It is important to acknowledge that decisions are made based on the best available evidence at the time, and as new data and evidence emerge, re-evaluating these decisions is essential to improve the quality of care and uphold public trust. Despite its inherent risk, the disinvestment process plays a crucial role in optimising healthcare services and ensure wise spending of resources. By embedding robust follow-up and impact monitoring mechanisms, these can stimulate continuous improvement as well as enhance the long-term effectiveness and equity of healthcare delivery.

Implementing disinvestment initiatives as a policy requires a combination of strong political will, unwavering leadership commitment, and the application of 'harder' governance. This includes decisive actions such as withdrawing outdated or low-value technologies and excluding them from the benefits package (108). These measures ensure that disinvestment efforts are not merely symbolic but lead to meaningful resource reallocation and the enhancement of healthcare quality and efficiency.

8.6 Areas for further research

In the evolving landscape of healthcare disinvestment, there are emerging areas that warrant further research. While these components were minimally touched upon in this thesis, they were indirectly highlighted by stakeholders during interviews and interactions, reflecting their relevance and importance in advancing healthcare disinvestment research.

Firstly, the involvement of the public and patients in disinvestment process in LMICs remains under-researched despite its potential for transparency, fairness, and

alignment with societal values. Most of the disinvestment studies involving public and patients were conducted in higher-income countries such as the UK and Australia (226), as well as the Netherlands (109, 119, 123, 227). Involving patients and the public can help uncover concerns about disinvestment. For instance, an online survey in the Netherlands revealed that individuals struggling financially or anticipating future healthcare needs were less supportive of disinvestment, likely due to fears about its impact on future healthcare costs (123). This highlights the importance of clearly communicating the rationale behind disinvestment, particularly for ineffective treatments. Educating citizens that such treatments offer no benefit may reduce their demand, alleviating concerns about additional costs associated with disinvestment.

Although engaging with patients and public was found to be difficult (109), patients emphasised the importance of receiving timely, clear, and appropriately tailored information to feel empowered in discussions about LVC and explore alternatives with their physicians (177). This finding highlighted that power dynamics between patients and providers significantly influence patients' understanding of LVC. In addition, public and patients involved in studies related to disinvestment implied the need for consumer advocacy through knowledgeable representatives, emphasising the importance of transparency in research evidence and decision-making outcomes (134). While some patients preferred their physicians to make decisions on their behalf, trusting them to stay informed on the best evidence, others expressed concerns that disinvestment decisions might be driven primarily by financial constraints (177). By actively incorporating the perspectives of patients and the public, healthcare professionals will be better equipped to stay abreast of current evidence related to LVC. This enhanced knowledge base will empower them to champion disinvestment initiatives, fostering greater acceptance and successful implementation within the healthcare system.

Secondly, while pilot testing of the proposed MCDA decision-making framework has been conducted; further refinement, evaluation, and validation are necessary. Techniques such as testing the framework with additional case studies or candidates,

and using Delphi panels for validation can help improve its steps or components where needed (87, 92, 144). Refinement involves updating the framework based on evaluation findings and presenting these updates to key experts and the study team for verification. These recommendations are not meant to be prescriptive, allowing the users or researchers to adapt the framework to suit their specific needs.

Thirdly, further research is warranted to assess the impact of disinvestment recommendations or decisions on healthcare systems, clinical outcomes and practices, and stakeholder trust. Implementing disinvestment decisions often faces significant delays, with studies indicating that some healthcare providers resist withdrawing services, continuing to offer them even after official discontinuation (94, 135). This underscores the importance of impact assessment and monitoring as integral components of change management strategies in disinvestment initiatives. Applying a life cycle approach to health technology management in healthcare services could facilitate these efforts, whether by reducing reimbursements for low-value services or supporting transitions to higher-value strategies.

A practical example of the importance of continuous monitoring is the CRC screening programme in Malaysia, which demonstrates how such efforts can be integrated into the concept of health technology management. My personal goal after PhD is to continue assessing the programme's impact, particularly after identifying through my case study that its implementation has been sub-optimal due to various challenges. This aligns with the broader principle of refining healthcare strategies, as the CRC screening programme has the potential to evolve from its current opportunistic screening model, focusing on health clinic attendees, to a population-based approach targeting average-risk groups on a wider scale.

Lastly, the integration of technology and digital health presents transformative yet underexplored opportunities for identifying, evaluating, and implementing healthcare disinvestment, highlighting an untapped potential for future research. Advancements such as artificial intelligence (AI) and big data analytics may help identify LVC and

ineffective practices, while their integration with limited RWD and RWE warrants further investigation. These innovations offer significant potential to enhance data analysis and increase transparency in disinvestment processes. With healthcare digital transformation recommended as a synergistic catalyst for achieving UHC (228), this technology should be leveraged not only to enhance decision-making for investment or reimbursement but also as a tool to identify and assess LVC for de-implementation or disinvestment. However, careful planning and evaluation are needed to ensure that these tools are implemented ethically and effectively.

8.7 Personal reflections

"Disinvestment is a myth." Someone I deeply respect shared this statement with me, which initially caused me a great deal of panic and disrupted my thought process while preparing this thesis. Upon reflection, I partially agree, particularly if we define disinvestment narrowly as a means to reduce healthcare costs. However, in adopting a more ambitious perspective, disinvestment should not be viewed solely through the lens of cost containment. Instead, its true value lies in fostering a healthcare system that prioritises high-value care, quality improvement, and the optimal use of limited resources. Therefore, I firmly believe that disinvestment in healthcare is not merely a myth but can become a tangible reality with a clear set of objectives, a tailored and robust methodological approach, strong political will from decision-makers and key stakeholders, and sufficient resources to support its implementation.

The terms disinvestment and de-implementation, while often used interchangeably in health policy discussions, reflect distinct concepts within the continuum of HTR. Disinvestment typically refers to the policy-level decision-making process aimed at reducing or eliminating funding for health technologies or practices that no longer provide sufficient value. In contrast, de-implementation focuses on the clinical and operational aspects of reducing or stopping the use of low-value or obsolete technologies in practice. As Esmail et al. (2018) highlight, disinvestment is often an outcome of HTR that informs funding or coverage decisions, whereas de-implementation relates to the translation of these decisions into practice, requiring

strategies for behaviour change, stakeholder engagement, and system readiness (224). Thus, while both are potential outputs of the HTR process, they operate at different levels: disinvestment occurs at the system or policy level, while de-implementation takes place at the service delivery level. It is important to understand these as complementary yet distinct phases in the broader effort to eliminate LVC.

The growing importance of optimising resource allocation in healthcare has brought the topic of disinvestment to the forefront of discussions on various platforms. I had the privilege of contributing as a panel speaker in two occasions. The first, organised by the Center for Global Development (CGD) in January 2023 as an online webinar, focused on integrating disinvestment strategies alongside investment initiatives to support UHC. One of the key takeaways from this session was the identification of three critical factors contributing to the success of healthcare disinvestment strategies: the nature of the disinvestment objective, political will, and the resources available (229). **The nature of the disinvestment objective** considers whether the initiative targets a singular goal, such as cost reduction, or pursues multiple, explicit policy objectives, which often require more complex designs. **Political will** reflects the level of mandate and leadership support, as well as the potential for the initiative to be sustained over time. Lastly, **the resources available** encompass the timeframe for decision-making, the availability of skilled personnel, relevant data, and financial resources, along with the awareness and acceptance of explicit priority-setting among health system stakeholders (229). By sharing my research and perspectives, I was able to contribute to the conversation around the importance of aligning these factors towards implementing disinvestment initiatives.

The second session, a plenary at the HTAsiaLink Conference 2023 with the theme "Innovative Approaches in Tackling HTA Challenges," where my presentation focused on the critical question: *"Can disinvestment shift resources towards higher-value technologies?"* I emphasised that disinvestment presents a valuable opportunity to optimise resource management by redirecting funds toward higher-value technologies

and care. However, several challenges were highlighted in implementing disinvestment frameworks, including the complexity of resource allocation across different levels of governance, the need for stakeholder acceptance and political will, and technical hurdles such as insufficient supporting data and the difficulty of balancing efficiency with equity. The session revealed a shared interest among Asian countries in establishing a robust framework for healthcare disinvestment. I expressed my commitment to contributing to collaborative efforts within the HTAsiaLink network to develop such a framework for the region in the future. The discussion on "Getting Serious About Disinvestment: Why Is It Important and How Can It Be Implemented?" continued at the HTAi Annual Meeting 2024 in Seville, Spain, where I participated as an attendee. This session revisited key issues, including the methodological approaches to disinvestment, fostering stakeholder acceptance, and addressing the challenges associated with implementing disinvestment processes.

Participating in oral presentations at international conferences has provided me with opportunities to showcase my work on healthcare disinvestment and to network with researchers who share similar interests in this area. While the topic may not be appealing among researchers, it is an essential area that must be addressed, particularly in countries transitioning toward explicit benefits packages for healthcare coverage and access. For example, Indonesia has adopted an HTA-based approach to developing its national health insurance benefits package (230). However, the strategy for disinvestment or de-implementation of LVC is inadequately considered, leaving them with challenges such as an overly extensive list of items within the benefits package. These discussions underscore the importance of integrating disinvestment strategies at the beginning of the implementation of benefits package development.

Healthcare disinvestment is undoubtedly a complex and challenging process, often requiring substantial time, resources, and effort, with outcomes that frequently fall short of policymakers' expectations (229). To improve stakeholder acceptance and the likelihood of success, it is essential to have robust health prioritisation systems, such

as a well-established HTA agency, and to ensure that initiatives are closely aligned with political will, policy objectives, and available resources. I am fortunate to bring nearly a decade of experience with MaHTAS, one of the pioneering national HTA agencies established globally. This background has provided me with significant insights into the complexities of healthcare decision-making, particularly in resource allocation within constrained budgets, and the pivotal role of explicit and transparent processes to guide decision-making. Furthermore, the networking I have built with HEHTA, as well as close connection maintained with colleagues at MaHTAS and Malaysian MOH serves a dual purpose: it allows me to engage in collaborative research with them while simultaneously raising awareness about disinvestment initiatives.

Specifically in Malaysia, this thesis posits that implementing disinvestment initiative is a promising effort for a better resource allocation process, with positive support from healthcare stakeholders based on the study that I conducted, and timely with the recent approval of Malaysian Health White Paper in the Parliament in 2023 as the policy window to initiate the discussion. After extensive reflection on initiating disinvestment in the Malaysian healthcare system, I realise that the challenges often extend beyond resource constraints. In many cases, the issue is not a lack of resources but the persistence of outdated or low-value practices. Therefore, the most suitable approach for Malaysia is to frame disinvestment as a ***systematic effort to de-implement no- or low-value care***. This perspective aligns with the broader goals of improving healthcare quality, optimising resource use, and ensuring that the healthcare system meets the evolving needs of the population.

8.8 Conclusion

In these four years that I have been researching on disinvestment initiatives in healthcare, there has been a growing interest in this topic area, particularly after the COVID-19 pandemic. The debate has shifted from determining which technologies to stop funding, to figuring out how to create the ideal environment for these initiatives to succeed. This is exactly the aim of this thesis, beginning with identifying the issues related to the implementation of disinvestment initiatives in healthcare by understanding the wider landscape of the topic including the methodological approach used, and delving into the facilitators and challenges involved. Subsequently, I progressed by exploring the healthcare stakeholders' perspectives and acceptance towards such programmes, focusing on the Malaysian healthcare system as one of the upper-middle-income countries that has no established framework for disinvestment yet. Finally, I proposed a criteria-based framework for priority setting and decision-making process by introducing the value of de-implementation, which was also pilot-tested to assess its practicality and acceptability.

This thesis concludes that the impetus for disinvestment hinges on changing practices, which necessitates strong political will and strategic planning involving key stakeholders. Moreover, the benefits and savings from disinvestment often take considerable time to materialise, and in some cases, cost savings may not be fully achieved for certain health technologies or services. The benefits are frequently more diffuse and less tangible than the perceived difficulties or losses. Importantly, de-implementing LVC represents just one component of a broader, ongoing effort to close gaps in timely, safe, patient-centred, and effective resource allocation within healthcare systems.

Strategic implementation of the initiatives requires clear objective on the purpose of disinvestment, strong support from stakeholders, and knowledge on the technical aspect of the process (i.e., identification of possible disinvestment candidates through various approaches, prioritisation for assessment based on defined criteria, expertise in methodological analysis, and a guided framework for decision-making). In

addition, additional resources are needed in sustaining the process for disinvestment, which extend towards monitoring and revisiting the decisions that have been made. While it is obvious that challenges in the implementation of this initiative will somehow occur throughout the process, the cost of inaction or 'doing nothing' is something that should not be disregarded. The persistence of LVC and ineffective interventions are mainly rooted in a lack of knowledge and motivation to change practice, as well as uncertainty around the benefits of disinvestment. Therefore, I strongly emphasise that stakeholders' engagement, empowerment, and enhancement through knowledge transfer are the most critical aspects in sustaining support and acceptance, hence determining the success of disinvestment initiatives.

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APPENDICES

Supplementary documents for Chapter 2

Disinvestment in healthcare: a scoping review of systematic reviews

Supplementary 2-1: Identified unique terms on de-adoption process

1. Disinvest*	23. Remov*
2. Decrease use	24. Replace
3. Discontinu*	25. Refute
4. Abandon*	26. Overuse
5. Reassess*	27. Stop*
6. Obsole*	28. Inappropriate use
7. Medical reversal	29. Relinquish*
8. Contradict	30. Ineffective
9. Re-invest	31. Misuse
10. Withdraw*	32. Re-appraisal
11. Reduc*	33. Re-prioritization
12. Decline in use	34. Substitutional re-investment
13. Health technology reassessment	35. Evidence-based reassessment
14. Change in use	36. Clinical re-design
15. De-implement*	37. Disadoption
16. De-list	38. Defunding
17. Low value practice/intervention	39. Resource release
18. Change in practice	40. Withdrawing from a service and redeploying resources
19. De-adopt*	
20. De-commission	41. Redeploy
21. Do not do	42. Reversal
22. Reallocation	43. Drop in use

Supplementary 2-2: The search string using Web of Science and Scopus

(first round of search was done on 4 February 2021 and repeated on 3 January 2022)

Database	Search string
Web of Science	TS=((“disinvest*” OR “defund*” OR “health technology reassess*” OR “resource reallocation” OR “de-implement*” OR “de-list*” OR “obsolete technolog*” OR “obsolete practi*” OR “evidence-based reassess*” OR “de-commission*” OR “discontinue*” OR “low value practi*” OR “low value technolog*” OR “health technology assessment”) AND (“healthcare” OR “health care”))
Scopus	TITLE-ABS-KEY((“disinvest*” OR “defund*” OR “health technology reassess*” OR “resource reallocation” OR “de-implement*” OR “de-list*” OR “obsolete technolog*” OR “obsolete practi*” OR “evidence-based reassess*” OR “de-commission*” OR “discontinue*” OR “low value practi*” OR “low value technolog*” OR “health technology assessment”) AND (“healthcare” OR “health care”))

Supplementary 2-3: Search strategy using OVID Medline

(using Boolean operator, phrase searching, truncation, wild card, and MeSH terms)

DATABASE: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) <1990 to February 04, 2021>

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1 Resource Allocation/
2 (allocative adj1 efficiency).tw.
3 (resource adj1 allocation*).tw.
4 disinvest*.tw.
5 discontinu*.tw.
6 reassess*.tw.
7 TECHNOLOGY ASSESSMENT, BIOMEDICAL/
8 biomedical technolog* assessment*.tw.
9 technology assessment*, biomedical.tw.
10 health technolog* assessment*.tw.
11 assessment*, health technolog*.tw.
12 technology assessment*, health.tw.
13 (obsolete adj1 technolog*).tw.
14 (obsolete adj1 practice*).tw.
15 medical reversal*.tw.
16 re-invest*.tw.
17 Health technology reassessment*.tw.
18 De-implement*.tw.
19 De-list*.tw.
20 low value practice*.tw.
21 low value intervention*.tw.
22 de-commission*.tw.
23 re-allocation*.tw.
24 reallocation*.tw.
25 Evidence-based reassessment*.tw.
26 defund*.tw.
27 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26
28 DELIVERY OF HEALTH CARE/
29 27 and 28
30 limit 29 to (English language and last 20 years)
31 limit 30 to "reviews (best balance of sensitivity and specificity)"

Supplementary 2-4: The inclusion and exclusion criteria

Criterion	Eligibility	Exclusion
Research type	Review articles	Book series or chapter, primary study, case study, conference proceeding, abstract, poster, technical report (organisational or government policy document), opinion paper, commentary
Language	English	Non-English
Publication date	Between 2001 and February 2021	Published <2001
Review type	Systematic review, scoping review, pragmatic review, overview, interpretative review, critical interpretative synthesis	Narrative review
Components covered in the review	1. Terms and concepts related to disinvestment 2. Description on disinvestment programme, tools or propose new framework 3. Description of "not to do" recommendations, no or low value technologies, practices, or services 4. Methods on decision-making related to disinvestment of health technologies 5. Stakeholder involvement in disinvestment process	1. Description of terms unrelated to disinvestment or health technology reassessment 2. Disinvestment in other field (not healthcare)

Supplementary 2-5: The main themes and sub-themes for Purpose of Disinvestment

Authors	Value-based spending			Resource re-allocation			Improving quality of health care					Informed policy-making		
	CE	RW	SH	FR	RHT	SR	IB	RNV	OES	VP	IQW	SDP	RR	BG
Walsh-Bailey (2021)		✓			✓			✓						
Mitchell (2021)	✓			✓			✓							
Embrett (2020)						✓								
Esandi (2020)				✓					✓					
Calabrò (2018)			✓		✓									✓
Soril (2018)									✓					
Agirrezabal (2017)			✓	✓	✓									
Chambers (2017)					✓						✓			
Maloney (2017)									✓		✓			
Orso (2017)				✓							✓	✓	✓	
Seo (2016)	✓								✓		✓			
Mayer (2015)		✓		✓							✓			
Niven (2015)									✓					
Parkinson (2015)					✓									
Polisena (2013)					✓									
Leggett (2012)		✓	✓						✓	✓	✓			

Value-based spending	Resource re-allocation	Improving quality of health care	Informed policy-making
• CE = Cost-effective spending • RW = Reduction of the waste • SH = Sustainability of health care	• FR = Reallocation of freed resource • RHT = Reinvestment in health technologies • SR = Shifting resources from one to another	• IB = Increase benefits to patients • RNV = Remove “no added value” technologies • OES = Optimum effectiveness and safety • VP = Reduce variation in practice • IQW = Improve quality and widen service provision	• SDP = Support decision and policy-making • RR = Rationalization of resource allocation • BG = Addressing budgetary gaps

Supplementary 2-6: Summary of disinvestment methods / processes, facilitators, and challenges

Author, publication year	Description on disinvestment process / methods					Facilitators and Challenges in implementation	
	Identification	Prioritization	Assessment	Decision	Dissemination	Facilitators	Challenges
Walsh-Bailey et al., 2021	Not specified	i. clinical & cost ineffectiveness	i. PBMA ii. HTA / HTR	Based on action targets: i. Reduce ii. Replace iii. Restrict iv. Remove	Not specified	Stakeholder involvement (multicomponent interventions involving patients and providers)	Not specified
Mitchell et al., 2021	Not specified	Not specified	Not specified	Not specified	Not specified	i. Engaging clinical champions to lead change ii. Using rigorous patient outcome data iii. Transparent decision-making processes	Negative responses by health professionals: i. staff feel anxiety, disempowered, disrespected ii. distrust the process iii. dismiss the directive to disinvest iv. misperception on the purpose of disinvestment
Embrett et al., 2020	i. new evidence ii. introduction of a new technology iii. budget restrictions	i. clinical & cost effectiveness ii. value assessment iii. stakeholder consultation	i. HTA / HTR	Transparent decision-making on medical service withdrawal (policy option)	i. Guidelines ii. Education for public, training for providers iii. Monitoring of service use	Stakeholder involvement as a factor in the success of initiative.	Not specified.

Author, publication year	Description on disinvestment process / methods					Facilitators and Challenges in implementation	
	Identification	Prioritization	Assessment	Decision	Dissemination	Facilitators	Challenges
Esandi et al., 2020	Three different but related themes on methods for identifying candidates for disinvestment; approaches, triggers, and methods (ATM) - Ad hoc method - Embedded method	Not specified	Not specified	Not specified	Not specified	i. Transparent, systematic, evidence-based approach ii. Flexible method by HTA organisation / country according to suitability iii. Inclusion of stakeholders perceptions increases legitimacy in decision-making	i. Additional workload for HTA units ii. Variation in processes for selecting and prioritising candidates for disinvestment - causes dispute if the decision is to disinvest
Calabrò et al., 2018	**Source:** i. expert panel ii. literatures iii. new / rising technology databases iv. consultation with NHS, hospital	i. PriTec Tool - prespecified criteria based on 3 domains	i. HTA method (majority) ii. PBMA (Making Choices Spending Wisely, MaCS-Wise)	Not specified	i. NICE “Do not do” databases (passive) ii. GuNFT (active)	Regional and international platform for discussion	A complex process - requires inputs from all relevant stakeholders
Soril et al., 2018	Not specified	Not specified	Value assessment	Utilisation of technology (increased, unchanged, decrease, complete exit of technology from the healthcare system	Not specified	i. The entire HTR process is a collective involvement of foundational stakeholders	i. Limited success due to insufficient engagement with and from stakeholders ii. Top-down initiatives without support from the top leads to disengagement among stakeholders tasked with implementation.

Author, publication year	Description on disinvestment process / methods					Facilitators and Challenges in implementation	
	Identification	Prioritization	Assessment	Decision	Dissemination	Facilitators	Challenges
Agirrezabal et al., 2017	Not mentioned	Not mentioned	i. Cost analysis ii. Retrospective study of adverse events notification	Mixed of disinvestment decisions, but not monitored	i. Publications ii. Technical reports	Not mentioned	Moving away from the public's understanding of "across the board cuts"
Chambers et al., 2017	Not specified. Programmes implemented: - Choosing Wisely - NICE Initiatives - US Preventive Services Task Force (grade D recommendation)	Not mentioned	Not specified. Programmes implemented: - Choosing Wisely - NICE Initiatives - US Preventive Services Task Force	The decisions and success of disinvestment initiatives has been mixed	i. NICE "Do not do" databases	Continuous promotion of the disinvestment initiative among practitioners is the key success	i. Gaining acceptance from the frontline service provider ii. Obtaining adequate resources to support disinvestment initiatives
Maloney et al., 2017	i. Search, monitoring, review of literature and databases ii. Fixed time or trigger for reassessment iii. Efficient and transparent processes	i. Stakeholder consultation and assessment of variation in technology use - methods for identification or prioritization or both ii. Fixed time or trigger for reassessment ii. Efficient and transparent processes	i. Stakeholder involvement in therapeutic review assessment ii. HTA method, including value assessment and opportunity cost	Disinvestment recommendation may result, but reinvestment in other drug technologies is also possible	i. Passive: publication on databases or websites ii. Active: incorporate in guidelines or decision support tools, changes to formulary and/or coverage reimbursement listings	i. Transparent process - promote acceptance among stakeholders ii. Using a more neutral term - "reassessment" instead of "disinvestment" iii. Adoption of fixed time HTRs or therapeutic reviews - increased engagement with stakeholders	i. Lack of political will and leadership ii. Hesitancy from stakeholders to allocate resources for disinvestment initiative iii. Variability in reimbursement and purchasing methods iv. Low engagement from stakeholders and decision-makers v. Resistant to losing access to a drug therapy that may still provide some benefit

Author, publication year	Description on disinvestment process / methods					Facilitators and Challenges in implementation	
	Identification	Prioritization	Assessment	Decision	Dissemination	Facilitators	Challenges
Orso et al., 2017	Depends on agencies / programme. - new evidence - temporal variation - conflicting with guidelines - public interest / controversy - effectiveness & safety issues - evidence-based consensus - utilization rate	i. cost of service ii. impact on health, equity iii. disease burden / population affected iv. Futility, obsolescence (age, type) v. access / capacity vi. sustainability vii. system integration	i. PBMA, HTA ii. scientific and colloquial data iv. macro-marginal analysis v. technology appraisal vi. CEA vii. critical appraisal of the evidence on uncertainties	Not mentioned	i. Printed / online ii. HTA reports, commissioners' guides (online) iii. Databases ("Do Not Do", Uncertainties database) iv. Short report and reviews (online)	The existence of HTA agency in the country is a strong predictor of the presence of disinvestment programs (p=0 .034)	Not mentioned
Seo et al., 2016	Similar criteria across countries: i. clinical guidelines ii. new evidence on safety and effectiveness iii. public interests iv. variation in practices v. leakage vi. legacy items Spain: use Guideline for Not Funding existing health Technologies	i. cost of services, ii. risk/benefit of technologies iii. disease burden iv. patient preferences v. evidence of futility Spain: use PriTec Tool which based on 3 domains	i. PBMA ii. HTR (not much different from HTA, but requires convincing evidence of at least no risk, or of a benefit, in removing the technology)	i. transparent, supported by robust evidence ii. appropriate knowledge transfer to all stakeholders - specific committee or council of experts and stakeholders involve at various level - 8 outcomes of HTR	i. Reports: technology appraisal, recommendation reminders, commissioning guidelines ii. Do Not Do database iii. knowledge transfer (conferences) iv. Email to stakeholders	i. Continuous knowledge transfer to educate stakeholders in PBMA ii. Stakeholder involvement (developing strategies for disinvestment) - from early phase to implementation iii. Spain - regulatory support at national level (Royal Decree 1030)	i. Lack of political motivation ii. Decentralised health system and evaluation iii. Technical difficulties of HTR processes iv. Reluctance in withdrawal (clinicians) v. Perception - removing an established intervention is harder than refusing new one of similar value vi. Absence of robust evidence to support disinvestment

Author, publication year	Description on disinvestment process / methods					Facilitators and Challenges in implementation	
	Identification	Prioritization	Assessment	Decision	Dissemination	Facilitators	Challenges
Mayer et al., 2015	i. Literature-based and expert-related ii. Criteria: overlap between effectiveness, efficiency/cost/cost-effectiveness, available alternatives and benefit iii. Involvement of physician is crucial Programmes: Choosing Wisely, NICE initiatives, GuNFT, Australia PBAC and MBS, Cochrane Quality and Productivity topics	i. Spain (Osteba) standardised tool, PriTec Prioritization Tool ii. Criteria are identical in majority of the programs, with cost/efficiency most frequently mentioned	i. HTA ii. PBMA	i. Implementation strategy: GuNFT and NICE program ii. Choosing Wisely: relies on physicians to implement recommendation and encourages patients/ consumers to discuss iii. PBAC,MBS: decisions are transferred into benefits schemes iv. PBMA: recommendation directed at specific organizations	i. HTA reports or concise lists summarizing the recommendation ii. Active (published online, print media, face-to-face communication with target groups or consumer organisations, commissioning guides) iii. Passive (database in website)	i. Broad involvement of stakeholders ii. Structured and evidence-based process, with transparent methods iii. Targeted group for dissemination strategy iv. Consideration of local contexts v. Encouragement of political discussion and raising awareness before and during program	i. Additional human and financial resources ii. Implementation strategy not well-planned iii. Lack of support from decision-makers and an absence of strong leadership
Niven et al., 2015	Review of available evidence combined with stakeholder engagement	i. Availability of evidence on harmful or ineffectiveness ii. Safety issues iii. Health and cost impact of de-adoption iv. availability of alternative practices	i. PBMA ii. HTA / HTR	Not specified	Not specified	i. Early stakeholder engagement during identification and prioritisation allow implementation of de-adoption process and improve the probability of success	Not mentioned

Author, publication year	Description on disinvestment process / methods					Facilitators and Challenges in implementation	
	Identification	Prioritization	Assessment	Decision	Dissemination	Facilitators	Challenges
Parkinson et al., 2015	i. Concerns on quality, cost and clinical effectiveness, higher than utilisation and/or international differences ii. Changes in evidence, regulatory status, or budget impact iii. Routine for all listed drugs (France) iv. Drugs with price competition v. Leakage: drug utilisation (NZ)	i. Evidence of insufficient safety, clinical- and cost-effectiveness after multiple technology assessment ii. SMR ratings (France): effectiveness, safety, disease severity, impact on individual health and public health alternatives iii. Not delivering value for money	Not mentioned	i. Drug delisting ii. Restricting treatment iii. Price or reimbursement rate reductions iv. Encourage generic prescribing v. Coverage with Evidence Development (CED)	Not mentioned	Stakeholder involvement: i. help diffuse any resulting politics ii. communicating with stakeholders upfront and throughout the process regarding what research is required and what level of evidence is needed for continuing funding the drug	i. Disinvestment removes subsidy to patient, restricts clinical autonomy, and reduces prescriber and patient choice ii. Resistance to change practice among clinicians iii. Insufficient information to patients leads to misunderstanding
Leggett et al., 2012	Depends on programmes / specific country (e.g., NICE initiative, Choosing Wisely, GuNFT, etc.)	i. Using existing tools for priority setting in resource allocation (similar with HTA) ii. PriTec Tool iii. "One in, one out" policy	i. HTA (majority) ii. PBMA	Not mentioned	i. HTA reports ii. “Do Not Do” databases iii. Choosing Wisely database iv. Technical reports and commissioning guides	A standard and tested approach for HTR which include stakeholder engagement in addressing resource allocation - enable more countries to begin reassessing health technologies.	i. Resistance to change practice among clinicians ii. Obtaining buy-in from stakeholders is difficult iii. Additional cost for human and financial resources

Author, publication year	Description on disinvestment process / methods					Facilitators and Challenges in implementation	
	Identification	Prioritization	Assessment	Decision	Dissemination	Facilitators	Challenges
Garner et al., 2013	i. Potential productivity and cash- savings ii. Potential impact on quality of clinical care and outcomes iii. Potential impact on patient safety iv. Potential impact on patient and carer experience	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	i. Recommendation not applicable to local health care setting ii. Framework and recommendation not relevant to clinical practice iii. Specific review / assessment found an **absence of evidence** rather than evidence of a lack of efficacy and effectiveness - Cochrane using randomised trials
Polisena et al., 2013	Not mentioned	i. Disease burden ii. Clinical effectiveness and safety iii. Cost-effectiveness, opportunity cost iv. Health services impact (ethical, legal, psychosocial) v. Stakeholder and public engagement vii. Data sources	i. PBMA (majority) ii. HTA iii. Accountability for Reasonableness (A4R) and quality improvement theory - Sweden	i. reduce utilisation, interventions discontinued ii. changes in resource allocation ii. cost reduction in overall management of the specific condition ii. no change (adequate funding)	Not mentioned	i. Interdisciplinary panel: executives, directors, managers, clinical leads, physicians, specialists, researchers and academics, health economists - robust decision-making ii. Patient/community representatives - improve acceptability iii. PBMA - transparent and structured framework	i. PBMA - uncertainty on whether the correct decisions were made ii. PBMA - require training and sufficient time to be executed iii. Insufficient clinical effectiveness, safety studies, or cost data - difficult to make evidence-based recommendations iv. HTA - focused on specific technologies, principally in fee-for-service structures.

Supplementary documents for Chapter 3

Methodological approach for disinvestment in healthcare

Supplementary 3-1: Stages in Programme Budgeting and Marginal Analysis (PBMA) and the key considerations

PBMA Stage	Considerations
1. Choose a set of meaningful programmes	• An awareness of boundaries is essential to consider at this stage. If activity occurs across boundaries, it can be difficult to attribute spending and outcomes to specific activities. • It is recommended that a PBMA panel comprise of experts in the field of the activity under scrutiny and have representation from relevant stakeholder groups • A further consideration is to include membership or representation from heads of departments, service managers, and finance managers who are able to effect changes resulting from the PBMA exercise. • A chairperson may also be appointed to facilitate panel discussion and summarise the key points to help the panel make its decisions.
2. Identify current activity and expenditure in those programmes	• Relevant finance staff expertise could be beneficial to establish the proportional spend for each activity and calculate potential cost savings based on alternative scenarios of resource allocation. • It is advised to operationalisation group contains expertise of the programme, service, or intervention under scrutiny, and health economists.
3. Think of improvements	• Use of platforms such as online surveys, engagement events, focus groups, one-to-one interviews, and previous audits or reviews undertaken by the service can be utilised to gain suggestions for improvements. • Seeking expert opinion provides justification of why these candidates were suggested to the panel.
4. Weigh up incremental costs and incremental benefits and prioritise a list	• The panel should create a list of criteria that will be used to appraise the resource reallocation candidates. • The panel should also assign rankings to their chosen criteria, or state weightings that are assigned to each criteria so it is clear how the candidates were appraised. • The aims of the PBMA exercise should also be considered and decided upon by the panel. This is particularly relevant if there is a target amount of cost savings the PBMA exercise needs to achieve due to shrinking budgets. The aim provides a steer for discussions and outcomes for the exercise. • Evidence should be presented consistently for all candidates to allow for cross-comparisons. Evidence should be presented in an accessible format and explain terminology that may be unfamiliar (eg. QALYs).

PBMA Stage	Considerations
5. Consult widely	• The PBMA panel should have plenty of opportunity and time to discuss the budget, activity, and review the related evidence. • Making the evidence gathered on candidates available prior to discussions allows panel members time to digest the evidence and come prepared to the discussion sessions. • Discussion (facilitated by a chairperson) to assist the panel to reach disinvestment and reinvestment recommendations. Presence of those who gathered evidence and prepared finance information is recommended so the panel may ask questions.
6. Decide on changes	• Based on the discussions undertaken by the panel (keeping in mind the criteria and aims of the PBMA exercise), recommendations should be presented. • These recommendations could take the form of dichotomous 'disinvest' or 'invest' choices for each candidate/activity, or which candidates/activities are high or low priority. • The panel should progress to state how much in monetary terms it wishes to disinvest or reinvest. • Recommendations could be achieved by; ▪ holding a vote (using open or closed/electronic techniques) ▪ conducting a ranking exercise ▪ chairperson judgement on the consensus in the room
7. Effect the changes	• The format of the presentation could be in the form of a report or verbal presentation. • Representation from managers and directors during the PBMA exercise would provide an understanding of the context and discussions that led to the recommendations. • In the absence of this, individuals are encouraged to bear in mind the importance of providing the audit trail to candidate generation and a summation of the key points raised in the discussions.
8. Evaluate progress	• PBMA should be viewed as a form of iterative audit. • The recommendations from the current PBMA exercise should be re-evaluated in the future. • Individuals should be guided by the factors that could affect the previous recommendations; for example, the availability of new programmes, initiatives, and technologies, relevant guidelines, new policies, change in directorship, and further restrictions on budgets to decide when to undertake this re-evaluation.

Adapted from Table 14.1 *(source: Charles J, Edwards R. To disinvest or invest? The role of programme budgeting and marginal analysis (PBMA) for economic evaluation and prioritization between public health interventions. Applied Health Economics for Public Health Practice and Research: Oxford University Press; 2019. p. 317-18)*

Supplementary documents for Chapter 4

Stakeholders' perspectives on disinvestment of low-value healthcare interventions and practices in Malaysia: An online survey

Supplementary 4-1: Examples of comments from face validity of survey questionnaire

Panel	Comments
FV1	• Time taken: 30 minutes • I think your participant information sheet is a very nice idea because without them, it's difficult to understand the terms too. • Especially Q11, 12, it took a while. • I think for your target group interviewers, they might take longer time than me. • Because they will fill more information (I did not fill the questions about Malaysian healthcare) • Probably from 40 minutes and up to one hour to finish it. • From my experience, if stakeholders get this form, they will use it as a chance to 'complaint' and write a lot.
FV2	• Time taken: 22 minutes • It is generally clear and easy to use but I have some specific comments below: • Q12 - maybe add a bit more to explain what you mean here - priority when you are assessing or when you are triggering disinvestment? • Q14 - do you only want people to answer this if they have experience of disinvestment? • Q14 - not allowing me to put numbers in - just crosses • Q16 - is this more complicated than it needs to be? I was wondering about the relevance of the red cell & serum folate • Q17 - 20 - maybe set out how you want people to indicate which answer they want - highlight? • Q18 - think this should be the agree/disagree answers • Q21 - do you need this question to be more than one question - should a disinvestment in another country automatically trigger a process in Malaysia? What should the process look like? Use the language around adaptability as for HTA reports.

Supplementary 4-2: Examples of content validity index assessment of survey questionnaire

Question	Are the items representative of concepts related to disinvestment?				Are the items relevant to the concepts related to disinvestment?				Are the items clear in term of wordings? (clarity)				Comments *(Panel A, Program manager in MOH Malaysia)*
	1	2	3	4	1	2	3	4	1	2	3	4	
Q8	☐	☐	☐	☒	☐	☐	☐	☒	☐	☐	☒	☐	Clear question and a good start for the domain.
Q9	☐	☒	☐	☐	☐	☐	☒	☐	☐	☐	☒	☐	Suggest having more options for critical successful factor to balance the factors related to unobtainable target.
Q10	☐	☐	☐	☒	☐	☐	☐	☒	☐	☐	☐	☒	Interesting question, may trigger the respondents to write a short essay on their opinion.
Q11	☐	☐	☐	☒	☐	☐	☐	☒	☐	☐	☒	☐	Very relatable. “One-in-one-out” policy might be confusing/unfamiliar for some respondent.
Q12	☐	☐	☐	☒	☐	☐	☐	☒	☐	☐	☐	☒	The explanations given in bracket are helpful.
Q13	☐	☐	☒	☐	☐	☐	☐	☒	☐	☐	☒	☐	Suggest separating “decision makers/key leaders” with “budget holders/resource managers”
Q14	☐	☐	☐	☒	☐	☐	☐	☒	☐	☐	☐	☒	Consistency in ranking must be decided.
Q15	☐	☐	☐	☒	☐	☐	☐	☒	☐	☐	☐	☒	Same as Q14, consistency in ranking.
Q16	☐	☐	☒	☐	☐	☐	☒	☐	☐	☒	☐	☐	Vignette too long. Maybe difficult to understand for non-clinical personnel. Suggest to simplify the text.
Q17	☐	☐	☒	☐	☐	☐	☐	☒	☐	☐	☐	☒	Instruction should be included.
Q18	☐	☐	☒	☐	☐	☐	☐	☒	☐	☐	☒	☐	For Q17-Q20, suggest having 5 scale, including neutral/neither agree nor disagree.
Q19	☐	☐	☐	☒	☐	☐	☐	☒	☐	☐	☐	☒	Same as above.
Q20	☐	☐	☐	☒	☐	☐	☒	☐	☐	☐	☐	☒	I expect majority will answer agree/strongly agree
Q21	☐	☐	☒	☐	☐	☐	☐	☒	☐	☐	☐	☒	Looks like prompt question. Suggest making it open to allow respondents give their opinion.

Ratings:
1 = not relevant/not clear
2 = item need revision
3 = relevant but need minor revision/clear but need minor revision
4 = very relevant/very clear or unambiguous

Adapted from:

1. *Polit DF, Beck CT. The content validity index: are you sure you know what's being reported? Critique and recommendations. Research in nursing & health. 2006 Oct;29(5):489-97.*
2. *Kumar PR, Yee A, Francis B, Danaee M. Adaptation and Validation of a scale to Assess Knowledge, Attitudes, and Perceptions of Healthcare Workers Towards Alcohol Withdrawal and Its Detection. International Journal of Mental Health and Addiction. 2022 Oct;20(5):3006-21.*

Supplementary 4-3: Overall item content validation index (I-CVI) and Kappa statistic for survey questionnaire (representativeness, relevancy and clarity)

Question	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5	Panel 6	Total Agreement (A)	Total Expert (N)	I-CVI	Kappa	Results
Q8	Y	Y	Y	Y	Y	Y	6	6	1.000	1.000	Validated
Q9	N	Y	Y	Y	Y	Y	5	6	0.833	0.816	Validated
Q10	Y	Y	Y	Y	Y	Y	6	6	1.000	1.000	Validated
Q11	Y	Y	Y	Y	Y	Y	6	6	1.000	1.000	Validated
Q12	Y	Y	Y	Y	Y	Y	6	6	1.000	1.000	Validated
Q13	Y	Y	N	Y	Y	Y	5	6	0.833	0.816	Validated
Q14	Y	Y	Y	Y	Y	Y	6	6	1.000	1.000	Validated
Q15	Y	Y	Y	Y	Y	Y	6	6	1.000	1.000	Validated
Q16*	N	N	Y	N	Y	Y	3	6	0.500	0.273	Corrected (clarity)
Q17	Y	Y	Y	N	Y	Y	5	6	0.833	0.816	Validated
Q18	Y	Y	Y	N	Y	Y	5	6	0.833	0.816	Validated
Q19	Y	Y	Y	N	Y	Y	5	6	0.833	0.816	Validated
Q20	Y	Y	Y	N	Y	Y	5	6	0.833	0.816	Validated
Q21	Y	Y	Y	Y	Y	Y	6	6	1.000	1.000	Validated
Proportion relevant	0.857	0.929	0.929	0.643	1	1					

Item content validity index (I-CVI): > 0.79 (validated), 0.70-0.79 (needs revision), < 0.70 (eliminated).
Kappa (k): excellent (≥0.74), good (0.60 to 0.73), moderate (0.40 to 0.59), poor (≤0.39).
***Question 16 (clinical vignette) was revised to ensure clarity of the case example and validated with the panel after the amendment.**

Supplementary 4-4: Final survey questionnaire

Stakeholder perspectives on disinvestment of low-value healthcare interventions and practices in Malaysia: A survey of healthcare key informants

The participants will have to complete this online survey which includes a series of open and closed questions, and comprises of **5 sections**:

A. Background information
B. Knowledge and perceptions on disinvestment in healthcare
C. Disinvestment initiatives within organisation / workplace
D. Facilitators and challenges in implementation of disinvestment activity and programme
E. Receptivity and expectation on implementation of disinvestment initiatives within Malaysian health care system

By clicking the button below, you acknowledge:

- Your participation in the study is voluntary
- All data and information that you provide will be kept confidential and will only be used for the purpose of this research project
- You are aware that you are free to withdraw at any time for any reason

Do you agree and consent to take part in this survey?

☐ Yes, I consent to begin the study.

☐ No, I do not consent and I disagree to participate. *(exit from survey)*

Section A: Background Information

Q.1 Your current workplace:

_____

Q.2 What is your primary professional role within the health care? *(Choose all that apply)*

☐ **Resource allocation decision makers / Budget holders**
(e.g. Programme Managers, Hospital Directors, Head of Clinical Services, others)
Please specify: _____

☐ **Clinical care providers** *(e.g. clinician, physician, pharmacist, nurse, allied health)*
Please specify: _____

☐ **Researchers / academia / experts in Health Technology Assessment (HTA) and/or Health Economics and/or Health Services** *(panels of Technical Advisory Committee, university lecturer, interested research groups working in HTA, health economics or health administration/ management)*
Please specify: _____

☐ **Other than mentioned above**
Please specify: _____

Q.3 Experience in the above role (years):

_____

Q.4 Level of governance / decision-making in health care system you are most familiar with: *(Choose all that apply) [Note: you do not need to be directly involved in decision-making]*

☐ National level

☐ State / Federal territory level

☐ Regional level (e.g., health authority, health district, health region)

☐ Single organisational level (e.g., hospital / institute, primary care, community organisation, residential care facility)

☐ Other than mentioned above
Please specify: _____

Q.5 What are the types of health technologies or scope in the context of decision-making that you are familiar with? *(Choose all that apply)*

☐ Pharmaceuticals / drugs / medicines

☐ Non-pharmaceuticals (e.g., medical devices, digital technologies, medical procedures, screening programmes, diagnostic devices, health programmes)
Please specify: _____

☐ Specific fields of care (e.g., primary care, cancer, public health).
Please specify: _____

☐ Work force / human resources

☐ Other than mentioned above
Please specify: _____

Section B: Knowledge and perceptions on disinvestment in healthcare

Q.6 What do you understand by the term "disinvestment in healthcare"?

Q.7 Do you think formal disinvestment process is needed in healthcare, related to the context of your level of governance?

☐ **Yes** (please state your reason)

☐ **No** (please state your reason)

Q.8 From your understanding, the purpose of disinvestment includes: *(Choose all that apply)*

☐ Cost-saving to health care system by removing unnecessary spending

☐ Reduction of the waste of resources by minimising ineffective spending

☐ Reinvestment in health technologies or interventions which have higher values

☐ Shifting resource from one area of healthcare to another (reallocation of resource)

☐ Removing "no- or low-value" technologies / treatments from clinical practice

☐ Improving quality of care and widening service provision

☐ Increase benefits to patients and community as a whole

☐ Ensuring optimum clinical effectiveness and safe treatments provided to patients

☐ Informed decision-making in addressing budgetary gaps or limited resources

☐ Reducing variation in clinical practice by limiting health technologies / treatments / practices in the benefits package / guidelines

☐ Other than mentioned above

Please specify: _____

Section C: Disinvestment initiatives within organisation / workplace

Q.9 Do you have any previous experience with disinvestment / resource reallocation activity in your organisation/institution/department?

☐ **Yes** (please provide example) *(go to Q.9a)*

☐ **No** *(go to Q.10)*

Q.9a *(If Yes in Q.9)* Does it achieve the purpose and goal of this activity within your organisation / institution / department?

☐ **Yes** *(go to Q.9b)*

☐ **No** *(go to Q.9c)*

Q.9b *(If Yes in Q.9a)* What are the factors that contribute to the success of the disinvestment activity? *(Choose all that apply)*

☐ Participation of a diverse range of stakeholders with varying roles and expertise

☐ Use of systematic and acceptable method or process for decision-making in disinvestment

☐ Availability of evidence and local data to support decision-making in disinvestment

☐ Presence of strong leadership (including funding) to ensure implementation of disinvestment decision taking place

☐ Ongoing interactions, training and knowledge exchange among stakeholders to support implementation of disinvestment recommendations

☐ Other than mentioned above

Please specify: _____

Q.9c *(If No in Q.9a)* What are the factors that contribute to the unobtainable target of this activity? *(Choose all that apply)*

☐ Reluctance from stakeholders (e.g. clinician, care provider) to change practice

☐ Lack of funding for implementation of disinvestment activity or decision

☐ Lack of training on how to conduct the assessment for disinvestment purpose

☐ Lack of support from key leader(s) to implement disinvestment decision

☐ Relevant data are not available to demonstrate inefficiency of a health technology or evidence of low-value care for the purpose of disinvestment

☐ Other than mentioned above

Please specify: _____

Q.10 Do you think disinvestment or reassessment of health practices and technologies should be carried out on a regular basis as part of the organisational / departmental activities? If so, why?

☐ **Yes** (please state your reason)

☐ **Maybe** (please state your reason)

☐ **No** (please state your reason)

Q.11 From your opinion or previous experience, what are the **triggers in initiating assessment for disinvestment activity**? *(Choose all that apply)*

☐ Change in budgetary planning / resource allocation

☐ Presence of new evidence on effectiveness or safety on a health technology

☐ Variation in practice at care level *(e.g. conflicting with CPG, guidance)*

☐ Evidence of public interest or controversies *(e.g. equity issues)*

☐ Evidence of harmful effect to patients or safety issues

☐ Decreased frequency of use / prescription / utilisation of a health technology

☐ Presence of new technology to be included in the service hence the low-value technology need to be taken out *("one-in-one-out" policy)*

☐ Other than mentioned above *(please specify)*

_____

Q.12 What criteria should be considered as **priorities** in conducting assessment for disinvestment? Please rank the statements with rank 1 is the highest priority.

☐ **Evidence of clinical effectiveness** *(effect and safety of treatment, quality of life before and after treatment, necessity for further research, clinical practice, patient relevance)*

☐ **Evidence of cost-effectiveness** *(high cost but low benefits / outcomes, cost for maintenance or implementation higher than expected benefits)*

☐ **Necessity** *(burden of illness, medical necessity, no alternative treatment, individual responsibility / lifestyle)*

☐ **Feasibility** *(support by society in discontinuing treatment, presence of alternative, availability of mechanism / data to support reassessment)*

☐ **Health technology life cycle** *(legacy items or interventions that had never been assessed before, obsolete technologies, approved to be used for research purpose but low uptake by patients)*

☐ **Equity / fairness** *(treatment affects a certain group of people in society such as vulnerable group or rare disease; end-of-life care, treatment for life-threatening condition in young people)*

☐ **Other than mentioned above** *(please specify)*

_____

Q.13 Who should be the stakeholders involved in disinvestment activity or resource reallocation? *(Choose all that apply)*

☐ Decision-makers / key leaders

☐ Budget holder / funding managers

☐ Clinical care providers (clinicians or physicians, pharmacists, nurses, allied health)

☐ Public society / community

☐ Patient or patient's representative (e.g. support group, cancer patient society)

☐ Other than mentioned above *(please specify)*

_____

Section D: Facilitators and challenges in implementation of disinvestment activity

Q.14 In your opinion, what are the facilitators for the implementation of disinvestment or resource reallocation of low-value care that you can identify in the context you are involved with? Please rank the statements with rank 1 is the highest priority.

- ☐ Involvement of various stakeholders in healthcare
- ☐ Organisational culture for improvement in quality of care and openness to change, including strong leadership.
- ☐ Transparent and robust method for identification, prioritisation, and assessment of candidates for disinvestment
- ☐ Integrating local context in formulating recommendation for disinvestment purpose
- ☐ Other than mentioned above *(please specify)*

_____

Q.15 In your opinion, what are the barriers or challenges for the implementation of processes for disinvestment or resource reallocation of low-value care that you can identify in the context you are involved with? Please choose maximum of 7 options.

- ☐ Lack of expertise to assess a health technology / practice / medicine for disinvestment decision
- ☐ Lack of support from the important stakeholders (e.g. refusal from care provider to remove certain practices / technologies / legacy drugs)
- ☐ Perceptions that disinvestment removes subsidies to patient or 'takes away' treatment options from patient.
- ☐ Lack of relevant data to conduct assessment for disinvestment
- ☐ Conflicting priorities among stakeholders in making decision
- ☐ Uncertainty over the benefits of the decision to disinvest low-value care
- ☐ Lack of systematic decision process for disinvestment (no available framework)
- ☐ Clinician reluctance to remove practices, thinking that disinvestment limits health providers' clinical autonomy and reduces prescriber treatment options
- ☐ Perception that the management priority is only to save money
- ☐ Lack of incentives and funding to implement disinvestment decision

Q.16 Please read the case scenario below and answer the following question:

As part of Quality Improvement initiatives in the Ministry of Health and in line with the call for implementation of value-based decision-making for resource allocation, Hospital X is encouraged to identify areas for improvement, where potential de-implementation of low-value practices (due to inefficiency or minimal benefit) can be suggested.

Concurrently, there is substantial rise in the test for vitamin B12 level in Hospital X. For a period of 6 months in 2022, the number of tests ordered for serum B12 reached 280 tests, doubled from the number of tests performed in 2021. This was alerted to the Head of Pathology and upon further investigation, it was found that most of the tests were done with the indication of "new episode of unexplained fatigue" among hospitalised adult patients. About 80% of tests were performed for the purpose of screening / diagnosing rather than monitoring. It was considered as unnecessary test and usually, patients with unexplained fatigue are treated symptomatically with oral B12 supplement without prior diagnostic test.

As the test for serum B12 was carried out together with red cell folate and serum folate, it incurred a higher cost compared to previous years. Hence, it is suggested that serum cobalamin test for "unexplained fatigue" should be considered for delisting from subsidised pathology test under public fund.

In your opinion, what are the factors that may influence your decision whether to disinvest or not in this scenario? Please rank the statements with rank 1 is the highest priority.

- ☐ Availability of evidence to support the assessment and decision
- ☐ Having something else to offer in compensating the de-listing of this practice (e.g. treatment with oral B12 without testing)
- ☐ Cost of current practice and cost of alternative strategy that will be implemented
- ☐ Patient factors and risk of not performing the test (e.g. prescribing B12 supplement without doing the test may be considered as over-treating)
- ☐ Feasibility to change practice, especially among the clinicians
- ☐ Other than mentioned above *(please specify)*

_____

Section E: Receptivity and expectation of disinvestment initiatives within the Malaysian health care system

Please select one answer for each statement on your opinion regarding implementation of disinvestment initiatives within the Malaysian healthcare system:

Q.17 I think, having a formal framework for disinvestment in the Malaysian health care system is important.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree

Q.18 If disinvestment initiatives are to be implemented, a specific training related to the process and methods for disinvestment is needed.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree

Q.19 I am concerned that most healthcare stakeholders in Malaysia lack the knowledge and guidance to implement the disinvestment decision.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree

Q.20 I am concerned that the implementation of disinvestment decisions will cause extra works and burden to my staff / myself.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree

Q.21 If a health technology has been disinvested in other setting (e.g. country or region), should the same technology be reassessed locally for disinvestment? Why?

☐ **Yes** (please state your reason)

☐ **No** (please state your reason)

Q.22 If formal process or framework for disinvestment of health technologies or reassessment of low-value care is to be developed by Ministry of Health Malaysia, what is your expectation from the process?

Q.23 If you have any other comments in relation to disinvestment in Malaysian healthcare system, please write them below.

Q.24 Do you know other healthcare professionals, decision-makers or researchers in Malaysia who may also be able to contribute to this project? Could you please list below their names and institutional affiliation (and/or email address)? Otherwise, please feel free to share the survey link with these potential participants.

Thank you for taking the time to complete this survey. We greatly value and appreciate your participation. For the researchers to gain a more in-depth perspectives on disinvestment initiatives and the process for its implementation in Malaysian healthcare, we wish to conduct **a semi-structured follow-up interview** (around 30-45 minutes) with healthcare stakeholders in Malaysia. If you are happy to participate in such an interview, please check the appropriate box below and leave your name and e-mail address. We will contact you for further information on the follow up interview.

☐	**Yes, I would like to participate in a follow-up interview (please give your name and email address / contact number)**
☐	**No, thank you.**

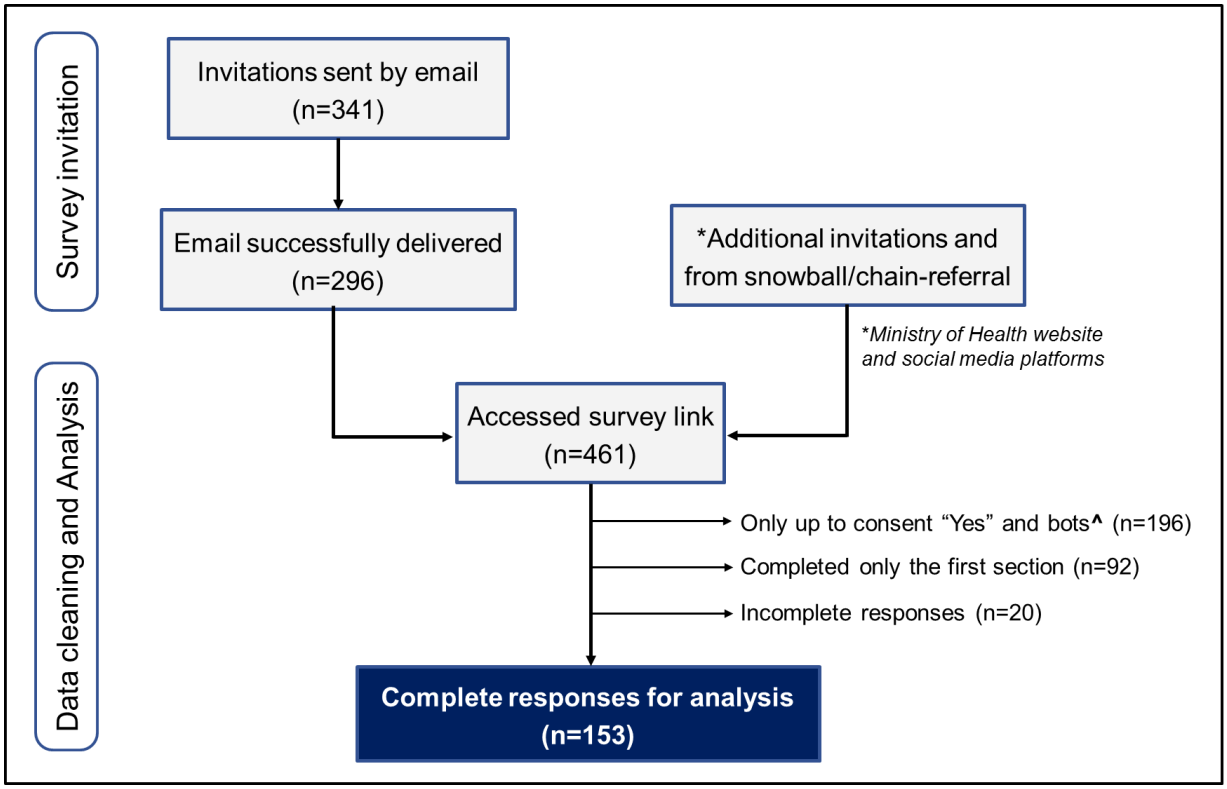
Supplementary 4-5: Checklist for Reporting of Survey Studies (CROSS)

Section/topic	Item	Item description	Reported on page #
Title and abstract			
Title and abstract	1a	State the word "survey" along with a commonly used term in title or abstract to introduce the study's design.	**96-98**
	1b	Provide an informative summary in the abstract, covering background, objectives, methods, findings/results, interpretation/discussion, and conclusions.	**98**
Introduction			
Background	2	Provide a background about the rationale of study, what has been previously done, and why this survey is needed.	**99-100**
Purpose/aim	3	Identify specific purposes, aims, goals, or objectives of the study.	**100**
Methods			
Study design	4	Specify the study design in the methods section with a commonly used term (e.g., cross-sectional or longitudinal).	**101**
Data collection methods	5a	Describe the questionnaire (e.g., number of sections, number of questions, number and names of instruments used).	**102**
	5b	Describe all questionnaire instruments that were used in the survey to measure particular concepts. Report target population, reported validity and reliability information, scoring/classification procedure, and reference links (if any).	**101, 102, Supplementary 4-1 to 4-3**
	5c	Provide information on pretesting of the questionnaire, if performed (in the article or in an online supplement). Report the method of pretesting, number of times questionnaire was pre-tested, number and demographics of participants used for pretesting, and the level of similarity of demographics between pre-testing participants and sample population.	**102**
	5d	Questionnaire if possible, should be fully provided (in the article, or as appendices or as an online supplement).	**Supplementary 4-4**
Sample characteristics	6a	Describe the study population (i.e., background, locations, eligibility criteria for participant inclusion in survey).	**101**
	6b	Describe the sampling techniques used (e.g., single stage or multistage sampling, simple random sampling, stratified sampling, cluster sampling, convenience sampling). Specify the locations of sample participants whenever clustered sampling was applied.	**101**
	6c	Provide information on sample size, along with details of sample size calculation.	**101-102**
	6d	Describe how representative the sample is of the study population (or target population), particularly for population-based surveys.	**101-102**
Survey administration	7a	Provide information on modes of questionnaire administration, including the type and number of contacts, the location where the survey was conducted (e.g., outpatient room or by use of online tools, such as SurveyMonkey).	**102-103**
	7b	Provide information of survey's time frame, such as periods of recruitment, exposure, and follow-up days.	**103**

	7c	Provide information on the entry process: ->For non-web-based surveys, provide approaches to minimize human error in data entry. ->For web-based surveys, provide approaches to prevent “multiple participation” of participants.	**103**
Study preparation	8	Describe any preparation process before conducting the survey (e.g., interviewers’ training process, advertising the survey).	**101-102**
Ethical considerations	9a	Provide information on ethical approval for the survey if obtained, including informed consent, institutional review board [IRB] approval, Helsinki declaration, and good clinical practice [GCP] declaration (as appropriate).	**103**
	9b	Provide information about survey anonymity and confidentiality and describe what mechanisms were used to protect unauthorized access.	**103**
Statistical analysis	10a	Describe statistical methods and analytical approach. Report the statistical software that was used for data analysis.	**103**
	10b	Report any modification of variables used in the analysis, along with reference (if available).	**NA**
	10c	Report details about how missing data was handled. Include rate of missing items, missing data mechanism (i.e., missing completely at random [MCAR], missing at random [MAR] or missing not at random [MNAR]) and methods used to deal with missing data (e.g., multiple imputation).	**NA**
	10d	State how non-response error was addressed.	**NA**
	10e	For longitudinal surveys, state how loss to follow-up was addressed.	**NA**
	10f	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for non-representativeness of the sample.	**NA**
	10g	Describe any sensitivity analysis conducted.	**103 (cross-tabulation, sub-group analysis)**
Results			
Respondent characteristics	11a	Report numbers of individuals at each stage of the study. Consider using a flow diagram, if possible.	**104, Table 4-1 & Supplementary 4-6**
	11b	Provide reasons for non-participation at each stage, if possible.	**104, Table 4-1 & Supplementary 4-6**
	11c	Report response rate, present the definition of response rate or the formula used to calculate response rate.	**NA**
	11d	Provide information to define how unique visitors are determined. Report number of unique visitors along with relevant proportions (e.g., view proportion, participation proportion, completion proportion).	**104, Table 4-1 & Supplementary 4-6**
Descriptive results	12	Provide characteristics of study participants, as well as information on potential confounders and assessed outcomes.	**104-105, Table 4-1**
Main findings	13a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates along with 95% confidence intervals and p-values.	**NA**

	13b	For multivariable analysis, provide information on the model building process, model fit statistics, and model assumptions (as appropriate).	**NA**
	13c	Provide details about any sensitivity analysis performed. If there are considerable amount of missing data, report sensitivity analyses comparing the results of complete cases with that of the imputed dataset (if possible).	**NA**
Discussion			
Limitations	14	Discuss the limitations of the study, considering sources of potential biases and imprecisions, such as non-representativeness of sample, study design, important uncontrolled confounders.	**116-117**
Interpretations	15	Give a cautious overall interpretation of results, based on potential biases and imprecisions and suggest areas for future research.	**115-117**
Generalizability	16	Discuss the external validity of the results.	**116-117**
Other sections			
Role of funding source	17	State whether any funding organization has had any roles in the survey's design, implementation, and analysis.	**118**
Conflict of interest	18	Declare any potential conflict of interest.	**118**
Acknowledgements	19	Provide names of organizations/persons that are acknowledged along with their contribution to the research.	**97 & 118**

Supplementary Figure 4-6: Flowchart of survey invitation and response



^Notes:

In our analysis, two indicators were used to identify whether the responses originated from bots or from human:

i. **Super-fast responses** (less than 3 minutes). For the completed survey, we checked the time to complete the survey one by one. The fastest time taken by the respondents to complete the survey was 9 minutes.

ii. **Duplicate IP addresses**. Bots often use the same IP address to answer surveys repeatedly in a short period of time.

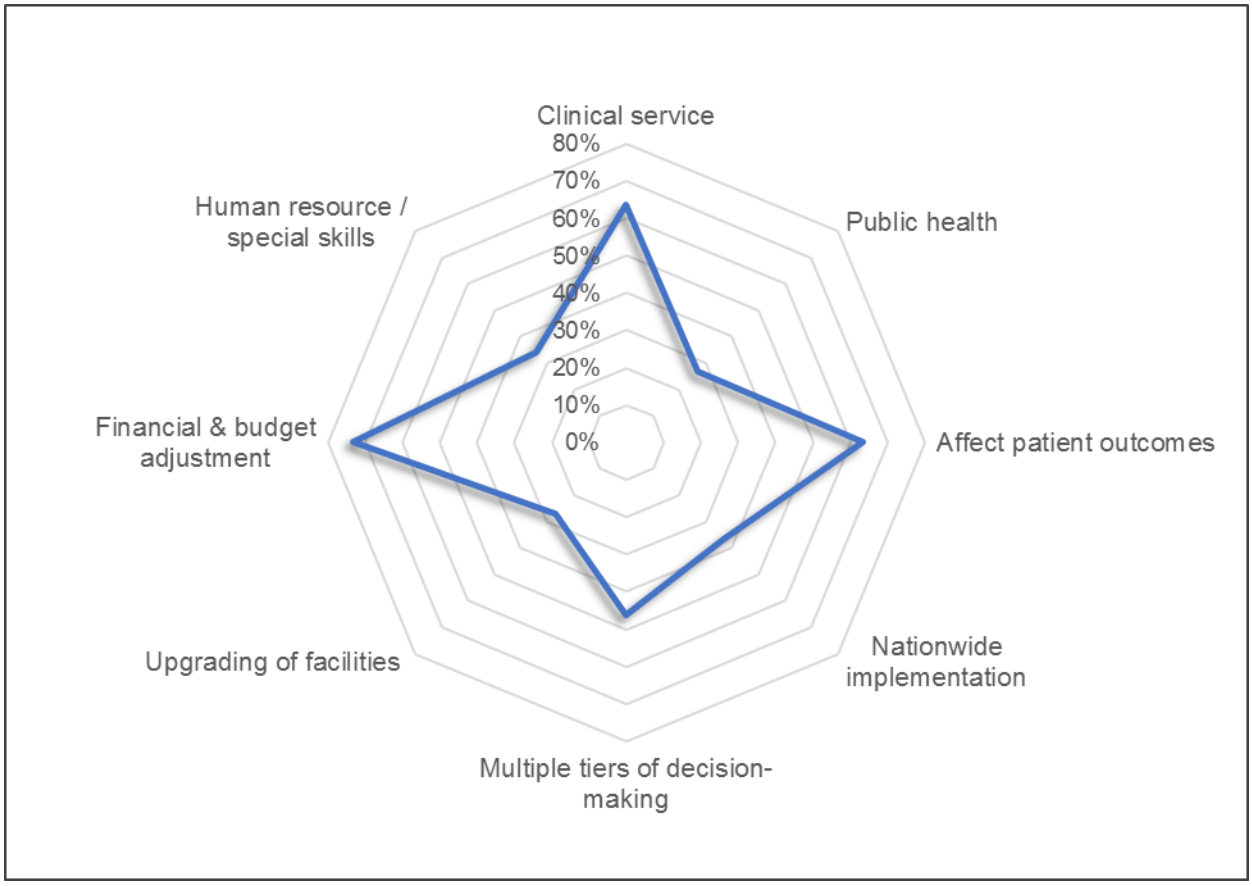
'Bot detection function' was enabled in Qualtrics which allows us to track which responses are likely to be bots.

Supplementary 4-7: Disinvestment activity experiences by survey respondents

(sub-grouping using content analysis based on similarity of activities)

A. Pharmaceuticals	
1.	Removing non-essential drugs that were not used much / has no clinical evidence and cost-effectiveness evidence from health clinics and hospitals formulary lists
2.	Re-proportionate the amount of generic and original brand of medications for patients
3.	Streamlined the use of angiotensin receptor blockers (ARB) as there were too many different strengths and types in the formulary (de-listing, revise indication for some ARBs)
4.	Cutting budget for some basic medications in district health clinic
5.	Reassessment and Selection Strategy of Dipeptidyl Peptidase-4 Inhibitors for Ministry of Health Malaysia Medicine Formulary
6.	Re-assessment of inhalers for COPD and asthma for listing and de-listing from formulary
7.	Reducing the purchase of unnecessary medicine such as oral supplement
B. Hospital management	
8.	Outsourcing kitchen service to third party for patient meals preparation
9.	Re-zoning the laboratories in hospital
C. Clinical and surgical procedures	
10.	Re-evaluate the need for 'routine' blood & radiological investigations before surgery
11.	Laser treatment for hemorrhoidal disease (beneficial in early disease but too costly)
12.	Shifting from thrombolysis care to primary PCI for acute myocardial infarction
13.	Removing annual ECG checking for stable hypertensive patients during clinic appointment
D. Medical devices and digital health	
14.	Re-assessment of outdated medical appliances and systems (ventilators, ultrasound machine, critical care monitoring system) to replace with the latest machines and system
15.	Change of conventional x-ray to digital x-ray in primary care clinics
16.	Re-location of laser machine to specialised center
17.	Relocation of biochemical machine to other district hospital
E. Community health and primary care	
18.	Closure of 1Malaysia clinics, rebranding to community health clinics
19.	Disinvest some of the services in PeKa B40 programs which involve private GP
F. Public health programmes	
20.	Removal of Hepatitis B screening from Occupational and Safety Health activities / stop screening staff that was born after 1989
21.	Shift from pap smear to HPV DNA testing for cervical cancer screening
22.	Re-assessment of vaccinations programs for national policy
G. Human resource and work force	
23.	Reallocation of staff to community-based wellness hub
24.	Combining units / departments due to lack of staff and redundant job scope
H. Others	
25.	Re-assessment of health education tools and services available
26.	Re-evaluation of budget for staff training that provide minimal output, low benefits
27.	Shifting from manual / paper-based patient satisfaction survey to online platform / QR code

Supplementary Figure 4-8: Complexity in decision-making related to reported disinvestment activities in Malaysian healthcare system



Supplementary 4-9: Examples of content analysis from respondents' direct quotes on the term 'disinvestment in healthcare'.

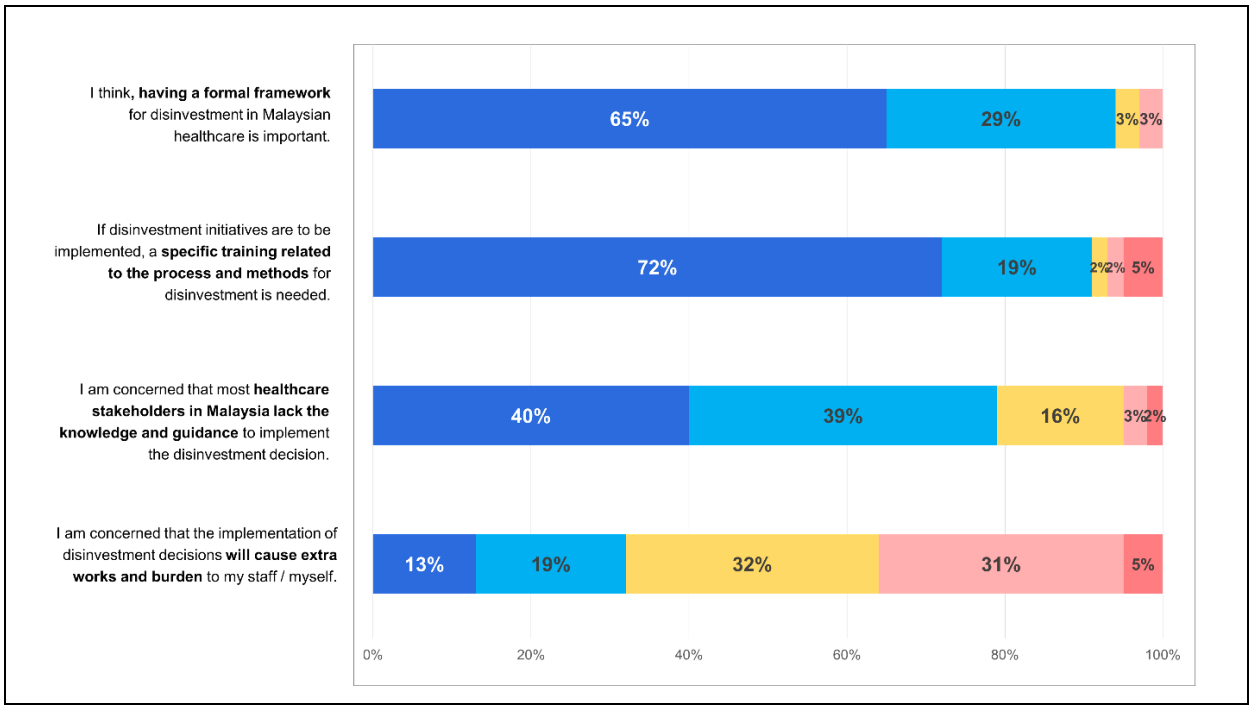
Examples of quotes	Themes / Sub-themes
"Taking out or withdrawing investment from existing healthcare practices/technology which no longer beneficial and efficient"	Withdrawing investment or funding Reduce budget / funding
"Decreasing the budget or funding for health-related programs"	
"Stop investment (money, time, human resource) into technologies with low impact or low yield"	
"Withdraw an existing investment or reduction of capital expenditures of healthcare thingy including policy, procedures, devices, medicines etc."	
"Not investing money, other resources, manpower anymore in healthcare"	
"Abstain something that have less value in healthcare system. For example, value of IT devices, health promotion devices."	Stop practice / provide low-value care (LVC) or inefficient programme Removal of obsolete technologies
"Stop doing things in healthcare that doesn't benefit anyone"	
"Discontinuation of certain healthcare technology/practices/procedures etc due to its devalue in healthcare."	
"Termination of unnecessary investment / spending things that does not give a good return in healthcare."	
"The necessity to stop offering low-value care and wasteful programs as it not given benefits anymore and furthermore becoming a burden"	
"Changes those higher authorities and policy-makers in health need to made to reassess, re-evaluate, re-analyse any form of low impact policies, less accurate guidelines, old technologies, unsuitable drugs, variety of healthcare programmes and others related to healthcare to better and effective ones"	Process of re-assessment of LVC Reallocation or shifting of resources
"Reallocation of funding and resources in the healthcare from least effective intervention/treatment based on latest medical evidence to another alternative that provide better outcome to the population."	
"Evaluate the allocation provided based on its outcome, to plan either to retain or re-allocate the allocation into other programmes"	
"To shift our country's resources from an ineffective healthcare services to a more cost-effective, robust & greater clinical evidence (of practice) ones."	

Supplementary 4-10: Examples of content analysis from respondents' direct quotes on the need for a formal disinvestment framework in Malaysian healthcare system.

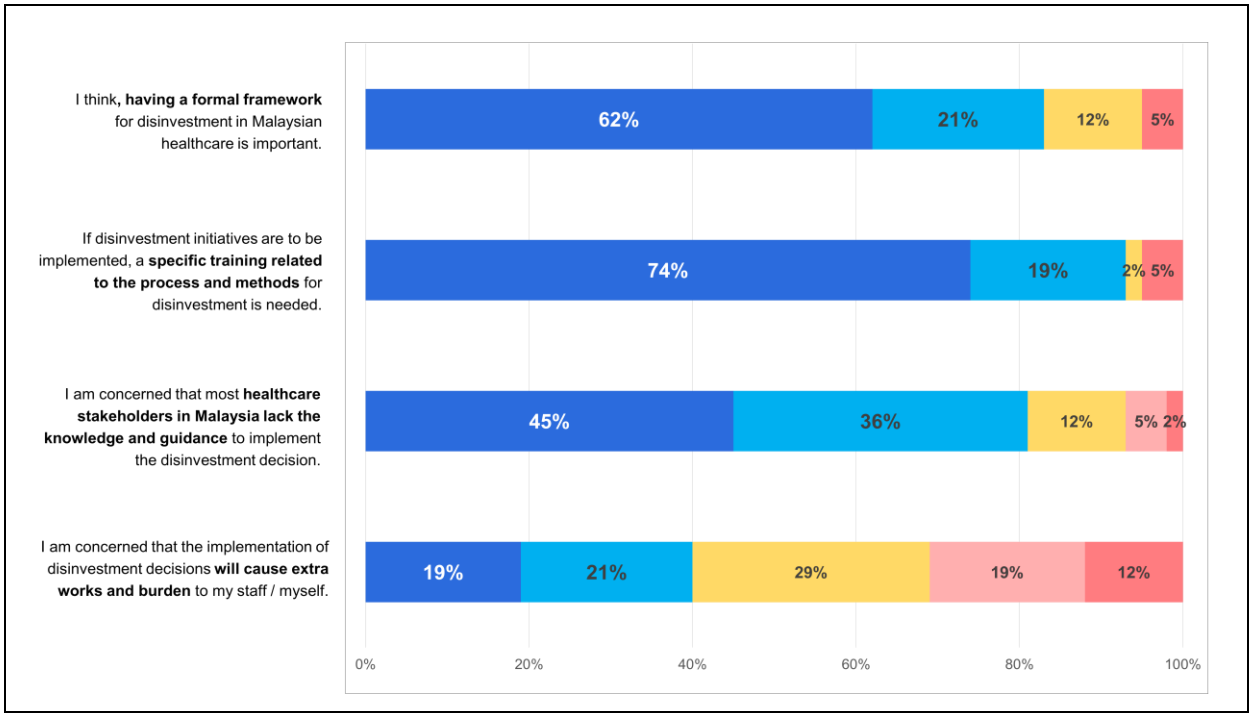
Examples of quotes	Themes / Sub-themes
"Will improve efficiency, reduce redundancies and remove obsolete technologies or work processes."	**Evaluate / monitor previous decision** **Healthcare sustainability**
"High cost of healthcare, unnecessary spending, therefore it is needed to ensure the system is more efficient and more people can get care that is both effective and safe"	
"Services / practices should be revised regularly to ensure program efficiency and effectiveness."	
"To identify potential health technologies that warrant reassessment which may have resulted from previous decision-making made in healthcare that were not evidence-based."	
"Save cost and better resource allocations to more important areas as the previous practices might be outdated."	**Priority-based resource allocation process** **Transparency in disinvestment decision-making**
"It is not necessarily needed for disinvestment or totally withdrawing the existing budget and resources. But on the other hand, it requires resources to be allocated based on priority and needs of health care practice."	
"So that the decision / evidence can be documented and disseminated formally to all healthcare institutions, can help to standardise practices."	
"Need to have certain criteria before decision on disinvestment is made, as for proper guidance."	
"To provide an evidence-based and structure approach towards disinvestment. Also, it will answer the question on why and how we remove a health technology so that all stakeholders agree with the decision eventually."	
"Improve healthcare delivery and indirectly affect the healthcare practices"	**Improve quality of care and health care services** **Shift resources to high-value care**
"Allow better technologies to come in because healthcare needs to be updated according 'what works best at the current time'."	
"This process would allow more latest & relevant healthcare equipment procured periodically to deliver substantial and first-class health care practices."	
"To ensure the optimum level of care and cost-effective intervention is provided to the population."	

Supplementary 4-11: Subgroup analysis of stakeholders' perspectives on implementing disinvestment initiatives based on years of experience.

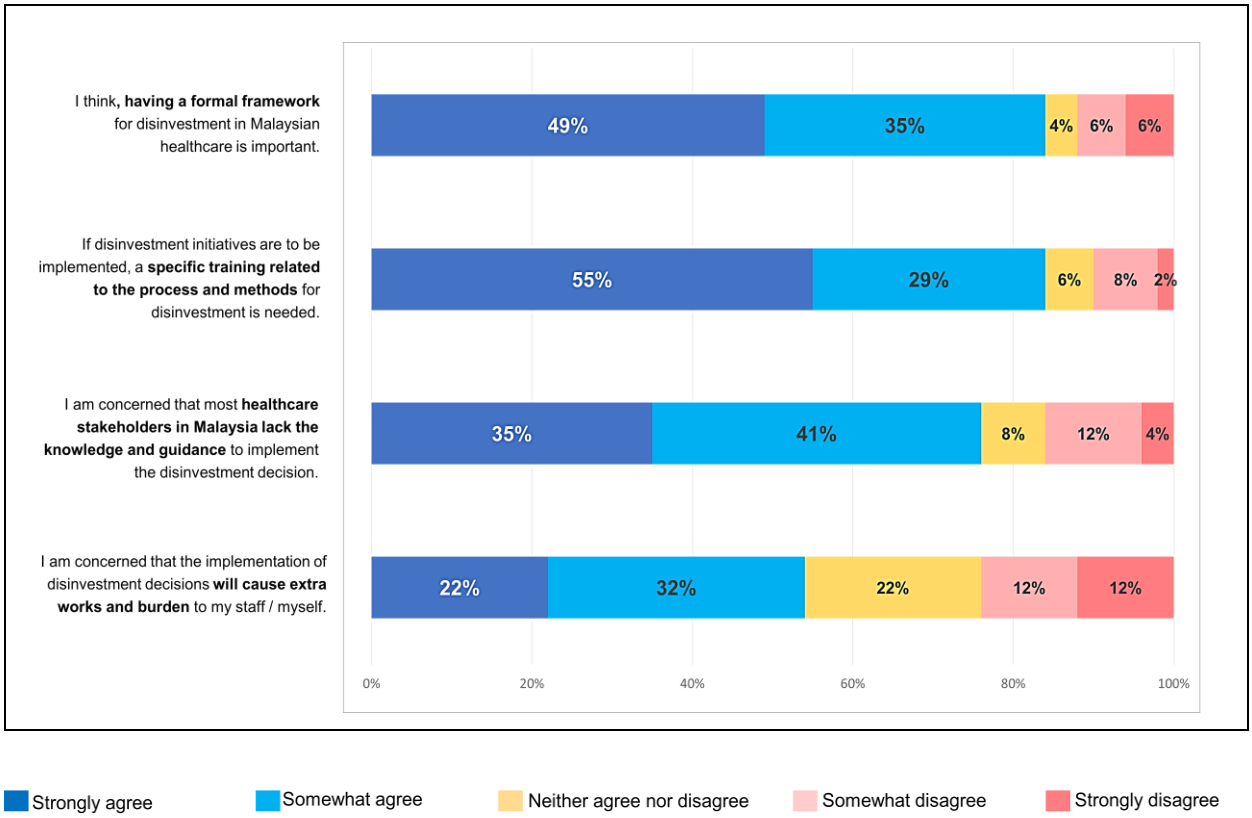
a. Experience in current role: 5 years and below (n=62)



b. Experience in current role: 6-10 years (n=42)



c. Experience in current role: More than 10 years (n=49)



Supplementary 4-12: Examples of content analysis from respondents' direct quotes on the stakeholders' expectation from the implementation of disinvestment framework in Malaysia.

Examples of quotes	Themes / Sub-themes
"Training of personnel provided, and information dissemination down to staff so we are aware of the objectives and this can align with our mindset and work process."	**Training on implementation of disinvestment framework**
"Awareness and training so that all are informed that the process benefits all level of healthcare. Not only feasible in tertiary hospital but in contrast, cannot be done in district hospital."	
"A clear term of reference (TOR) of the developed framework and relevant training should be offered."	
"A general framework that gives a guideline and links to important queries (legal, ethical and monetary policies)."	
"It should involve all stakeholders to optimize patients' care without compromising the cost of the treatment."	**Stakeholder involvement and awareness** **Health policy development**
"Upper management should be made aware that this is normal and could be done in their lifetime. They should provide support and continuously motivate the staff to change practices."	
"Should be part of the Health White Paper. Not implemented piece-meal. Other parts of the healthcare system need to support implementation. This framework should be briefed to us, hospital administrators."	
"The framework includes opinion from all stakeholders and assessment of pros and cons of the new health technologies versus the older ones."	
"Should be strong policy decision made in consensus of multiple discipline and stakeholders to ensure feasibility of implementation of the framework. Must also ensure that budget to conduct should be allocated."	
"The framework could help in establishing the culture on optimization of technology to facilitate work process."	**Better quality of care & efficient resource allocation** **Transparent and comprehensive process**
"That the implementation will hopefully improve our current healthcare policies without burdening our existing fragile infrastructure."	
"The process should be fair for all low-value care. Thorough but less bureaucratic process to smooth the implementation."	
"It should be transparent and conducted by experts in the field, free of political influence and conflict of interest. The aim should always be for the benefits of the patients and the people."	

Supplementary 4-13: Subgroup analysis based on stakeholder roles and perspectives on facilitators in implementing disinvestment initiatives (ranking)

Roles of stakeholders (by group)	Ranking			
	1st	2nd	3rd	4th
Overall respondents	**Organisational culture**	**Stakeholder involvement**	**Transparent method**	**Integrate local context**
Resource allocation decision-makers / budget holders	**Organisational culture**	**Transparent method**	**Stakeholder involvement**	**Integrate local context**
Clinical care providers (doctors, pharmacists, nurses, *AHP)	**Transparent method**	**Organisational culture** **Stakeholder involvement**		**Integrate local context**
Researchers / experts in HTA & health economics, others	**Organisational culture**	**Stakeholder involvement**	**Transparent method**	**Integrate local context**

**AHP, allied health professionals*

Description of facilitators (as in survey questionnaire):

- ***Organisational culture:*** organisational culture for improvement in quality of care and openness to change, including strong leadership.
- ***Stakeholder involvement***: involvement of various stakeholders in healthcare.
- ***Transparent method***: transparent and robust method for identification, prioritisation and assessment of candidates for disinvestment.
- ***Integrate local context:*** integrating local context in formulating recommendation for disinvestment purposes.

Supplementary documents for Chapter 5

"Unloading the excess baggage": Key informant interviews with Malaysian stakeholders on healthcare disinvestment initiatives

Supplementary 5-1: Participant information sheet for the mixed-method study

1. Invitation:

You are being invited to take part in this research study on "Stakeholder perspectives on disinvestment of low-value health care intervention and practices in Malaysia: A survey and interview of healthcare key informants". Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and ask us if there is anything that is not clear or if you would like more information.

The main investigator for this study is Dr. Hanin Farhana Kamaruzaman, a PhD student in Health Economics and Health Technology Assessment (HEHTA), University of Glasgow and receiving scholarship from Ministry of Health Malaysia. This study forms part of her doctoral research project and the supervisors are Professor Olivia Wu and Dr. Eleanor Grieve from HEHTA, University of Glasgow.

2. What is the purpose of the study?

Disinvestment from ineffective or low-value health technologies and practices has been identified as a priority for international health policy, both for improved quality of care and sustainability of resource allocation. It focuses on the approach of reassessment of health technologies and practices and reallocation of resources with the aim to improve the benefits and health of patients and population. In Malaysian public health care system, HTA programme was established in August 1995 to support coverage or purchasing decisions for health technologies due to the increasing needs for a more effective mechanism in the selection and introduction of health technologies for the healthcare system. This timely and important study is conducted as there is a demand to expand the scope of HTA to include re-evaluation of ineffective health technologies and practices. This study aims to identify current disinvestment activity levels in Malaysian healthcare system and to describe the understanding, practices, and receptivity of Malaysian healthcare stakeholders on disinvestment initiatives.

3. Why have I been invited to participate?

This study requires the participation from Malaysian healthcare stakeholders who may involve in priority setting and decision-making for resource allocation at various

health care levels in Malaysia. This will include decision-makers, budget holders and programme managers within four major Programmes in the Ministry of Health Malaysia, the leaders at regional and local level such as Health State Directors, Hospital Directors, and Head of Public Health Sectors at state level, as well as care providers, namely the doctors, pharmacists, nurses and other allied health professionals. The participants will also be extended to the researchers at the local universities and research institutes who might be involved with studies related to disinvestment and quality improvement initiatives in Malaysia.

4. Do I have to take part?

Your participation is voluntary and there is no consequence for declining this invitation. If you do agree to take part, an interview schedule, information sheet and a consent form will be issued prior to the interview. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

5. What will happen to me if I take part?

The interviews will take around 30-60 minutes using Zoom online platform and will be recorded using Zoom video recording, with your permission. It will be converted to audio-only recording for analysis and will later be transcribed. The video recordings will be deleted after transcription is verified. You will have the opportunity to review and correct the interview transcript if you do agree to be interviewed. Follow-up questions will be sent to the you to clarify issues or unclear information obtained during the interview, if any. The interviews will be conducted in March to May 2023.

6. What are the possible disadvantages and risks of taking part?

Your participation in the interview will not bring any disadvantage or reputational risk on you or your organisations. If you feel uncomfortable with the questions imposed during the interview, you can refuse to answer the questions. Should there be any occasion where you wish to postpone the interview, a new date will be set for the next interview session.

7. What are the possible benefits of taking part?

You will receive no direct benefit from taking part in this study. The information that is collected during this study will give us a better understanding on the current landscape of disinvestment activities in Malaysia and exploring stakeholder perspectives on de-implementation of low-value care in Malaysian healthcare system.

8. Will my taking part in this study be kept confidential?

- All information which is collected about you, or responses that you provide, during the research will be kept strictly confidential. You will be identified by an ID number, and any information with your name and email address will be removed so that you cannot be recognised from it. Please note that assurances on confidentiality will be strictly adhered to unless evidence of serious harm, or risk of serious harm, is uncovered.
- All data in electronic format will be stored on secure password-protected folders. No one outside of the research team or appropriate governance staff will be able to find out your name, or any other information which could identify you.

9. What will happen to my data?

Your data will be held in accordance with The General Data Protection Regulation 2018.

- The information you provide will be used for research purposes and your personal data will be processed in accordance with current data protection legislation. The University is responsible for looking after your information and using it properly. We may keep identifiable information about you for 2 years after the data has completely analysed. Your personal data will be treated in the strictest confidence and will not be disclosed to any unauthorised parties without your permission.
- **Interview recordings:** The video recording of your interview will be deleted as soon as there is an authoritative written transcript of your interview. Your audio recording might be shared with people who check that the study is done properly.
- **Interview transcripts:** Interview transcripts will be held and used on an anonymous basis, with no mention of your name, but we will refer to the group of which you are classified. If you request it, you will be supplied with a copy of your interview transcript so that you can comment on and edit it as you see fit (please give your email in the consent form).

10. What will happen to the results of the research study?

This research will be published in the form of doctoral thesis which estimated to be submitted in 2025. It is also our intention to publish the results of this research in peer-reviewed journals and present it in scientific conferences or meetings. If you wish to be informed on the publications, you can contact the main investigator for further communication.

In any of the publication and/or presentation, direct quotes may be used. However, we ensure you that your name will not appear in any of these.

11. Who has reviewed the study?

The project has been reviewed by the College of Medical, Veterinary & Life Sciences Ethics Committee, University of Glasgow. It also has been approved by the Malaysian Medical Research Ethics Committee (MREC) and registered under National Medical Research Registry (NMRR).

12. Contact for Further Information

If you have any questions about this study, you may contact the following people:

i. Dr. Hanin Farhana Kamaruzaman: h.kamaruzaman.1@research.gla.ac.uk
ii. Dr. Eleanor Grieve (Supervisor): Eleanor.Grieve@glasgow.ac.uk
iii. Dr. Izzuna Mudla Ghazali (Deputy Director of MaHTAS): drizzuna@moh.gov.my

Supplementary 5-2: Key informant interview guide

Part A: Introduction

- *(Greeting and thank the participant for agreeing to involve in the interview)*
- As was described in the information sheet, this research concerns disinvestment which involve any existing healthcare practices, procedures, technologies, or pharmaceuticals. In this study, disinvestment includes:
  i. **removal** or withdrawal of resources, either full or partial disinvestment
  ii. the **restriction** of reimbursement or funding, such as for certain group of patients with specific criteria
  iii. the **retraction** of budget or funding from **reimbursement**
  iv. the **replacement** of healthcare interventions by alternatives

- To be able to analyse the interview later, I will record this using Zoom video recording. However, only the audio recording will be retained for further process, transcribing and analysis.
- I will send you the transcribed interview, so that you can check for any inaccuracy or misinformation. The research team will handle the audio recordings confidentially. Only the research team will have access to these files.
- The results of this study may be published and presented in scientific meetings or conferences. We may use any of your quotes in these publication or presentations to substantiate the results. We will, however, ensure that both the results and the quotes will not contain information that may reveal your identity.
- Do you agree with:
  - Participation in this study?
  - The video / audio recording and writing down of the interview?
  - The inclusion of the results and possible quotes in a publication?
- Is everything clear? Do you have any question before we start the interview?

- Can you please tell me briefly on your background information, experience and your roles in healthcare system?

Part B: Interview Questions

1. **Assessment Method**
    a. Are you familiar with any method or process for priority setting and resource allocation within your organisation / level of governance you are involved in?
    b. What do you think are the criteria involved for disinvestment or decision to stop funding any practices or use of technologies / drugs? Is there a formal process or framework in place for this?
    c. What do you think is the underlying rationale or principles in disinvestment that must be prioritise? (*even if a formal process does not exist yet*)

2. **Evidence & Data**
    a. In the absence of robust data (eg. published evidence or data collected for clinical trials), would you be confident to use RWE for disinvestment purposes?
    b. Apart from this, what do you think constitutes optimal evidence for reassessment of obsolete technologies or disinvestment of low-value care?
    c. In your opinion, should Axitinib and Everolimus be included in the formulary? If yes, what are the method that can be used to assess for listing in the formulary / new indications for clinical practice?

3. **Stakeholder Involvement**
    a. In our survey, the majority agreed that reassessment or disinvestment process should be done routinely as part of monitoring the decisions that was done before. What do you think are the impacts of implementing this process in terms of acceptance from your staff / colleagues and the benefits of it?
    b. Do you think public / patients should be involved actively in this process? At which level and how?

4. **Equity / boundary in disinvestment**
    a. Should we set a 'boundary' or exclusion to implement disinvestment process in the areas that are considered as **emotive / sensitive**, such as end-of-life care, **rare diseases** and **vulnerable populations** (children, terminally ill, elderly?)

5. Implementation

a. Should the disinvestment decisions that have been implemented / approved in other countries be adopted to the Malaysian context in terms of service provision?

b. What is / are your biggest concern when it comes to the implementation of a potential disinvestment decision?

Part C: Closing

- Are there other things you would like to discuss about disinvestment processes/ initiative? Are there any relevant issues that have not yet been discussed?
- Are there other stakeholders you think I should interview about this? If so, who could we approach?
- *(If no more questions, thank the respondent and close session)*

Supplementary 5-3: Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

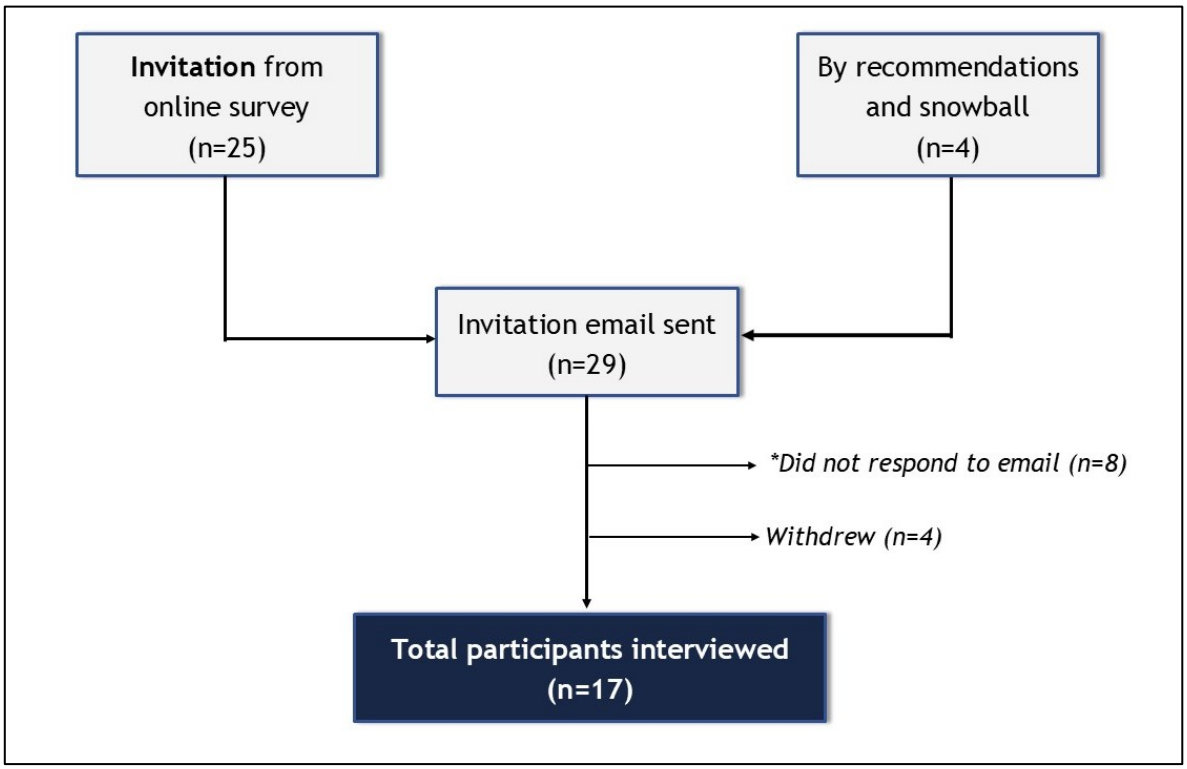
Developed from:

Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International Journal for Quality in Health Care. 2007. Volume 19, Number 6: pp. 349 – 357

Item No	Guide Questions/Description	Reported Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/ facilitator	Which author/s conducted the interview or focus group?	124
2. Credentials	What were the researcher's credentials? E.g., PhD, MD	124
3. Occupation	What was their occupation at the time of the study?	124
4. Gender	Was the researcher male or female?	124
5. Experience and training	What experience or training did the researcher have?	124-125
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	N/A
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research?	124
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	124
Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	125
Participant selection		
10. Sampling	How were participants selected? e.g., purposive, convenience, consecutive, snowball	124-125
11. Method of approach	How were participants approached? e.g., face-to-face, telephone, mail, email	123-124
12. Sample size	How many participants were in the study?	126-127
13. Non-participation Setting	How many people refused to participate or dropped out? Reasons?	126
14. Setting of data collection	Where was the data collected? e.g., home, clinic, workplace	124-125
15. Presence of nonparticipants	Was anyone else present besides the participants and researchers?	124

Item No	Guide Questions/Description	Reported Page #
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	123-124
Data collection		
17. Interview guide	Were questions, prompts, and guides provided by the authors? Was it pilot tested?	124, Supp. 5-2
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	N/A
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	124-125
20. Field notes	Were field notes made during and/or after the interview or focus group?	N/A
21. Duration	What was the duration of the interviews or focus group?	124-125
22. Data saturation	Was data saturation discussed?	N/A
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	125
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	125
25. Description of the coding tree	Did the authors provide a description of the coding tree?	125
26. Derivation of themes	Were themes identified in advance or derived from the data?	125
27. Software	What software, if applicable, was used to manage the data?	125
28. Participant checking	Did participants provide feedback on the findings?	N/A
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g., participant number	129-142
30. Data and findings consistent	Was there consistency between the data presented and the findings?	129-142
31. Clarity of major themes	Were major themes clearly presented in the findings?	128-142
32. Clarity of minor themes	Is there a description of diverse cases or a discussion of minor themes?	128

Supplementary Figure 5-4: Flowchart recruitment of participants for interviews



* An invitation email was sent to those who initially agreed to a follow-up interview from the online survey. A second email was sent two weeks after the first invitation. If there was no response after the second invitation, we considered that the individuals were not interested to participate in the interview.

Supplementary documents for Chapter 7

Supplementary 7-1: Case studies for Value of De-implementation Framework

Candidate 1: Colorectal cancer screening using iFOBT, two-yearly testing
Candidate 2: Colorectal cancer screening using iFOBT, annual testing

A nationwide implementation of CRC screening using iFOBT took place in 2014 as an opportunistic screening programme in a selected health clinics in Malaysia. At these clinics, patients who met the initial selection criteria (average-risk, asymptomatic individuals aged 50 to 75 years) were invited for the screening test. In the event of a positive test result, the patient will be referred to a nearby hospital for colonoscopy for a more thorough investigation and for diagnostic purpose. If it is negative, the patient is recommended to have iFOBT **every two years**. Figure 1 shows the detailed patient pathway for opportunistic CRC screening using iFOBT.

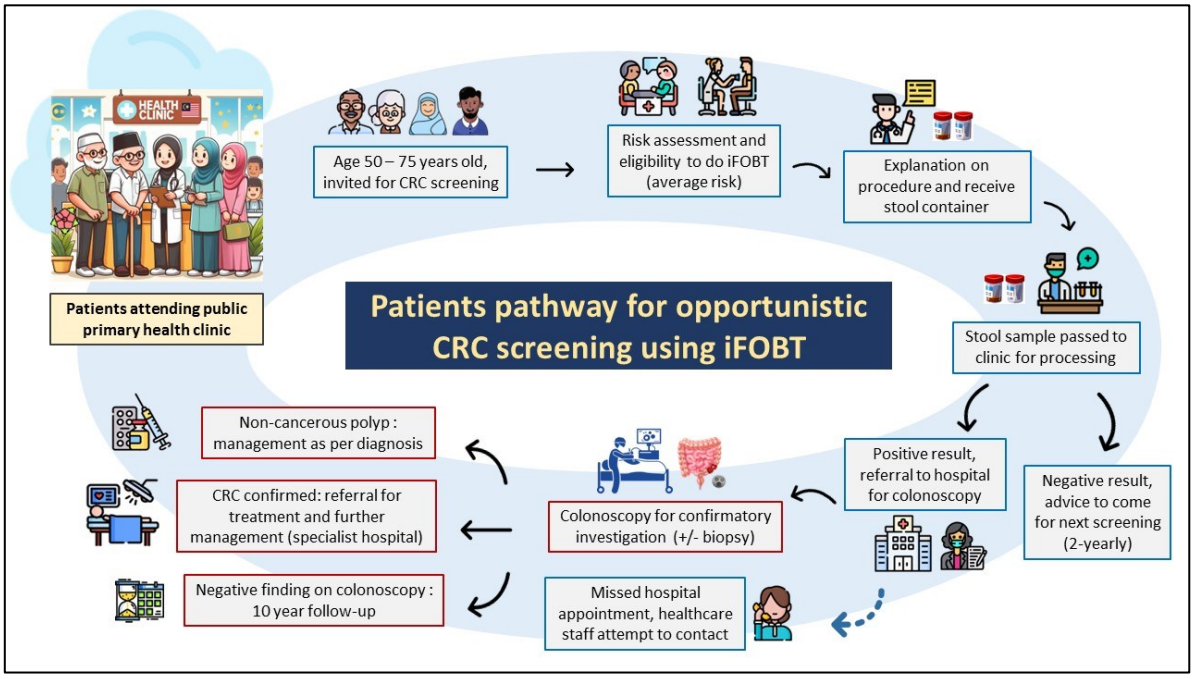


Figure 1: Clinical pathway for opportunistic colorectal cancer screening using immunofaecal occult blood test in Malaysia

In 2016, a technology review with local economic and financial implications was conducted by MaHTAS to investigate the cost-effectiveness of screening an asymptomatic population aged 50 to 65 years old for CRC using colonoscopy. Using the decision-tree model, the assessments found that the combination of iFOBT+colonoscopy dominated colonoscopy by having a lower cost with a higher QALY. The estimated incremental cost-effectiveness ratio (ICER) of iFOBT+colonoscopy compared with no screening strategy at all was approximately RM9,400 per QALY gained. Using the age group of 50 to 65 years old as the target for population-based screening (around 3 million people), the resulted financial implications were estimated to be RM1 billion for annual iFOBT and RM1.1 billion for biennial iFOBT.

Based on this report, the CPG on Management of Colorectal Carcinoma published in 2017 recommended that screening of CRC should be offered at the age of 50 years and continues until age 75 years for average-risk population. The preferred screening modality is iFOBT, and if it is positive, colonoscopy is necessary. If iFOBT is negative, a yearly test should be performed (Figure 2). However, on a national scale, the implementation of the CRC screening programme remains focused on opportunistic screening for individuals aged 50 to 75 with two-yearly iFOBT as outlined in the recent National Strategic Plan for Cancer Control Programme 2021-2025. **Hence, there is a discrepancy between the recommendation provided in the CPG and the actual implementation in clinical practice and national strategic policy.**

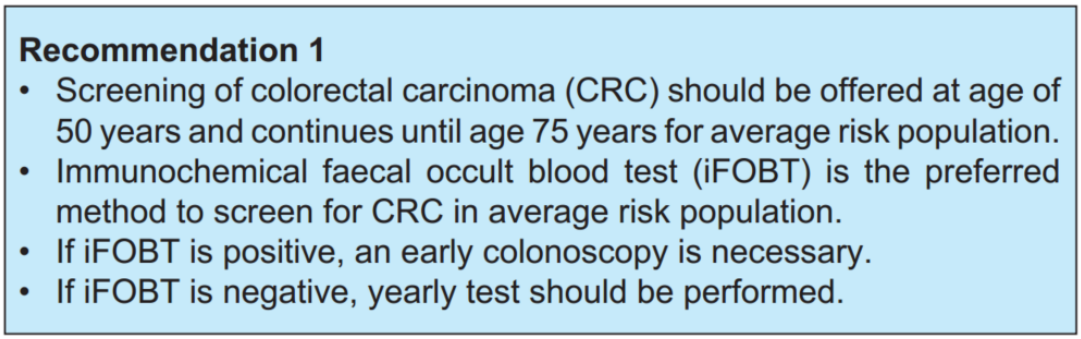


Figure 2: Recommendation on screening for CRC using iFOBT in CPG Management of Colorectal Carcinoma

Health impacts:

- Based on a recent meta-analysis (Meklin et al., 2020), the **sensitivity and specificity** of iFOBT were **0.86 and 0.85**, respectively, regardless of the interval of screening strategy and the cut-off threshold of the test.
- **WHO Report (Regional Office for Europe) 2022**: one of the **WHO Best Buys** for NCD screening. Recommend screening for CRC with organised and high-quality programmes that are linked to timely treatment.
- Countries should **focus on delivering WHO best buys screening programmes**, prioritizing cervical cancer, followed by breast and colorectal cancers (with high-quality and good coverage [70% target population]) before considering starting new screening programmes for other cancers.
- Whyte 2021: the optimal strategy was **2-yearly, age 51 to 65 years**, and FIT threshold of 161 (8 screening episodes). As the endoscopy capacity increases, it is recommended to first to reduce the starting age for screening and thereafter adjusting the FIT threshold.

Guidelines comparison:

- **Four guidelines recommend 2-yearly iFOBT, 50-75 years age group** (Scotland, Canada, Australia, NICE UK)
- **Two guidelines recommend annual faecal immunochemical test, 50 to 75 years** (US Preventive Services Task Force, American Cancer Society)

Safety:

- None reported for iFOBT.
- **Colonoscopy:** 4 perforation and 8 major bleeding per 10,000 procedures respectively (Systematic review on screening for colorectal cancer, US Preventive Services Task Force, 2015)

Patient preference / acceptance:

- A proportion of respondents perceived CRC screening as time-consuming, with **43.5% indicating preference for a test that does not need to be done annually.** (Bujang 2021) – *local study*
- Generally, **low awareness** leads to **low acceptance** of screening and **late presentation** (Bujang 2021; Schliemann 2020).

- **Providers factor:** Primary care clinic face continuously **high-level patient flows** and the **time for doctor-patient consultation** and provision of encouragement to avail of cancer screening seems to be **limited** (Su 2020).

Availability of alternative & access of services

- Alternative to each other as opportunistic screening (two-yearly vs annually).
- Widening the services (currently, only covered by MOH for those attending public health clinics) [National Strategic Plan for Cancer Control Programme 2021-2025].
- Colonoscopy services: all cluster hospitals will have colonoscopy set by 2025.

Under-served population

- Those attending public health clinics will have access to the service.
- No issues with disadvantaged population.

Facility and infrastructure

- Readily available. Require more resources if annual strategy is to be suggested.

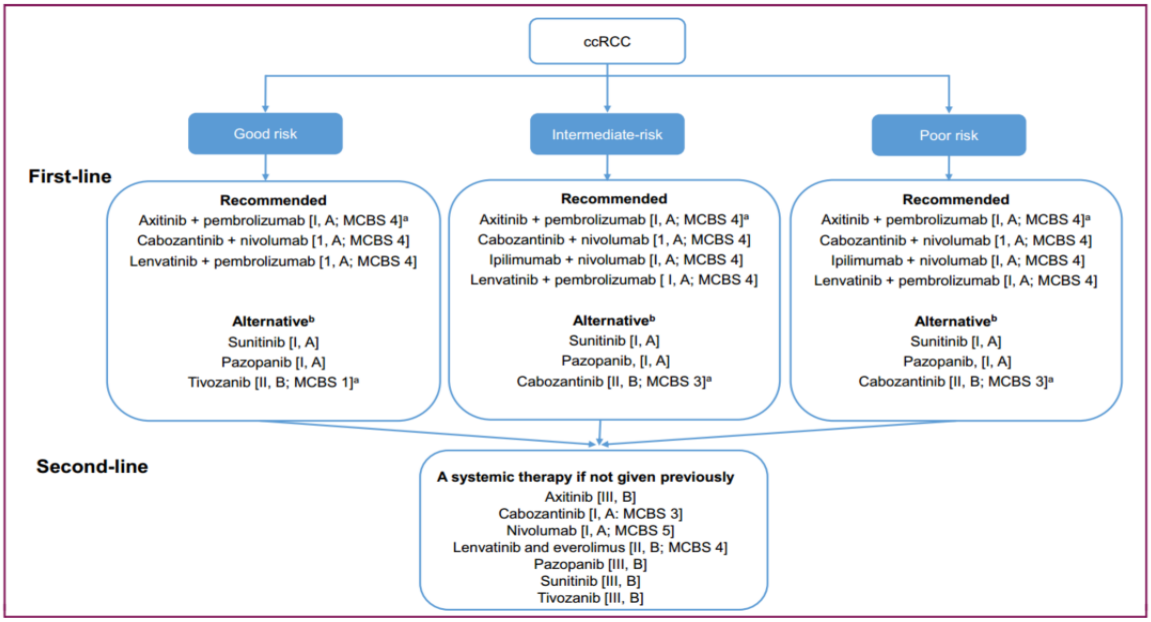
No reported legal implications.

Candidate 3: Interferon-alfa in advanced renal cell carcinoma

- Malaysia reported a 40% increase in the number of new cases of renal cell carcinoma (RCC) in men, accounting for an incidence rate of 2.5% from 1.9% (NCR 2012-2016). No specific CPG in Malaysia on management of RCC.
- Malaysian Systemic Therapy Protocol (2017): 3 drugs listed in National Formulary for advanced RCC: Sunitinib, Pazopanib, Interferon-alfa-2a.
- Treatment landscape for advanced renal cell carcinoma:
    - Surgery, radiation, chemotherapy.
- Changes from non-specific therapy (eg. cytokines) to specific regiments (eg. immunotherapy, tyrosine kinase inhibitors, VEGF & VEGFR, mTOR inhibitors)
- **Trigger for reassessment of Interferon-alfa**: suggestion by an Oncologist to remove the indication for treatment of advanced RCC in the formulary.

Health impacts:

- The **use of IFN-alfa has been restricted due to the superiority of newer treatments** (anti-VEGFR agents, immune checkpoint inhibitors, ICI), $p < 0.0001$ (Demasure 2022).
    - IFN-alpha as first line: 13 months
    - VEGFR-TKI as first line: 19 months
    - ICI as first line: 45 months
- **Pan-Asian Adapted ESMO Guidelines (2021):** the use of IFN-alfa is no longer regarded as a standard option.



Safety:

- Most of the "positive" trials reported that IFN-alfa were used at a relatively high dose (9-18 MIU 3 times per week), but the clinical benefits are very small with considerably high toxicities, hence the eligible patients need to be carefully selected (Malaysian Systemic Therapy Protocol 2017).

Patient preference / acceptance:

- Patients in sunitinib group experienced statistically significantly better cancer-specific HRQoL and general health status (in social utility scores) compared with IFN-alfa (Castellano 2009).

Availability of alternative & access of services

- Available alternatives in formulary: Pazopanib & Sunitinib (most used)
- Prescribing pattern in two cancer centres using real-world evidence:
  - Axitinib & Everolimus used as off-label (5.3% of total patients)
- No information from other cancer centres.

Under-served population

- No concerning issues.

Facility and infrastructure

- No concerning issues if IFN-alfa delisted for the indication of treatment for advanced RCC.

Technology life-cycle

- Prescribing data from two cancer centres: No prescription of IFN-alfa for advanced RCC from 2015 to 2021. (?obsolete drug)

Supplementary 7-2: Group work Excel scoring sheet for value of de-implementation framework pilot workshop

Candidate 1: CRC screening, two-yearly

PANEL	Health benefits				Equity				Enablers			System readiness			
	Ineffective	*Safety*	*Reluctance*	*TOTAL*	*Alternative*	*Access*	*Under-served*	*TOTAL*	*Guidance*	*Life-cycle*	*TOTAL*	*Infrastructure*	*Capacity*	*Legal*	*TOTAL*
Panel 1				0				0			0				0
Panel 2				0				0			0				0
Panel 3				0				0			0				0
Panel 4				0				0			0				0
Panel 5				0				0			0				0
Panel 6				0				0			0				0
	Mean score			0	*Mean score*			0	*Mean score*		0	*Mean score*			0

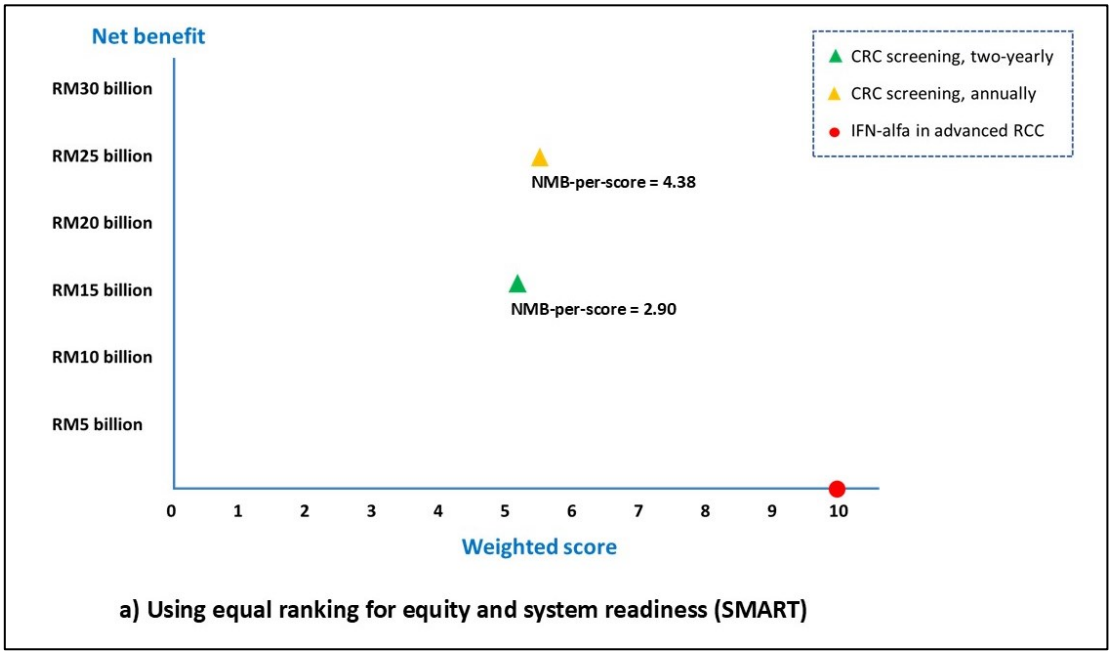
Candidate 2: CRC screening, annually

PANEL	Health benefits				Equity				Enablers			System readiness			
	Ineffective	*Safety*	*Reluctance*	*TOTAL*	*Alternative*	*Access*	*Under-served*	*TOTAL*	*Guidance*	*Life-cycle*	*TOTAL*	*Infrastructure*	*Capacity*	*Legal*	*TOTAL*
Panel 1				0				0			0				0
Panel 2				0				0			0				0
Panel 3				0				0			0				0
Panel 4				0				0			0				0
Panel 5				0				0			0				0
Panel 6				0				0			0				0
	Mean score			0	*Mean score*			0	*Mean score*		0	*Mean score*			0

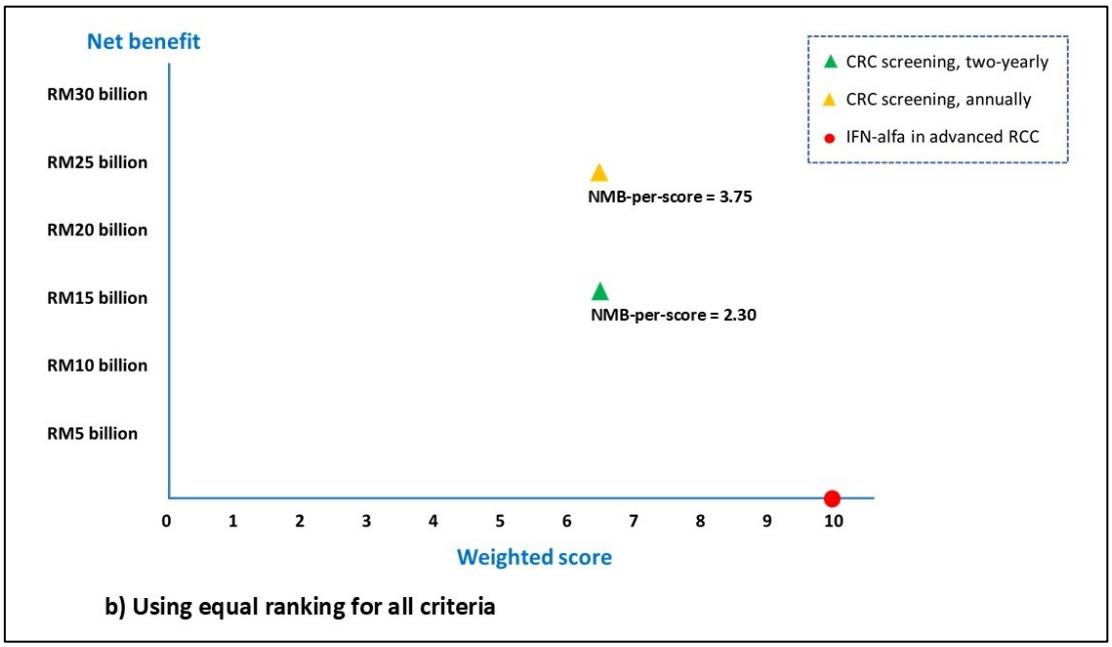
Candidate 3: Interferon-alpha in advanced RCC

PANEL	Health benefits				Equity				Enablers			System readiness			
	Ineffective	*Safety*	*Reluctance*	*TOTAL*	*Alternative*	*Access*	*Under-served*	*TOTAL*	*Guidance*	*Life-cycle*	*TOTAL*	*Infrastructure*	*Capacity*	*Legal*	*TOTAL*
Panel 1				0				0			0				0
Panel 2				0				0			0				0
Panel 3				0				0			0				0
Panel 4				0				0			0				0
Panel 5				0				0			0				0
Panel 6				0				0			0				0
	Mean score			0	*Mean score*			0	*Mean score*		0	*Mean score*			0

Supplementary 7-3: Sensitivity analysis for NMB-per-score based on different criteria ranking and weight allocation for assessed candidates



a) Using equal ranking for equity and system readiness (SMART)



b) Using equal ranking for all criteria

Supplementary documents for Chapter 8

Supplementary 8-1: Summary of challenges in implementing disinvestment initiatives based on data triangulation from literature review, online survey and key informant interviews

Planning and implementation	Stakeholder resistance	Evidence and data issues	Bureaucracy and governance
• Lack of clear strategy • Inadequate guidelines and frameworks • Poor coordination between stakeholders • Limited knowledge of disinvestment processes	• Misunderstanding of the disinvestment process • Fear of losing funding or resources • Reluctance to change existing practices • Concerns over professional autonomy or workloads	• Inadequate real-world evidence • Lack of reliable data for decision-making • Concerns over trustworthiness of data • Conflicts between evidence and stakeholder expectations	• Rigid healthcare policies • Excessive bureaucracy slowing decision-making • Limited autonomy for local decision-makers • Poor alignment between national and local strategies
Financial and budgetary constraints	**Ethical and equity concerns**	**Systemic barriers**	**Consequences of poor implementation**
• Pressure to balance budgets • Risk of restricting funding for innovation • High upfront costs in implementation of disinvestment initiatives • Uncertainty of net savings or long-term benefits	• Potential inequity for disadvantaged groups • Perceived loss of access to necessary services • Ethical dilemmas in prioritising care • Lack of public engagement or transparency	• Fragmented healthcare systems • Persistence of outdated technology and practices • Lack of skilled personnel for implementation • Extra workload for healthcare professionals	• Professional frustration and apprehension • Increased uncertainty in clinical outcomes • Delays in technology adoption or practice changes • Experience-based rather than evidence-based decision-making