Universidade do Minho
Escola de Economia, Gestão e Ciência Política

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Value-Based Hospital Payment: Integrating Measurement, Organisational Capabilities and Payment Design

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Value-Based Hospital Payment: Integrating Measurement, Organisational Capabilities and Payment Design

Doctoral Thesis
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Professor José António Crispim

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the Universidade do Minho.

Resumo

Pagamento Hospitalar Baseado em Valor: Integração da Medição de Valor, das Capacidades Organizacionais e do Desenho dos Modelos de Pagamento

Os sistemas de saúde enfrentam uma pressão crescente para melhorar os resultados em saúde, assegurando uma utilização eficiente dos recursos. Neste contexto, os Cuidados de Saúde Baseados em Valor (Value-Based Healthcare, VBHC) emergem como um paradigma de reforma orientado para alinhar a prestação de cuidados com resultados relevantes para os doentes. A sua operacionalização no financiamento hospitalar enfrenta, contudo, desafios conceptuais, organizacionais e metodológicos. Esta tese analisa como os modelos de pagamento hospitalar podem alinhar incentivos financeiros com uma conceção multidimensional de valor. Adotando uma abordagem multimétodo, a investigação organiza-se em cinco componentes: síntese da evidência sobre VBHC, através de uma umbrella review e de uma scoping review sobre o papel dos sistemas de informação em saúde na sua operacionalização; desenvolvimento de um enquadramento de medição multidimensional do valor, com base em análise multicritério; desenvolvimento conceptual de um modelo de maturidade de capacidades organizacionais; e validação, por especialistas, de um enquadramento de apoio à decisão para o desenho e implementação de modelos de pagamento hospitalar baseados no valor. Os resultados mostram que as iniciativas de VBHC podem melhorar a qualidade, a eficiência e a satisfação dos doentes, reduzindo custos, embora a sua implementação permaneça condicionada por métricas fragmentadas, resistência organizacional e limitações na medição de custos. A evidência destaca ainda a qualidade dos dados, a capacidade analítica e os recursos especializados como condições críticas. O enquadramento de medição do valor permite avaliar o desempenho de forma multidimensional, integrar perspetivas de stakeholders e apoiar a monitorização através de um dashboard estruturado. O modelo de maturidade identifica lacunas de prontidão organizacional ao longo de cinco níveis. A validação por especialistas sustenta a aplicabilidade de um enquadramento em seis fases para orientar o desenho e a implementação de modelos de pagamento baseados no valor. Globalmente, a tese propõe uma

arquitetura integrada que articula medição do valor, capacidades organizacionais e desenho de sistemas de pagamento, apoiando a transição de modelos baseados no volume para modelos baseados no valor.
Palavras-Chave: Capacidades Organizacionais; Cuidados de Saúde Baseados em Valor; Medição do Valor; Modelos de Pagamento Hospitalar; Reforma do Financiamento da Saúde

Abstract

Value-Based Hospital Payment: Integrating Measurement, Organisational Capabilities and Payment Design

Healthcare systems face increasing pressure to improve health outcomes while ensuring efficient resource use. In this context, Value-Based Healthcare (VBHC) has emerged as a reform paradigm aimed at aligning healthcare delivery with outcomes that matter to patients. However, its operationalization within hospital financing faces significant conceptual, organizational, and methodological challenges. This thesis examines how hospital payment models can align financial incentives with a multidimensional conception of value. Adopting a multimethod approach, the research is structured around five components: synthesis of the evidence on VBHC through an umbrella review and a scoping review on the role of health information systems in its operationalization; development of a multidimensional value measurement framework based on multi-criteria decision analysis; conceptual development of an organizational capability maturity model; and expert validation of a decision-support framework for the design and implementation of value-based hospital payment models. The findings show that VBHC initiatives can improve quality of care, efficiency, and patient satisfaction while reducing costs, although implementation remains constrained by fragmented value metrics, organizational resistance, and limitations in cost measurement. The evidence highlights data quality, analytical capacity, and specialized resources as critical enabling conditions. The value measurement framework enables multidimensional performance assessment, integrates stakeholder perspectives, and supports monitoring through a structured dashboard. The capability maturity model identifies gaps in organizational readiness across five levels. Expert validation supports the applicability of a six-phase framework to guide the design and implementation of value-based payment models. Overall, the thesis proposes an integrated architecture linking value measurement, organizational capabilities, and payment system design, supporting the transition from volume-based to value-based payment models.

Key-words: Healthcare Financing Reform; Hospital Payment Models; Organisational Capabilities; Value Measurement; Value-Based Healthcare

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Acronyms

AHP – Analytic Hierarchy Process

APM – Alternative Payment Model

CIMO – Context-Intervention-Mechanism-Outcome

CMM – Capability Maturity Model

EHR – Electronic Health Record

IQR – Interquartile Range

IT – Information Technology

JBI – Joanna Briggs Institute, Joanna Briggs Institute

KPI – Key Performance Indicator

LZN – Linguistic Z-number

MCDA – Multiple Criteria Decision Analysis

NR – Not reported

PCA – Principal Component Analysis

PCC – Population (or participants), Concept, Context

PREM – Patient-Reported Experience Measure

PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PRISMA-ScR – Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews

PROM – Patient-Reported Outcome Measure

ROC – Rank-Order Centroid

ScR – Systematic Scoping Review

SD – Standard Deviation

TDABC – Time-Driven Activity-Based Costing

TOPSIS – Technique for Order of Preference by Similarity to Ideal Solution

VAF – Value Assessment Framework

VBHC – Value-Based Healthcare

VBIC – Value-Based Integrated Care

VBID – Value-Based Insurance Design

VBP – Value-Based Payment

VBPc – Value-Based Procurement

VBP-CMM – Value-Based Payment Capability Maturity Model

VBPr – Value-Based Pricing

VBPu – Value-Based Purchasing

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1

Introduction

1.1 Background and Motivation

In healthcare, the notion of value has become central to contemporary reform debates, yet it remains conceptually complex and lacks a universally accepted definition (Antoñanzas et al., 2016). The emergence of Value-Based Healthcare (VBHC) reflects efforts to anchor system performance in outcomes rather than activity (Steinmann et al., 2020; van Staalduinen et al., 2022). However, interpretations of VBHC vary across contexts and levels of implementation. Recent global analyses confirm that although adoption of VBHC principles has expanded across health systems, implementation remains uneven and highly context-dependent, reflecting differences in institutional design and financing structures (Douglas et al., 2025).

Porter's influential definition, which frames value as the health outcomes achieved relative to the resources used, provides a practical basis for linking clinical performance to efficiency considerations (De Maeseneer et al., 2019; Porter, 2010). While economic and policy perspectives recognise that value encompasses multiple dimensions, the main challenge lies not in its theoretical definition but in its consistent operationalisation within real-world health systems (De Maeseneer et al., 2019; Garrison et al., 2018). In this sense, value becomes a guiding principle that connects outcomes, costs, and overall system performance. This perspective naturally extends the discussion to the design of healthcare financing systems. Recent system-level analyses emphasise that moving from isolated provider-level initiatives to comprehensive financing reform requires integrated governance and payment redesign across the entire health system (Smith et al., 2023).

Value is also interpreted differently across stakeholders. Patients, clinicians and policymakers emphasise distinct priorities shaped by expectations, professional norms and system-level objectives. Contemporary perspectives increasingly define value as alignment between measurable health outcomes and what matters to patients and society, including health improvement, equity and system responsiveness, often supported by patient-reported outcomes and collaborative decision-making

processes (Bechthold et al., 2022; Peng et al., 2022; P. C. Smith et al., 2023). This study adopts a multidimensional understanding of value that recognises its dependence on both outcomes and stakeholder priorities.

Healthcare financing structures play a decisive role in shaping how value is produced and sustained within health systems (Conrad, 2015; Reid et al., 2022). Traditional fee-for-service models tend to incentivise service volume rather than outcomes, contributing to overutilisation, rising costs and the provision of low-value care (Adida et al., 2017; Hennig-Schmidt et al., 2011; Mafi & Parchman, 2018; Roehr, 2012). Diagnosis-related group systems were introduced to strengthen cost control and efficiency, however, they can also generate unintended effects, such as premature discharge, coding optimisation, and variability in care quality (Bystrov et al., 2015; Mihailovic et al., 2016; L. Zhang & Sun, 2021). Although both models represent important stages in the evolution of hospital financing, they primarily reward activity and cost containment rather than sustained health improvement. This creates a structural misalignment with the outcome-oriented logic underpinning VBHC (Berenson & Ginsburg, 2019; Porter & Lee, 2013; Sandhu et al., 2023). In response, Value-Based Payment (VBP) models have emerged as an alternative paradigm to realign incentives through outcome-linked payment and performance-oriented contracts (Conrad, 2015; Conrad et al., 2016; Porter, 2009; Werner et al., 2021).

Interest in VBP has intensified in response to demographic ageing, the growing burden of chronic disease and sustained cost pressures on health systems (Prince et al., 2015; Tsiachristas, 2018). Empirical findings suggest that outcome-focused contracts and alternative budgeting mechanisms can improve care coordination and patient experience in some settings (Golinelli et al., 2024; van Leersum et al., 2019). However, these effects are not consistent, and performance varies substantially across institutional contexts. Recent evaluations of Medicare and other national VBP programmes continue to report mixed results and persistent structural barriers, particularly in relation to incentive design and provider adaptation (Figueroa et al., 2025). Despite substantial policy momentum, implementation still lacks structured operational guidance and coherent implementation pathways (van Elten et al., 2023; van Staalduinen et al., 2022; Vijverberg et al., 2022). Comparative analyses further indicate that many reforms remain pilot-based or partial, without achieving full system integration (Douglas et al., 2025).

Overall, VBP models are widely regarded as a promising pathway for aligning financial incentives with improved health outcomes and system efficiency. However, their implementation raises structural, organisational, and conceptual challenges that complicate their translation into practice. In particular, the absence of a coherent and integrated pathway linking conceptualisation, operationalisation, and incentive design remains a central limitation. Recent work on risk adjustment and provider payment design further

highlights the technical complexity of developing VBP systems that are both theoretically robust and operationally feasible (Panturu et al., 2025). Against this backdrop, the following section introduces the research problem and outlines the objectives guiding this study.

1.2 Research Problem and Objectives

Despite the global shift toward value-oriented healthcare, operationalising the concept of "value" within hospital financing remains an unresolved economic and organisational challenge (Boscolo et al., 2020; Douglas et al., 2025; Porter, 2010). Existing VBP models aim to link payment to outcomes and efficiency, yet they face persistent barriers that hinder practical implementation. These barriers are threefold: conceptual ambiguity in defining and measuring value, organisational misalignment caused by data and capability limitations, and fragmented payment model design (Abdalla et al., 2022; Panturu et al., 2025; Silveira Bianchim et al., 2023). These limitations constrain hospitals' ability to evaluate performance and align financing with measurable improvements systematically (Figueroa et al., 2025; He et al., 2023; van Elten et al., 2023).

First, the absence of consistent and multidimensional metrics, such as harmonised Patient-Reported Outcome Measures (PROMs) and Patient-Reported Experience Measures (PREMs) and transparent cost data, limits hospitals' ability to assess performance systematically. Second, weak information systems, data interoperability issues, and limited analytical capacity prevent effective outcome monitoring and reinforce institutional inertia (Leao, Cremers, et al., 2023b; van Staalduinen et al., 2022; Walsh et al., 2020). Finally, existing VBP models, including pay-for-performance and bundled payments, remain conceptually fragmented and lack structured pathways to support the transition from volume- to value-based financing (Conrad, 2015; Joynt Maddox et al., 2017; Leao, Cremers, et al., 2023b; Panturu et al., 2025).

Consequently, health systems lack a coherent, evidence-based, and operationally feasible pathway for implementing Value-Based Hospital Payment. While multiple strands of research offer relevant insights, they remain analytically and conceptually disconnected, and no integrated model currently consolidates value measurement, organisational capabilities, and payment-system design into a unified operational framework capable of guiding hospitals. Recent comparative and policy analyses confirm that while VBP initiatives have expanded, integration across measurement, organisational capabilities and financing design remains limited (Figueroa et al., 2025). Addressing this gap is crucial for improving hospital productivity and financial sustainability.

This thesis addresses this gap by asking a central question that connects these unresolved issues: How can hospital payment models be designed, structured, and operationalised to align financial incentives with multidimensional value, given existing organisational, informational, and conceptual barriers?

To answer this question, the research aims to achieve the following objectives. The general objective is to develop and validate an integrated conceptual and operational framework for VBP, providing hospitals with a structured pathway to shift from volume-based to value-based financing.

Specifically, the thesis aims to:

1. Synthesise global evidence on VBHC implementation to identify its impacts, challenges, and enabling conditions, clarifying gaps that affect payment reform.
2. Map the requirements, facilitators, and barriers of health information systems necessary for implementing VBHC and supporting value-oriented payment models.
3. Develop a multi-stakeholder value measurement framework that operationalises value through explicit indicators, Multiple Criteria Decision Analysis (MCDA) methods, and cost integration.
4. Construct a Capability Maturity Model (CMM) for organisations transitioning to VBP, identifying essential capabilities, developmental trajectories, and strategic priorities.
5. Consolidate and validate a comprehensive decision-support framework for the design and implementation of VBP models across developmental phases.

These objectives follow a cumulative logic: the study progresses from synthesising global evidence to identifying operational enablers, developing measurement and capability models, and finally integrating them into a unified framework. This sequential approach builds a coherent pathway from conceptual understanding to practical implementation of Value-Based Hospital Payment.

1.3 Overview of the Articles

This thesis comprises five scientific articles, each addressing a different dimension of the transition toward Value-Based Hospital Payment. The purpose, methodology, main findings, and connection of each article to the overall thesis are summarised below.

Article 1 – *The Value-Based Healthcare Big Picture: An Umbrella Review*

Purpose: This article synthesises global evidence on the VBHC initiatives, identifying key impacts, challenges, and opportunities across health systems.

Method: An umbrella review of reviews and meta-analyses published between 2006 and 2024, using the Context-Intervention-Mechanism-Outcome (CIMO) framework for data extraction and the Joanna Briggs Institute (JBI) quality checklist.

Main findings: The study included 48 reviews and identified seven thematic categories. VBHC initiatives show potential to improve quality, efficiency, patient satisfaction, and cost control, but implementation is hindered by fragmented metrics, weak integration of PROMs and PREMs, organisational resistance, skill gaps, inadequate cost models, and inconsistent performance evaluation. Payment reforms such as Pay-for-Performance and bundled payments produce mixed results, whereas Value-Based Insurance Design (VBID) demonstrates positive effects on adherence.

Relation to thesis: This article establishes the empirical and conceptual foundation for the thesis by identifying system-level barriers relevant to hospital payment reform.

Article 2 – *The Importance of Health Information Systems in Value-Based Healthcare Initiatives: A Scoping Review*

Purpose: This article examines how health information systems influence the implementation of VBHC, focusing on facilitators and barriers affecting data collection, analysis, and sharing.

Method: A scoping review was conducted in accordance with the JBI methodology, searching two electronic databases between 2012 and 2023. Facilitators and barriers to VBHC implementation were extracted and categorised.

Main findings: Of the 147 records identified, 24 studies met the inclusion criteria. The findings indicate that successful VBHC implementation depends on data quality, analytical capacity, interoperable infrastructures, and specialised human resources in information and communication technologies. Limitations in these areas consistently undermine the feasibility of outcome measurement and value-oriented decision-making.

Relation to thesis: This article identifies the organisational and informational prerequisites for operationalising value in hospital settings.

Article 3 – *A Multiple Criteria Framework for Value-Based Assessment of Health Care Services Applied to a Radiology Case*

Purpose: This article develops a comprehensive and customisable MCDA framework for assessing value in healthcare services, integrating multiple stakeholder perspectives.

Method: A four-step MCDA-based framework supported by a case study in a radiology department involving administrators, physicians, radiographers, and patients. One hundred and sixty indicators were synthesised into seven value-assessment dimensions.

Main findings: The framework operationalises value through stakeholder-specific indicators, combines perceived benefits with direct clinical costs, and offers a dashboard for monitoring value evolution. It enables transparent value assessment and can be adapted to other departments and organisational contexts.

Relation to thesis: This article provides the methodological basis for operationalising value measurement within value-based financing.

Article 4 – *Value-Based Payment Capability Maturity Model: A Conceptual Framework*

Purpose: This article proposes a Value-Based Payment Capability Maturity Model (VBP-CMM) to guide organisations in building the capabilities required for VBP implementation.

Method: A structured scoping review following JBI guidelines, inductive thematic analysis, and development of a conceptual maturity model supported by a data collection instrument and fuzzy multi-criteria methods.

Main findings: The model structures capability development across five maturity levels and supports systematic assessment of organisational readiness, identification of capability gaps, and prioritisation of strategic actions. It aligns managerial processes, financing, and care delivery with patient-centred value.

Relation to thesis: This article defines the organisational maturity pathways required for adopting VBP.

Article 5 – *Operationalising Value-Based Payment: A Decision-Support Framework for Health System Reform*

Purpose: This article develops and validates a decision-support framework to guide the design and sequencing of VBP models aimed at improving productivity and sustainability in publicly oriented health systems.

Method: A two-stage conceptual study combining a scoping review of conceptual literature (2015–2025) with an international expert survey to validate and refine the proposed framework. The review uses the same search and data extraction process as Article 4 but extends the analysis by additionally extracting components, design thinking phases, and implementation activities relevant to VBP design.

Main findings: The study identifies six sequential phases supported by cross-cutting components linking value definition, incentive alignment, and organisational readiness. Expert validation confirms the framework's conceptual coherence and practical applicability, particularly regarding early analytical stages and leadership capabilities.

Relation to thesis: This article consolidates previous insights into a decision-support framework for the design and sequencing of VBP reforms.

1.4 Methodological Approach

This thesis adopts a multi-method research design aligned with its cumulative, article-based structure. The methodological strategy progresses from evidence synthesis to model development, mirroring the conceptual pathway required to operationalise Value-Based Hospital Payment. Each article applies a complementary method that collectively contributes to an integrated response to the research problem.

The overall design follows a sequential logic. Article 1 employs an umbrella review to synthesise global evidence on VBHC initiatives and identify system-level challenges (Aromataris, Fernandez, et al., 2024; Choi & Kang, 2023; Conn & Coon Sells, 2014; Papatheodorou & Evangelou, 2022). Article 2 employs a scoping review (Arksey & O'Malley, 2005; Peters et al., 2020; Tricco et al., 2018) to map organisational and information system requirements, with emphasis on Electronic Health Record (EHR), related facilitators and barriers. Article 3 develops and applies an MCDA framework in a hospital radiology department, supported by a Delphi process, to operationalise multidimensional value (Angelis & Kanavos, 2017; Beiderbeck et al., 2021; Phelps & Madhavan, 2017). Article 4 constructs a CMM for VBP using a scoping review and inductive thematic analysis (Braun & Clarke, 2006). Article 5 integrates evidence through a combined scoping review and expert survey to develop a consensus-based framework for VBP model design (Leao, Cremers, et al., 2023b; Okoli & Pawlowski, 2004; Tricco et al., 2018), building on the same scoping review dataset as Article 4 but extending the analysis to additional variables related to VBP design thinking phases and resources.

This methodological progression ensures that each stage builds on the previous one: evidence synthesis informs the identification of organisational and informational enablers, which support the operationalisation of value measurement, leading to the structured assessment of organisational capabilities and, ultimately, the design of VBP models.

The selected methods were chosen for their fit with the multidimensional nature of the research problem. The umbrella review provides a macro-level understanding of VBHC implementation; scoping

reviews capture heterogeneity in emerging evidence; MCDA structures value trade-offs across multiple criteria; the CMM assesses organisational readiness; and the consensus-based approach integrates diverse insights into a coherent framework. Together, they maintain internal coherence and cumulative logic while addressing distinct analytical layers of the problem.

Data sources vary across the five articles and include both secondary and primary evidence. Article 1 draws on secondary data from an umbrella review, while Article 2 relies on secondary evidence from a scoping review. Article 3 combines secondary evidence from a scoping review with primary and secondary data collected through a radiology case study and expert input via a Delphi method. Article 4 is based on secondary data derived from a scoping review and subsequent thematic analysis. Finally, Article 5 integrates secondary evidence from a scoping review with primary data from expert judgements collected through structured surveys. Across the five articles, the research adheres to established standards of methodological transparency, including the application of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021) and Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018) reporting guidelines and the JBI framework for scoping reviews (Peters et al., 2020). In addition, the thesis employs triangulation of data sources, systematic data extraction procedures, and validation through structured consensus methods, such as Delphi and expert surveys. These shared methodological principles ensure consistency, transparency, and robustness across the thesis.

Acknowledged limitations include reliance on the quality and heterogeneity of existing literature, the context specificity of the MCDA case study, and the conceptual nature of the maturity and design frameworks, which require further empirical validation. These limitations and their implications for future research are discussed in the concluding chapter.

1.5 Structure of the Thesis

This dissertation follows a cumulative, article-based format. The chapters progress from evidence synthesis to model development and integration, in line with the methodological logic outlined in Section 1.4.

- Chapter 1 presents the general introduction, including the research background, problem and questions, objectives, contributions, article overview, and methodological approach.
- Chapter 2 (Article 1) presents *The VBHC Big Picture: An Umbrella Review*, synthesising global evidence on VBHC implementation.

- Chapter 3 (Article 2) presents *The Importance of Health Information Systems in Value-Based Healthcare Initiatives: A Scoping Review*, examining organisational and technological requirements for VBHC implementation.
- Chapter 4 (Article 3) presents A Multiple Criteria Framework for Value-Based Assessment of Health Care Services Applied to a Radiology Case, developing and applying a multidimensional value assessment framework.
- Chapter 5 (Article 4) presents *Value-Based Payment Capability Maturity Model: A Conceptual Framework*, proposing a maturity model for organisational readiness in VBP adoption.
- Chapter 6 (Article 5) presents *Operationalising Value-Based Payment: A Decision-Support Framework for Health System Reform*, developing and validating a structured framework for the design and sequencing of VBP reforms.

The final chapter synthesises the overall conclusions of the thesis, discusses theoretical and practical implications, identifies overarching limitations, and outlines directions for future research. Appendices include supplementary methodological materials supporting transparency and reproducibility.

2

The Value-Based Healthcare Big Picture: An Umbrella Review

2.1 Introduction[1]

Porter and Teisberg offer a transformative perspective on healthcare, emphasising the dual goal of improving healthcare outcomes for patients and achieving cost-effectiveness, which translates into the concept of VBHC (Porter & Teisberg, 2006). This approach is a key reference point for evaluating the efficiency and effectiveness of healthcare systems. The strategy aims to align patient outcomes with the incentives of healthcare providers, thus promoting a more efficient and patient-centred healthcare system (Porter & Lee, 2013) . Nevertheless, the concept of value is complex and subjective in healthcare, and there is no single, universally accepted definition (Antoñanzas et al., 2016). This complexity is intensified by the challenges associated with conceptualising and implementing VBHC, as interpretations can vary significantly across different contexts (Steinmann et al., 2020; van Staalduinen et al., 2022).

Although it emphasises the optimisation of health outcomes in relation to costs (Porter & Teisberg, 2006), the concept of total value is complex and varies between the various stakeholders, including patients, providers, insurers, manufacturers and payers/ policymakers (Allen et al., 2023; T. R. Smith et al., 2015; Uyei et al., 2020). This divergence of perspectives has led to the development of various value-based mechanisms, such as VBID (Fendrick & Zank, 2013; Lee et al., 2013; Stecker et al., 2015), Value-Based Pricing (VBPr) (Dane et al., 2024; Jommi et al., 2020), Value-Based Purchasing (VBPu) (Hong et al., 2020; Tanenbaum, 2016), VBP (Cattel et al., 2020; Werner et al., 2021), Value Assessment Framework (VAF) (Dubois & Westrich, 2019; Westrich & Buelt, 2020), Value-Based Reimbursement (Paulden et al., 2015) Value-Based Integrated Care (VBIC) (van Hoorn et al., 2024) and

[1] This chapter is co-authored with José Crispim and is published (Moreira & Crispim, 2025).

Value-Based Procurement (VBPc) (Rahmani et al., 2021). This Core Concepts in VBHC addressed in this study are in describe in *Appendix A.1A.* The concept of total value in healthcare cannot be reduced to a single metric. Instead, different stakeholders assess value through different perspectives (Phelps & Madhavan, 2017; Terkola et al., 2019). Understanding the interaction of these mechanisms and their impacts, challenges and opportunities is essential to developing a cohesive and comprehensive understanding of VBHC.

Despite the existence of a scoping review analysing research on VBHC from 2006 to 2021, which shows that this concept has gained considerable attention since its introduction and that the volume of research in this field has been increasing (Vijverberg et al., 2022), there is still a need for a more integrated analysis that synthesises how VBHC is conceptualised and implemented at different levels of healthcare. The existing literature provides information on VBHC frameworks, implementation strategies (van Staalduinen et al., 2022), and stakeholder perspectives (de Mattia et al., 2024), but these studies often examine the topic in isolation.

To develop a comprehensive and cohesive understanding of VBHC, aligning the various viewpoints surrounding them is essential. By bridging these gaps, this study aims to contribute to advancing value-driven healthcare by providing an overview of this complex topic. This study aims to explore the global evidence and key lessons regarding the impacts, challenges and opportunities involved in implementing the VBHC model in diverse healthcare systems. To this end, this study adopted an umbrella review approach to provide a comprehensive synthesis that systematically integrates fragmented knowledge (Choi & Kang, 2023; Conn & Coon Sells, 2014). This method will allow for a broader understanding of the adoption of VBHC at various levels of healthcare, ultimately defining future research directions and informing policy development.

2.2 Methodology

2.2.1 Umbrella Review Concept

Umbrella reviews provide an innovative method for synthesising evidence from multiple systematic reviews and meta-analyses on related research questions (Choi & Kang, 2023; Conn & Coon Sells, 2014). Their primary objective is identifying trends, addressing inconsistencies, and guiding future research directions (Papatheodorou & Evangelou, 2022). As the volume of reviews continues to increase, umbrella reviews are crucial in advancing knowledge and enhancing health outcomes (Conn & Coon Sells, 2014).

2.2.2 Study Design

We systematically conducted searches and extracted extensive data from published systematic reviews and meta-analyses that investigated the concept of value in healthcare (Aromataris, Lockwood, et al., 2024; Belbasis et al., 2022). This method comprehensively synthesised existing evidence by summarising findings from prior reviews and meta-analyses (Papatheodorou & Evangelou, 2022). Through this approach, the study aimed to address the primary research question: *What are the global evidence and key lessons regarding the impacts, challenges, and opportunities of adopting the VBHC model in healthcare systems?*

Based on an inductive process, seven categories, and some of them with subcategories, were defined, enabling the qualitative organisation of the studies. The evidence was structured according to these predefined categories and subcategories established by the researchers (Table 1). Two independent reviewers performed this classification, and any disagreements were resolved through discussion and mutual agreement between the reviewers.

Table 1 - Categories of Analysis Defined by the Authors

Category	Subcategory	Definition
1. Implementation		The process and all activities of integrating VBHC practices.
2. Value Metrics and Evaluation process	2A. Evaluation process	The systematic analysis of healthcare interventions to determine their effectiveness, efficiency, and alignment with value-based care principles.
	2B. Value Metrics	Quantifiable indicators are used to assess value in healthcare.
3. Payment		Financial models and payment or reimbursement strategies that incentivise high-value care.
4. Cost Analysis and Savings Practices	4A. Cost Analysis	Examining financial data to determine the direct and indirect costs of healthcare services and interventions.
	4B. Savings Practices	Methods and initiatives aimed at reducing unnecessary spending while preserving or enhancing healthcare quality.
5. Low-Value Care		Medical activities that provide little or no benefit to patients often lead to unnecessary costs and potential harm without improving health outcomes.
6. Education and Skills		Training and competencies required for healthcare professionals to implement and sustain VBHC.
7. Value Models and Frameworks	7A. Value Models	Conceptual structures that guide the design, evaluation, and implementation of VBHC systems.
	7B. Frameworks	Structured methodologies that guide adopting VBHC concepts.

Note: VBHC — Value-Based Healthcare.

2.2.3 Literature search

A thorough search was conducted across PubMed, Scopus, Web of Science, and EBSCO from 2006 to April 2024 for systematic reviews and meta-analyses examining the concept of value in healthcare. The search strategy employed a variety of keywords related to VBHC, along with its

implementation models and methodologies based on existing reviews: (a) keywords related to VBHC (e.g., value-based healthcare or value-base program) and (b) keywords related to types of study (e.g., review or meta-analysis). We enhanced our search by carefully reviewing the reference lists of included studies, which enabled us to acquire additional articles derived from the references in the primary research literature.

Our search strategy was purposefully narrowed to include only the search terms present in the titles of articles, allowing us to identify studies that clearly articulated the concept of value in health. While we recognise that this approach has limitations, it was chosen to ensure that the selected articles were strongly aligned with the specific focus of our review. This decision was based on preliminary testing with broader criteria (Title and Abstract), which resulted in a significantly higher number of retrieved articles (e.g., 1449 instead of 68 in PubMed), but which, for the most part, did not describe actual implementations of VBHC. Instead, they focused on isolated topics such as economic evaluations (e.g., cost-utility analysis), patient perceptions of care, payment or reimbursement decisions, PROMs, or performance and quality indicators. We did not find any article describing the implementation of VBHC, without explicitly referencing it in the title. The detailed electronic search strategy is available in *Appendix A.2.*

2.2.4 Eligibility criteria

The exclusion criteria applied were: non-English or non-Portuguese publications, conference abstracts, editorials, narrative reviews, non-systematic reviews, opinion articles, case studies, primary research studies, clinical trials, lacking data on health outcomes, protocols for systematic review, reviews focused exclusively on the concept of value without addressing implementation, and duplicate results.

These criteria were defined to ensure alignment with the aim of this umbrella review, which is to synthesise global evidence on concept of value in health or VBHC (Porter & Teisberg, 2006).

2.2.5 Study Selection

This study utilised a qualitative methodology, incorporating a systematic literature review that complied with the PRISMA guidelines (Page et al., 2021). The selection process unfolded in three stages: (a) the removal of duplicates using EndNote 21 (Reuters, n.d.), (b) the screening of titles and abstracts, and (c) a comprehensive review of the full text of potentially relevant articles. Two investigators independently reviewed the titles and abstracts of all citations identified through the literature search. One investigator conducted the full-text review of all potentially eligible studies, while the second

investigator independently verified the assessments. Any discrepancies were resolved through discussion, and consensus was reached by mutual agreement between the reviewers.

2.2.6 Data Extraction

Two investigators extracted data to ensure accuracy and consistency. Any disagreements that arose during the extraction process were resolved through discussion and mutual agreement between the two reviewers. Before the extraction, a calibration exercise was conducted using a sample of three articles per reviewer to align their approaches and minimise variability.

To mitigate potential bias in the comprehensive review process, the CIMO framework (Denyer et al., 2008; Tranfield et al., 2003) was used as a data extraction tool following the guidelines outlined in the methodological framework for the development, execution, and reporting

Table 2 Following the inductive approach, this analysis and discussion framework was applied to each identified category.

Table 2 - Components of the CIMO Framework in the Context of This Review

Component	Approach	Question	Explanation within the context of this study
Context	Inductive (from the data collected about each case)	What are the environments in which the VBHC concept is implemented?	The environments in which the VBHC concept is implemented include. for example: - Medical conditions or specialities: Encompasses various medical conditions and specialities where VBHC principles guide diagnosis, treatment, and patient outcomes. - Healthcare system(s) or Healthcare organisation(s): Includes hospitals, integrated care networks, and regional or national healthcare systems that adopt VBHC models to enhance care delivery. - Healthcare practice: Refers to clinical and operational practices focused on diagnosis, treatment, rehabilitation, and prevention, aligning with VBHC principles. - Healthcare Technologies: Encompasses digital health solutions, medical devices, and data-driven tools that support value-based decision-making and patient-centred care. - Human Resources: Includes healthcare professionals such as physicians, nurses, therapists, and other providers who deliver medical, diagnostic, therapeutic, and supportive services within VBHC.
Intervention		What is the event, action, or activity that is intended to be analysed in the study?	This category refers to the event, action, or activity intended for analysis in the study, based on categories that emerged inductively, for example: - Identification: Recognising and defining key components, objectives, and significance within a given context.

Component	Approach	Question	Explanation within the context of this study
			- Description: A detailed characterisation of key aspects, including structure, processes, and interactions within the given context. - Impact: The measurable effects, including changes in efficiency, quality, and overall value within the given context.
Mechanism		What processes elucidate how the results of the study were achieved?	This includes the methodology followed by the studies, for example: - Framework-Based Analysis: Framework-Based Analysis or Cross-Tabulated and Framework Analysis. - Structured Data Extraction: Structured Data Extraction or Cochrane Meta-Analysis. - Thematic and Content Analysis: Thematic Mapping or Analysis, or Content Analysis.
Outcome		What are the results examined in studies assessing the effects of adopting the VBHC concept?	These aim to identify the results achieved within the scope of VBHC.

Note: VBHC – Value-Based Healthcare.

The presentation of the CIMO model elements as interconnected pairs, with Context and Intervention on one axis, and Mechanism and Outcome on the other, reflects the analytical strategy we adopted to better capture the causal logic present in the studies reviewed. This matrix-like structure allowed us to more effectively identify how specific interventions operate within given contexts by linking them to observed mechanisms and outcomes. With this approach, we aimed to go beyond simple thematic categorization and instead uncover causal patterns and generate practical insights from the literature.

2.2.6.1 Quality Assessment

The methodological quality of the systematic reviews and meta-analyses was assessed by the authors using the Checklist for Systematic Reviews and Research Syntheses developed by the JBI (Aromataris, Lockwood, et al., 2024). Further details regarding adherence to reporting standards can be found in PRISMA Checklist *(Appendix A.3).* Although several other checklists and tools are available to evaluate research syntheses (Shea et al., 2007; Whiting et al., 2016), the umbrella review methodology working group explicitly designed this checklist. It consists of 10 questions, each of which can be categorised as “yes”, “no”, “unclear”, or “Not applicable” (Aromataris, Lockwood, et al., 2024).

One point was awarded for each question if the corresponding criterion was met. Based on the total score achieved, studies were categorised as follows: those with a score below three out of 10 were

excluded; studies scoring between four and six out of 10 were deemed to be of moderate quality and were included in the analysis; and studies with scores ranging from seven to 10 out of 10 were classified as high quality and also included in the analysis (Aromataris, Lockwood, et al., 2024). The evaluation was carried out by two independent reviewers, who resolved any disagreements through discussion and reached consensus by mutual agreement.

2.3 Results

A total of 318 publications were initially identified, and after the removal of duplicates, 131 were included in the first screening phase. Based on the established inclusion and exclusion criteria, 77 publications advanced to the subsequent screening phase. A thorough analysis of the full texts of these publications resulted in the inclusion of 41 in the umbrella review. Additionally, we reviewed the reference lists of these publications, which contributed to an additional seven publications. In total, the review included 48 publications. Further details can be found in Figure 1.

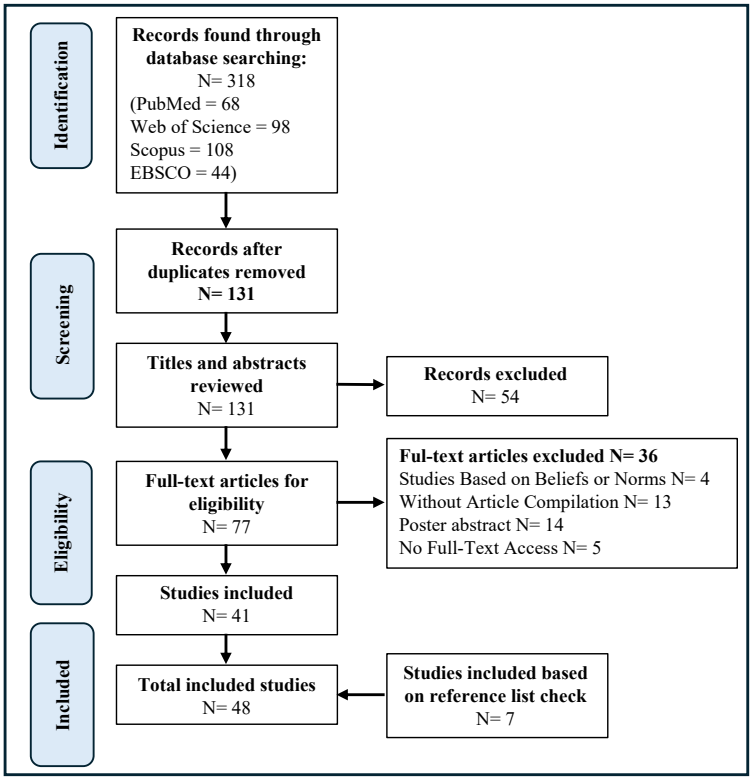


Figure 1 - PRISMA Flowchart

2.3.1 General Description of the Selected Publications

The principal characteristics of the publications included in this analysis are detailed in Table 3. A substantial portion of these publications (58%) was released between 2021 and 2023. Most of the

studies (58%) employed a systematic review methodology, while 18 studies (38%) conducted scoping reviews. Only two studies (4%) used mixed methods, combining systematic reviews with meta-analyses.

An assessment of the included studies of each of the 48 publications revealed a diverse diversity. Observational studies were cited in 13% of the reviews, experimental studies in 11%, qualitative studies in 15%, and quantitative studies in 9%. Mixed methods studies constituted 11%, with review studies and reports accounting for 4%. Empirical and non-empirical studies collectively made up 8% of the total. There was also variation in the number of studies included in each review, with most (73%) incorporating fewer than 50 articles.

Geographically, the included studies drew on research from multiple countries. European countries led with 42% of the reviews, followed by American countries at 29%. Table 3 also summarises the quality assessment of the included studies: 27 were rated as high quality, representing 56% of the total. No study received a score below the acceptable threshold, ensuring that all met the inclusion criteria for this umbrella review. A detailed description of the included studies is provided in Appendix A.4.

Table 3 - General Description of the Publications Included in the Analysis.

Classification category and subcategories	**N**	**%**	**References**
Year of Publication			
2014	2	4%	(Chambers et al., 2014; Tang et al., 2014)
2015	3	6%	(Niven et al., 2015; Paulden et al., 2015; Stammen et al., 2015)
2016	0	0%	-
2017	1	2%	(Colla et al., 2017)
2018	0	0%	-
2019	3	6%	(DeBaun et al., 2019; Krack, 2019; Seixas et al., 2019)
2020	7	15%	(Cattel & Eijkenaar, 2020; Etges et al., 2020; Hong et al., 2020; Nilsen et al., 2020; Prieto-Pinto et al., 2020; Renee Rutter & Park, 2020; Walsh et al., 2020)
2021	5	10%	(Indrakanti et al., 2012; Miracolo et al., 2021; Rahmani et al., 2021; Reitblat et al., 2021; Zanotto et al., 2021)
2022	11	23%	(Abdalla et al., 2022; de Vasconcelos Silva et al., 2022; Gunawan et al., 2022; Kokko, 2022; Leusder et al., 2022; Parker et al., 2022; van Engen et al., 2022; van Staalduinen et al., 2022; Vijverberg et al., 2022; Zhang et al., 2022; Zhou et al., 2022)
2023	12	25%	(Eijsink et al., 2023; He et al., 2023; Khoo et al., 2024; Kidanemariam et al., 2023; Leao, Cremers, van Veghel, Pavlova, & Groot, 2023; Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023; Moreira & Crispim, 2023; Silveira Bianchim et al., 2023; Takami et al., 2023; van der Voorden et al., 2023; van Elten et al., 2023; Vandemaele et al., 2023)
2024	4	8%	(Abubakar et al., 2024; Fernández-Salido et al., 2024; Marino & Capone, 2024; van Hoorn et al., 2024)
Total	*48*	*100%*	-
Type of study			

Classification category and subcategories	N	%	References
Systematic Review	28	58%	(Abdalla et al., 2022; Cattel & Eijkenaar, 2020; Colla et al., 2017; de Vasconcelos Silva et al., 2022; DeBaun et al., 2019; Etges et al., 2020; Hong et al., 2020; Indrakanti et al., 2012; Kokko, 2022; Leao, Cremers, van Veghel, Pavlova, & Groot, 2023; Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023; Leusder et al., 2022; Moreira & Crispim, 2023; Prieto-Pinto et al., 2020; Reitblat et al., 2021; Renee Rutter & Park, 2020; Seixas et al., 2019; Stammen et al., 2015; Takami et al., 2023; Tang et al., 2014; van der Voorden et al., 2023; van Engen et al., 2022; van Hoorn et al., 2024; Vandemaele et al., 2023; Walsh et al., 2020; Zanotto et al., 2021; Zhang et al., 2022; Zhou et al., 2022)
Scoping Review	18	38%	(Abubakar et al., 2024; Eijsink et al., 2023; Fernández-Salido et al., 2024; Gunawan et al., 2022; He et al., 2023; Khoo et al., 2024; Kidanemariam et al., 2023; Marino & Capone, 2024; Miracolo et al., 2021; Nilsen et al., 2020; Niven et al., 2015; Parker et al., 2022; Paulden et al., 2015; Rahmani et al., 2021; Silveira Bianchim et al., 2023; van Elten et al., 2023; van Staalduinen et al., 2022; Vijverberg et al., 2022)
Mixed Methods	2	4%	(Chambers et al., 2014; Krack, 2019)
Total	*48*	*100%*	-
Reported research strategies of articles included in the selected reviews			
Observational Studies	11	14%	(Abdalla et al., 2022; Hong et al., 2020; Kidanemariam et al., 2023; Krack, 2019; Marino & Capone, 2024; Niven et al., 2015; Reitblat et al., 2021; Silveira Bianchim et al., 2023; van Elten et al., 2023; van Hoorn et al., 2024; Vijverberg et al., 2022)
Experimental Studies	9	11%	(Chambers et al., 2014; Kidanemariam et al., 2023; Krack, 2019; Niven et al., 2015; Reitblat et al., 2021; Silveira Bianchim et al., 2023; Stammen et al., 2015; Tang et al., 2014; van Hoorn et al., 2024)
Qualitative Studies	12	15%	(Abdalla et al., 2022; Fernández-Salido et al., 2024; Kidanemariam et al., 2023; Marino & Capone, 2024; Niven et al., 2015; Parker et al., 2022; Silveira Bianchim et al., 2023; Stammen et al., 2015; van der Voorden et al., 2023; van Elten et al., 2023; van Engen et al., 2022; van Hoorn et al., 2024)
Quantitative Studies	7	9%	(Kidanemariam et al., 2023; Leao, Cremers, van Veghel, Pavlova, & Groot, 2023; van der Voorden et al., 2023; van Elten et al., 2023; van Engen et al., 2022; van Hoorn et al., 2024; Vijverberg et al., 2022)
Mixed Methods Studies	9	11%	(Fernández-Salido et al., 2024; Kidanemariam et al., 2023; Niven et al., 2015; Parker et al., 2022; Silveira Bianchim et al., 2023; Stammen et al., 2015; van der Voorden et al., 2023; van Engen et al., 2022; Vijverberg et al., 2022)
Review Studies and Reports	3	4%	(Kokko, 2022; Rahmani et al., 2021; Vijverberg et al., 2022)
Empirical and Non-Empirical Studies	6	7%	(Abubakar et al., 2024; Parker et al., 2022; Paulden et al., 2015; van Hoorn et al., 2024; van Staalduinen et al., 2022; Vijverberg et al., 2022)
Others	2	2%	(Marino & Capone, 2024; Silveira Bianchim et al., 2023)
No reported research strategies	22	27%	(Cattel & Eijkenaar, 2020; Colla et al., 2017; de Vasconcelos Silva et al., 2022; DeBaun et al., 2019; Eijsink et al., 2023; Etges et al., 2020; Gunawan et al., 2022; Indrakanti et al., 2012; Khoo et al., 2024; Leusder et al., 2022; Miracolo et al., 2021; Moreira & Crispim, 2023; Nilsen et al., 2020; Prieto-Pinto et al., 2020; Renee Rutter & Park, 2020; Seixas et al., 2019; Takami et al., 2023; Vandemaele et al., 2023; Walsh et al., 2020; Zanotto et al., 2021; Zhang et al., 2022; Zhou et al., 2022)
Total (1)	*81*	*100%*	-
Number of articles included in the selected reviews			

Classification category and subcategories	N	%	References
≤25	20	42%	(Abubakar et al., 2024; de Vasconcelos Silva et al., 2022; DeBaun et al., 2019; Eijsink et al., 2023; Fernández-Salido et al., 2024; Kokko, 2022; Krack, 2019; Marino & Capone, 2024; Moreira & Crispim, 2023; Nilsen et al., 2020; Rahmani et al., 2021; Reitblat et al., 2021; Renee Rutter & Park, 2020; Takami et al., 2023; Tang et al., 2014; van der Voorden et al., 2023; van Elten et al., 2023; van Hoorn et al., 2024; Vandemaele et al., 2023; Walsh et al., 2020)
]25; 50]	15	31%	(Abdalla et al., 2022; Chambers et al., 2014; Etges et al., 2020; Gunawan et al., 2022; He et al., 2023; Hong et al., 2020; Indrakanti et al., 2012; Khoo et al., 2024; Kidanemariam et al., 2023; Parker et al., 2022; Paulden et al., 2015; Seixas et al., 2019; Silveira Bianchim et al., 2023; van Engen et al., 2022; Zanotto et al., 2021)
]50; 100]	4	8%	(Prieto-Pinto et al., 2020; Stammen et al., 2015; van Staalduinen et al., 2022; M. Zhang et al., 2022)
]100; 250]	6	13%	(Cattel & Eijkenaar, 2020; Colla et al., 2017; Leao, Cremers, van Veghel, Pavlova, & Groot, 2023; Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023; Miracolo et al., 2021; Niven et al., 2015)
]250; 500]	2	4%	(Leusder et al., 2022; Zhou et al., 2022)
>1000	1	2%	(Vijverberg et al., 2022)
Total	*48*	*100%*	-
Reviews of countries from:			
Europe	20	42%	(Cattel & Eijkenaar, 2020; Eijsink et al., 2023; Kidanemariam et al., 2023; Kokko, 2022; Krack, 2019; Leao, Cremers, van Veghel, Pavlova, & Groot, 2023; Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023; Leusder et al., 2022; Marino & Capone, 2024; Miracolo et al., 2021; Moreira & Crispim, 2023; Nilsen et al., 2020; Silveira Bianchim et al., 2023; Stammen et al., 2015; van der Voorden et al., 2023; van Engen et al., 2022; van Hoorn et al., 2024; van Staalduinen et al., 2022; Vijverberg et al., 2022; Walsh et al., 2020)
America	*14*	29%	(Chambers et al., 2014; Colla et al., 2017; de Vasconcelos Silva et al., 2022; DeBaun et al., 2019; Hong et al., 2020; Indrakanti et al., 2012; Niven et al., 2015; Parker et al., 2022; Paulden et al., 2015; Prieto-Pinto et al., 2020; Reitblat et al., 2021; Renee Rutter & Park, 2020; Tang et al., 2014; Zanotto et al., 2021)
Asia	5	10%	(Abubakar et al., 2024; Gunawan et al., 2022; Krack, 2019; Takami et al., 2023; Zhou et al., 2022)
Multiple countries	9	19%	(Abdalla et al., 2022; Etges et al., 2020; Fernández-Salido et al., 2024; He et al., 2023; Khoo et al., 2024; Seixas et al., 2019; van Elten et al., 2023; Vandemaele et al., 2023; M. Zhang et al., 2022)
Total	*48*	*100%*	-
Quality assessment (qualitative and quantitative)			
Exclusion	0	0%	-
Moderate	21	44%	(Cattel & Eijkenaar, 2020; Chambers et al., 2014; Colla et al., 2017; de Vasconcelos Silva et al., 2022; DeBaun et al., 2019; Gunawan et al., 2022; Khoo et al., 2024; Kokko, 2022; Leusder et al., 2022; Miracolo et al., 2021; Moreira & Crispim, 2023; Nilsen et al., 2020; Parker et al., 2022; Rahmani et al., 2021; Reitblat et al., 2021; Renee Rutter & Park, 2020; Seixas et al., 2019; Takami et al., 2023; Vandemaele et al., 2023; Walsh et al., 2020; Zhou et al., 2022)
High	27	56%	(Abdalla et al., 2022; Abubakar et al., 2024; Eijsink et al., 2023; Etges et al., 2020; Fernández-Salido et al., 2024; He et al., 2023; Hong et al., 2020; Indrakanti et al., 2012; Kidanemariam et al., 2023; Krack, 2019;

Classification category and subcategories	N	%	References
			Leao, Cremers, van Veghel, Pavlova, & Groot, 2023; Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023; Marino & Capone, 2024; Niven et al., 2015; Paulden et al., 2015; Prieto-Pinto et al., 2020; Silveira Bianchim et al., 2023; Stammen et al., 2015; Tang et al., 2014; van der Voorden et al., 2023; van Elten et al., 2023; van Engen et al., 2022; van Hoorn et al., 2024; van Staalduinen et al., 2022; Vijverberg et al., 2022; Zanotto et al., 2021; Zhang et al., 2022)
Total	*48*	*100%*	-
QA Mean	6,833	-	-
QA Score = 4	1	2%	(Vandemaele et al., 2023)
Quality assessment Score = 5	9	19%	(Cattel & Eijkenaar, 2020; Chambers et al., 2014; Gunawan et al., 2022; Kokko, 2022; Moreira & Crispim, 2023; Parker et al., 2022; Seixas et al., 2019; Walsh et al., 2020; Zhou et al., 2022)
Quality assessment Score = 6	11	23%	(Colla et al., 2017; de Vasconcelos Silva et al., 2022; DeBaun et al., 2019; Khoo et al., 2024; Leusder et al., 2022; Miracolo et al., 2021; Nilsen et al., 2020; Rahmani et al., 2021; Reitblat et al., 2021; Renee Rutter & Park, 2020; Takami et al., 2023)
Quality assessment Score = 7	10	21%	(Abubakar et al., 2024; Etges et al., 2020; Fernández-Salido et al., 2024; He et al., 2023; Leao, Cremers, et al., 2023a; Marino & Capone, 2024; Prieto-Pinto et al., 2020; Tang et al., 2014; van Elten et al., 2023; van Staalduinen et al., 2022)
Quality assessment Score = 8	11	23%	(Eijsink et al., 2023; Kidanemariam et al., 2023; Krack, 2019; Niven et al., 2015; Paulden et al., 2015; Stammen et al., 2015; van der Voorden et al., 2023; van Engen et al., 2022; Vijverberg et al., 2022; Zanotto et al., 2021; Zhang et al., 2022)
Quality assessment Score = 9	5	10%	(Abdalla et al., 2022; Hong et al., 2020; Indrakanti et al., 2012; Leao, Cremers, et al., 2023b; Silveira Bianchim et al., 2023)
Quality assessment Score = 10	1	2%	(van Hoorn et al., 2024)
Total	*48*	*100%*	-

2.3.2 General Classification of Selected Publications

Seven categories emerged from analysing the 48 studies considered, reflecting the main conceptual domains observed. Some of these categories were subdivided into subcategories for better organisation and content differentiation. Figure 2 illustrates it, highlighting the proportional representation of each category. The tree map visually groups the categories, presented in Table 1, that derived from the review of the 48 studies, which facilitates the quick identification of the most and least addressed topics. The descriptions of *Implementation, Value Metrics and Evaluation Process, and Value Models and Frameworks* (each comprising 21% of a total of 63%) are proportionally the most discussed topics, while *Education and Skills* account for only 4% of the 48 studies considered. This comparative analysis of proportions is not intended to indicate the relative importance of each category, but rather to highlight those most and least published.

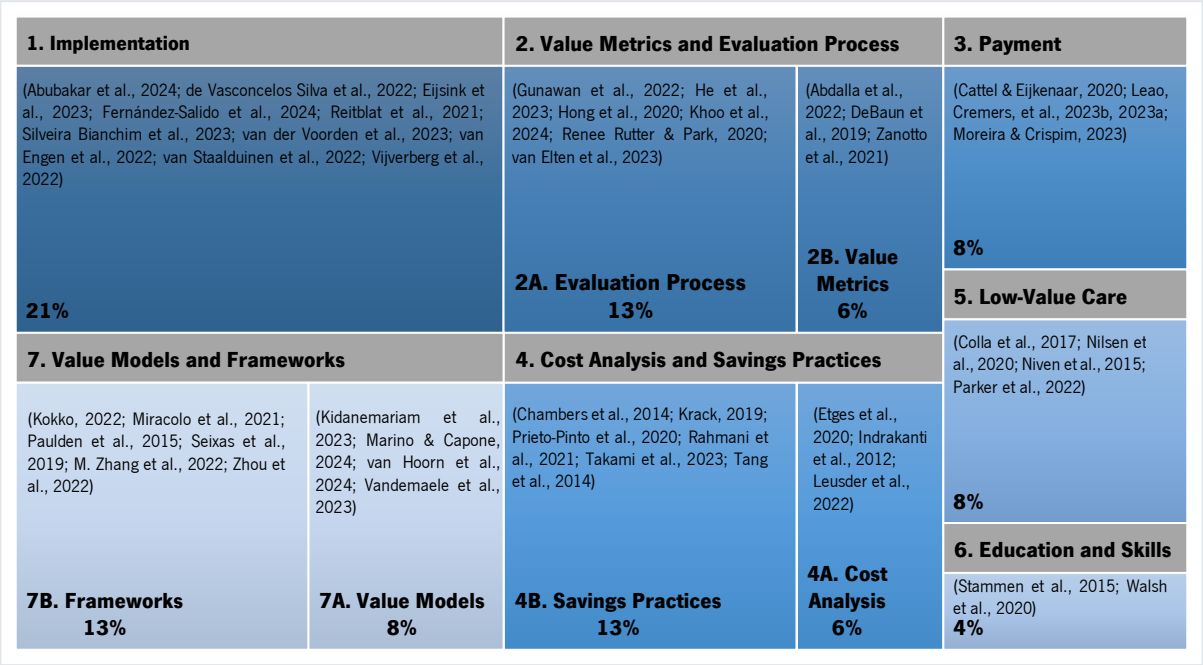


Figure 2 - Distribution of Selected Articles by the Established Groups

2.3.3 Implementation

Implementing VBHC (details in Table 4) has impacted healthcare systems and organisations by emphasising essential factors such as cost reduction, outcome improvement, and adherence to VBHC principles (de Vasconcelos Silva et al., 2022). A set of key strategies for successful implementation was described (van Staalduinen et al., 2022), along with a set of outcome categories that were implemented (Fernández-Salido et al., 2024), which can lead to cost reduction, increased satisfaction, and decreased healthcare utilisation (van Staalduinen et al., 2022).

Despite challenges in VBHC implementation, such as the misalignment between developing PROMs and their implementation in hospitals, the positive effects on communication, symptom awareness, and overall healthcare costs were evident (Eijsink et al., 2023; Silveira Bianchim et al., 2023). There were regional differences in focus; North America prioritises clinical outcomes and costs, while Europe emphasised clinical outcomes and PROMs. The reported success rate for VBHC implementation is 79% (Vijverberg et al., 2022).

Table 4 - Implementation category CIMO results

		Intervention		
		Actions	**Description**	**Impact**
Context	**Medical conditions or specialities**	- Implementation needs: structural changes, practical implementation, and contributions to designing value-based care services by synthesizing current practices and key premises (de Vasconcelos Silva et al., 2022). - Factors influencing PROMs implementation: digital factors, patient-related factors, staff factors, and organisational factors (Silveira Bianchim et al., 2023).	- Papers VBHC implementation focus essential on: costs (34%), outcomes (24%) and VBHC agenda (24%) (de Vasconcelos Silva et al., 2022). - Implementation gaps: lack of fully developed value-based care models for cancer patients and challenges with adherence to the value agenda (de Vasconcelos Silva et al., 2022). - Implementation challenges: Misalignment between PROMs/PREMs development and hospital implementation; need for VBHC process improvements (Eijsink et al., 2023). - Limitations PROMs implementation: for use in multiple comorbidities, limited transferability and unclear cost-effectiveness (Silveira Bianchim et al., 2023).	- Impact of VBHC implementation: positive impact, with partial agenda implementation and reduced healthcare costs (Abubakar et al., 2024), along with improved guideline adherence, reduced unnecessary procedures in multidisciplinary clinics, enhanced surgical outcomes, significant cost reductions through activity-based costing, and mixed outcomes for centralized care integration (Reitblat et al., 2021). - Impact of PROMs implementation: positive and enhanced communication, symptom awareness, health outcomes, clinician efficiency, adherence, reduced costs, and improved patient experience (Eijsink et al., 2023; Silveira Bianchim et al., 2023).
	Healthcare system(s) or Healthcare organisation(s)	- Implementation regional differences: North America focused on clinical outcomes and costs, while Europe emphasized clinical outcomes and PROMs (Vijverberg et al., 2022). - Implementation strategy: hospitals have not adopted VBHC as a fully integrated strategy (van Staalduinen et al., 2022). - Implementation key strategies: education, multidisciplinary teams, strong leadership, patient involvement, organizational structure, standardisation, data, and adequate resources (Fernández-Salido et al., 2024; van Staalduinen et al., 2022). - Implementation key agenda item: measuring outcomes and costs was the most common (Vijverberg et al., 2022)	- Concept used in implementation: varied conceptualizations of VBHC, and definitions emphasizing patient-centred care (Fernández-Salido et al., 2024; van Staalduinen et al., 2022). - Outcomes assessed: the most implemented components for assessing outcomes are measuring outcomes and costs, with clinical outcomes and costs being the most common, while PROMs and PREMs are less frequently used (van Staalduinen et al., 2022; Vijverberg et al., 2022).	- Outcomes assessed impact: cost reduction, increased satisfaction, and decreased healthcare utilisation (van Staalduinen et al., 2022). - Implementation success: 23% assessed implementation, with 79% reporting success (Vijverberg et al., 2022). - VBHC implementation: influences care pathways, outcome validation, and problem-solving (van der Voorden et al., 2023). - Consultation vs. Partnership: Most studies prioritised consultation over partnership and shared leadership (van der Voorden et al., 2023).

		Intervention		
		Actions	**Description**	**Impact**
		- Implementation outcomes: quality, efficiency and sustainability, job satisfaction among staff and quality data (Fernández-Salido et al., 2024).		
	Human Resources	- Key factor in engagement in VBHC: organisational support is crucial in balancing these impacts (van Engen et al., 2022).	NR	- Positive outcomes in engagement in VBHC: increased job satisfaction and enhanced sense of pride (van Engen et al., 2022). - Negative outcomes in engagement in VBHC: exhaustion and loss of focus (van Engen et al., 2022).
			Outcomes	
Mechanism	**Systematic review**	Thematic analysis (van Engen et al., 2022) Thematic Mapping (de Vasconcelos Silva et al., 2022)	Thematic Mapping (de Vasconcelos Silva et al., 2022)	Thematic analysis (van der Voorden et al., 2023) (van Engen et al., 2022)
	Scoping review	Framework-Based Analysis (Fernández-Salido et al., 2024) Structured Data Extraction (Silveira Bianchim et al., 2023; van Staalduinen et al., 2022)	Structured Data Extraction (Eijsink et al., 2023; Silveira Bianchim et al., 2023; van Staalduinen et al., 2022; Vijverberg et al., 2022) Framework-Based Analysis (Fernández-Salido et al., 2024)	Structured Data Extraction (Vijverberg et al., 2022) Framework-Based Analysis (Abubakar et al., 2024)

Note: CIMO - Context-Intervention-Mechanism-Outcome; NR - Not reported; PREMs - Patient-Reported Experience Measures; PROM - Patient-Reported Outcome Measure; VBHC - Value-Based Healthcare.

2.3.4 Value Metrics and Evaluation Process

2.3.4.1 Evaluation Process

The value evaluation process (details in Table 5) within healthcare systems was centred on the transition from volume-based care to VBHC (Gunawan et al., 2022). This shift underscored the significance of performance management systems (van Elten et al., 2023), which incorporates a variety of outcome measures (Khoo et al., 2024) and could be influenced by hospital characteristics as well as external socioeconomic factors (Abubakar et al., 2024).

Key challenges in this transition included organisational readiness, outcomes measurement, and bundled payments implementation (Gunawan et al., 2022). While performance management systems emphasised the importance of successful VBHC implementations, they often overlook examples of failure (van Elten et al., 2023). Research indicated that VBHC enhances quality and cost efficiency; however, the results varied significantly based on specific hospital attributes and geographic locations (He et al., 2023).

Table 5 - Evaluation Process category CIMO results

		Intervention		
		Focus	**Description**	**Impact**
Context	**Medical conditions or specialities**	- Key performance management outcome measures: clinical metrics and patient-reported metrics (Khoo et al., 2024). - Process measures focus: elderly care and quality indicators (Khoo et al., 2024).	- Awareness for performance management: emphasis on physician-level performance and accuracy in documentation (Khoo et al., 2024).	NR
	Healthcare system(s) or Healthcare organisation(s)	- Factors that influence value-based program performance and financial penalties: hospital characteristics (size, safety-net status, location and teaching status) and external factors (patient populations, socioeconomic status, acuity levels) (Renee Rutter & Park, 2020). - Performance management systems approaches: top-down (structured) and bottom-up (patient-driven) (van Elten et al., 2023). - Performance management systems tools: performance measures, scorecards and benchmarking (van Elten et al., 2023)	- Transition from volume-based care to VBHC: the adoption remains limited, focusing primarily on outcome and cost measurement. (Gunawan et al., 2022). - Key challenges in the transition from volume-based care to VBHC: organizational readiness for integrated practice units, outcome measurement, bundled payments for chronic conditions, IT integration, and multi-site care coordination (Gunawan et al., 2022). - External influence on performance management: insurance and policymakers significantly shape VBHC adoption (van Elten et al., 2023) - Performance management systems: learning from failures requires studying both successful and unsuccessful VBHC cases (van Elten et al., 2023).	- The VBPu program impact: minimal on quality outcomes and costs, with mixed results depending on hospital characteristics and location, slight benefits for patient experience and pneumonia mortality, and negative effects on safety-net hospitals (Hong et al., 2020). - Performance management systems: emphasize successful VBHC implementations, neglecting failures (van Elten et al., 2023). - Effects of VBHC on performance: Most studies showed positive improvements in quality, cost saving and enhanced decision-making and fewer studies reported neutral or negative effects of VBHC on performance (He et al., 2023).
		Outcomes		
Mechanism	**Systematic review**	Structured Data Extraction (Renee Rutter & Park, 2020)	NR	NR
	Scoping review	Framework-Based Analysis (Khoo et al., 2024) Structured Data Extraction (van Elten et al., 2023)	Framework-Based Analysis (Gunawan et al., 2022; Khoo et al., 2024) Structured Data Extraction (van Elten et al., 2023)	Framework-Based Analysis (Hong et al., 2020) Structured Data Extraction (He et al., 2023; van Elten et al., 2023)

Note: CIMO - Context-Intervention-Mechanism-Outcome; IT - Information Technology; NR - Not reported; VBPu - Value-Based Purchasing.

2.3.4.2 Value Metrics

Value metrics (Table 6) are vital indicators for evaluating the performance and quality of healthcare services, encompassing a range of dimensions (Abdalla et al., 2022). In specific medical conditions, different categories of quality measures were identified (Abdalla et al., 2022; DeBaun et al.,

2019). However, these measures concentrate primarily focused on processes and then on outcomes (DeBaun et al., 2019). In broader healthcare systems, patient-reported outcomes frequently addressed factors such as recovery time and long-term consequences (Zanotto et al., 2021). Mortality metrics were reported less often, while financial outcomes focusing on value generally emphasised cost savings (Zanotto et al., 2021). Furthermore, financial measurement practices indicated that microcosting methods were underutilised, with non-microcosting approaches being more widely adopted (Zanotto et al., 2021).

Table 6 - Value Metrics category CIMO results

		Intervention	
		Identification of measures	**Description of measures**
Context	**Medical conditions or specialities**	- Seven themes of quality measures for cardiovascular diseases and cancer: survival, quality of life, time to recovery, treatment process disutility, sustainability of health, long-term therapy consequences, and process measures (Abdalla et al., 2022)	- Quality measures of orthopaedic trauma surgery: out of 189 with the Donabedian framework, 7% address structure, 52% focus on processes and 41% focus on outcomes (DeBaun et al., 2019). 12 were identified as candidate quality measures (DeBaun et al., 2019).
	Healthcare system(s) or Healthcare organisation(s)	NR	- Patient-Reported Outcomes more frequently reported: time to recovery and long-term consequences (Zanotto et al., 2021). - Financial Measurement: microcosting methods were underused in literature and Harvard Business School cases; non-microcosting methods were more common (Zanotto et al., 2021). - Mortality metrics: were reported less frequently (Zanotto et al., 2021). - Value-based financial outcomes: most of the studies reported results that contributed to this, and the primary focus was on cost savings (Zanotto et al., 2021).
			Outcomes
Mechanism	**Systematic review**	Framework-Based Analysis (Abdalla et al., 2022)	Framework-Based Analysis (DeBaun et al., 2019; Zanotto et al., 2021)

Note: CIMO - Context-Intervention-Mechanism-Outcome; NR - Not reported.

2.3.5 Payment

In healthcare, VBP aimed to promote high-quality and efficient care (details in Table 7). For example, in radiology, 56 key performance indicators (KPIs) were identified for developing these payments (Moreira & Crispim, 2023). However, implementing VBP faced various barriers and requires changes in behaviour, procedures, and infrastructure (Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023).

VBP initiatives often included global base payments and quality incentives linked to clinical and patient outcomes (Cattel & Eijkenaar, 2020). In primary care, risk adjustments were essential for success (Cattel & Eijkenaar, 2020). Models like pay-for-performance and shared savings differenced in their approaches (Leao, Cremers, van Veghel, Pavlova, & Groot, 2023). While VBP generally resulted in lower costs and improved quality, they also had potential drawbacks, including negative effects on provider ownership and motivation, which could influence reported outcomes (Leao, Cremers, van Veghel, Pavlova, & Groot, 2023).

Table 7 - Payment category CIMO results

			Intervention	
		Identification of characteristics	**Description of models**	**Impact of models**
Context	**Medical conditions or specialities**	- Indicators categorization for payment model development: Radiology has 56 KPIs grouped into 7 categories (service accessibility, exam prescription adequacy, exam process, report, results, safety, and contribution to the institution) (Moreira & Crispim, 2023).	NR	NR
	Healthcare system(s) or Healthcare organisation(s)	- VBPs barriers: Financial, organizational, and implementation challenges, weak incentives, poor coordination, and complexity (Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023). - VBPs facilitators: Adequate funding, strong leadership, stakeholder engagement, clear incentives, and efficient processes (Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023).	- VBPs initiatives: design and payment structure variation typically include global base payments (Cattel & Eijkenaar, 2020). - Quality Incentives in VBP: linked to clinical and patient outcomes (Cattel & Eijkenaar, 2020). - VBPs in primary care: focus on incorporating risk adjustments (Cattel & Eijkenaar, 2020). - VBPs success factors: effective incentives and quality measures are essential (Leao, Cremers, van Veghel, Pavlova, & Groot, 2023). - Pay-for-Performance and shared savings models: show significant differences (Leao, Cremers, van Veghel, Pavlova, & Groot, 2023). - Implementation challenges in VBPs: complexity and inexperience require behavioural, procedural, and infrastructural adjustments (Leao, Cremers, van Veghel, Pavlova, & Groot, 2023).	- Impact of VBPs: positive impact on results (Leao, Cremers, van Veghel, Pavlova, & Groot, 2023) presenting lower costs and improved quality (Cattel & Eijkenaar, 2020) and negative impact reducing ownership and motivation, affecting the results reported by the organization (Leao, Cremers, van Veghel, Pavlova, & Groot, 2023).
			Outcomes	

			Intervention	
		Identification of characteristics	**Description of models**	**Impact of models**
Mechanism	**Systematic review**	Structured Data Extraction (Leao, Cremers, et al., 2023b; Moreira & Crispim, 2023)	Structured Data Extraction (Cattel & Eijkenaar, 2020) Cross-Tabulated and Framework Analysis (Leao, Cremers, et al., 2023a)	Structured Data Extraction (Cattel & Eijkenaar, 2020) Cross-Tabulated and Framework Analysis (Leao, Cremers, et al., 2023a)

Note: CIMO - Context-Intervention-Mechanism-Outcome; KPI - Key Performance Indicator; NR - Not reported; VBP - Value-Based Payment.

2.3.6 Cost Analysis and Savings Practices

2.3.6.1 Cost Analysis

Cost analysis (details in Table 8) was an essential evaluation method for examining the costs associated with various interventions and strategies within healthcare systems. This analysis revealed challenges such as limited literature, multiple diagnoses, and inconsistent assessment methods (Indrakanti et al., 2012). Time-Driven Activity-Based Costing (TDABC) was shown to enhance cost accuracy, transparency, and resource allocation, facilitating the transition to VBHC systems (Etges et al., 2020). Furthermore, cost analysis highlighted the necessity of considering comprehensive costs across entire care cycles to achieve effective VBHC implementation (Leusder et al., 2022).

Table 8 - Cost Analysis category CIMO results

		Intervention	
		Description of methods	**Impact**
Context	**Medical conditions or specialities**	- Cost-effectiveness of operative vs. nonoperative care: operative interventions generally show better cost-effectiveness for spinal disorders (Indrakanti et al., 2012). - Challenges identified: limited literature, diversity in diagnoses and inconsistent assessment methods (Indrakanti et al., 2012).	- The impact of using TDABC: improves cost accuracy, increases transparency, enhances resource allocation, facilitates the transition to value-based systems and enhances overall value through better cost management (Etges et al., 2020).
	Healthcare system(s) or Healthcare organisation(s)	- Cost information for VBHC: essential for enabling VBHC (Leusder et al., 2022). - Costing Methods: TDABC (the most effective costing method, but its success depends on implementation), and partial care costing (while accurate, is limited for decision-making) (Leusder et al., 2022). - Focus Areas: emphasis on full care cycles and the need for comprehensive cost consideration (Leusder et al., 2022).	NR
		Outcomes	
Mechanism	**Systematic review**	Structured Data Extraction (Indrakanti et al., 2012; Leusder et al., 2022)	Structured Data Extraction (Etges et al., 2020)

Note: CIMO - Context-Intervention-Mechanism-Outcome; NR - Not reported; TDABC - Time-Driven Activity-Based Costing; VBHC - Value-Based Healthcare.

2.3.6.2 Savings Practices

Research indicates that VBID led to more significant improvements in patient adherence when full coverage was provided, in contrast to partial coverage (Krack, 2019). VBID significantly impacted treatments for osteoporosis and chronic cardiovascular diseases (Chambers et al., 2014; Tang et al., 2014). Additionally, educational interventions further enhanced this effectiveness, though not always to a statistically significant degree (Krack, 2019).

Health Technology Assessment methods encompassed Cost-Effectiveness Analysis. Reported methods considered productivity and disease factors while also emphasising efficacy, rarity, unmet needs, and broader elements of value (Prieto-Pinto et al., 2020; Takami et al., 2023).

Finally, VBPc prioritised comprehensive evaluations of patient outcomes. Integrating economic methods into decision-making required reliable data and stakeholder collaboration for effective implementation (Rahmani et al., 2021). More details are in Table 9.

Table 9 - Savings Practices category CIMO results

		Intervention	
		Approaches	**Impact**
Context	**Medical conditions or specialities**	NR	- Impact of VBID on Osteoporosis treatments: By eliminating co-pays for top treatments and shifting patients to more effective options, VBID can reduce adverse outcomes and healthcare costs while yielding improved clinical outcomes and significant cost savings by preventing severe complications (Chambers et al., 2014). - Impact of VBID on Cardiovascular Chronic Diseases: positive impact on patient adherence, though its broader effects on clinical outcomes, healthcare utilization, and spending remain uncertain (Tang et al., 2014).
	Healthcare system(s) or Healthcare organisation(s)	- Therapeutic value and pricing frameworks: focus on aligning costs with clinical and economic benefits through Health Technology Assessments (Prieto-Pinto et al., 2020). - Variations in implementation influenced by: local priorities, value perceptions and economic strategies (including cost-effectiveness, negotiated pricing and budgetary considerations) (Prieto-Pinto et al., 2020).	- VBID coverage impact: full coverage had a stronger effect on adherence than partial coverage and educational interventions further boosted effectiveness, though not always significantly (Krack, 2019).

		Intervention	
		Approaches	**Impact**
		- Methods utilized in drug pricing assessments: Cost-effectiveness analysis (integrating costs, Quality-Adjusted Life Years, productivity and disease factors) and alternative approaches (focusing on efficacy, rarity, unmet needs and broader value elements) and various methodologies are used to quantify these elements (Takami et al., 2023).	- VBID adherence impact: adherence consistent across different scenarios and populations (Krack, 2019).
	Healthcare Technologies	- VBPc: emphasises comprehensive evaluation of patient outcomes, incorporates economic methods in decision-making and focuses on total cost (functionality and value-driven decisions) (Rahmani et al., 2021). - VBPc requirements for success: requires reliable data for effective assessment, involves collaboration among stakeholders and encourages multidisciplinary efforts (Rahmani et al., 2021).	NR
		Outcomes	
Mechanism	**Systematic review**	Structured Data Extraction (Prieto-Pinto et al., 2020; Takami et al., 2023)	Structured Data Extraction (Tang et al., 2014)
	Scoping review	Structured Data Extraction (Rahmani et al., 2021)	NR
	Mixed methods	NR	Framework-Based Analysis (Chambers et al., 2014) Cochrane Meta-Analysis (Krack, 2019)

Note: CIMO - Context-Intervention-Mechanism-Outcome; NR - Not reported; VBPc - Value-Based Procurement; VBID - Value-Based Insurance Design.

2.3.7 Low-Value Care

Reducing Low-Value Care involved identifying and eliminating medical practices that yield minimal patient benefits (more detail in Table 10). Key strategies included using clinical decision support systems, multi-component interventions, and addressing inappropriate antibiotic use and medication optimisation (Niven et al., 2015; Parker et al., 2022). Effective frameworks were essential for implementing these strategies despite challenges like insurer restrictions (Colla et al., 2017; Nilsen et al., 2020; Niven et al., 2015). Some medical conditions demonstrated significant reductions in Reducing Low-Value Care (Niven et al., 2015). While clinician and patient education varied in effectiveness, interventions such as provider report cards and pay-for-performance programs have produced mixed results (Colla et al., 2017). More details are in Table 10.

Table 10 - Low-Value Care category CIMO results

		Intervention		
		Identification of strategies	**Key factors of strategies**	**Impact of strategies**
Context	**Healthcare practice Healthcare practice**	- Terminology and citations: "disinvest" was the most used term, and it identified barriers and facilitators to de-adoption strategies (Niven et al., 2015). - Key strategic steps: identifying critical factors and guiding data analysis and implementation (Parker et al., 2022). - Approaches used: determinant frameworks, classic theories and implementation theories (Parker et al., 2022). - Strategies: efforts focus on reducing inappropriate antibiotic use, optimizing drug utilization, and enhancing imaging practices for diagnostics (Niven et al., 2015; Parker et al., 2022). - Frameworks & Insights: diverse, adapted frameworks (e.g., Theoretical Domains Framework, Tailored Implementation for Chronic Disease, Grol's Process Model) have been used to identify low-value practices and guide low-value care reduction strategies (Nilsen et al., 2020; Niven et al., 2015).	- Drivers: de-adoption is primarily driven by harm risks and lack of efficacy (Niven et al., 2015). - Key Domains and activities: have been identified for de-implementation (Nilsen et al., 2020). - Challenges: implementation is sometimes hindered by insurer restrictions (Colla et al., 2017).	- Effectiveness in reducing low-value care: Ten studies demonstrated successful reductions (Parker et al., 2022). - Most effective strategies: clinical decision support and multicomponent interventions were the most effective in reducing low-value care (Colla et al., 2017). - Success in specific areas: High success rates were observed, particularly in cardiovascular, arthritis, and menopause-related practices (Niven et al., 2015). - Variable effectiveness: interventions such as clinician and patient education and cost-sharing showed varying levels of effectiveness (Colla et al., 2017). - Mixed results: provider report cards and Pay-for-Performance programs had inconsistent outcomes (Colla et al., 2017).
		Outcomes		
Mechanism	**Systematic review**	NR	Structured Data Extraction (Colla et al., 2017)	Structured Data Extraction (Colla et al., 2017)
	Scoping review	Framework-Based Analysis (Nilsen et al., 2020) Structured Data Extraction (Niven et al., 2015)	Framework-Based Analysis (Nilsen et al., 2020) Structured Data Extraction (Niven et al., 2015)	Framework-Based Analysis (Parker et al., 2022) Structured Data Extraction (Niven et al., 2015)

Note: CIMO - Context-Intervention-Mechanism-Outcome.

2.3.8 Education and Skills

Effectively management hospital operations in a VBHC system demanded essential competencies (Table 11), including leadership, healthcare knowledge, business acumen, relationship management, and general management (Walsh et al., 2020). Teaching health economics and patient preferences was essential in improving decision-making while fostering reflective practice and cultivating a supportive, collaborative environment (Stammen et al., 2015).

Table 11 - Education and Skills category CIMO results

		Intervention	
		Competencies	**Success factors**
Context	**Human Resources**	- Key management competencies for hospital managers in a VBHC system: leadership skills, healthcare knowledge, business acumen, relationship management, human resource management and general management (Walsh et al., 2020).	- Key success factors for improving healthcare decision-making in VBHC: teaching health economics and patient preferences, fostering reflective practice with feedback and creating a supportive environment through collaboration and role models (Stammen et al., 2015).
		Outcomes	
Mechanism	**Systematic review**	Content analysis (Walsh et al., 2020)	Thematic analysis (Stammen et al., 2015)

Note: CIMO - Context-Intervention-Mechanism-Outcome; VBHC - Value-Based Healthcare.

2.3.9 Value Models and Frameworks

2.3.9.1 Value Models

Value models (Table 12), like VBIC, aimed to improve patient outcomes through coordinated care and collaboration among stakeholders (van Hoorn et al., 2024). While VBIC interventions positively impacted collaboration, follow-up care, and service accessibility, facilitators and limitations were also identified (van Hoorn et al., 2024).

Value co-creation highlights the dependence between organisations and patients, leading to better outcomes and increased patient satisfaction (Marino & Capone, 2024). However, evidence for VBHC and Patient-Centred Care was limited, mainly reflecting the views of providers and payers rather than patients (Kidanemariam et al., 2023).

Table 12 - Value Models category CIMO results

		Intervention		
		Identification of characteristics	**Description of value model**	**Impact**
Context	**Healthcare system(s) or Healthcare organisation(s)**	- VBIC key facilitators: supportive IT systems, effective payment models and strong leadership (van Hoorn et al., 2024).	- Definition of VBIC (van Hoorn et al., 2024). - Patient-centred care and VBHC: There is limited evidence on VBHC and Patient-centred care, and most studies on VBHC focus on quality measures from the perspectives of providers, institutions, and payers rather than from patients (Kidanemariam et al., 2023).	- Impact of VBIC interventions: Interventions across multiple levels have positively impacted outcomes, improving collaboration, enhanced follow-ups and better care accessibility (van Hoorn et al., 2024).

		Intervention		
		Identification of characteristics	**Description of value model**	**Impact**
		- VBIC key barriers: IT limitations, payment challenges and cultural resistance (van Hoorn et al., 2024).	- Value co-creation in healthcare: relies on the interdependence between organizations and patients, emphasizes collaboration, communication, and active participation, and enhances outcomes, patient satisfaction, and well-being in clinical encounters and preventive health services (Marino & Capone, 2024).	NR
		Outcomes		
Mechanism	**Systematic review**	Framework-Based Analysis (van Hoorn et al., 2024)	Framework-Based Analysis (van Hoorn et al., 2024)	Framework-Based Analysis (van Hoorn et al., 2024)
	Scoping review	NR	Structured Data Extraction (Kidanemariam et al., 2023; Marino & Capone, 2024)	NR

Note: CIMO - Context-Intervention-Mechanism-Outcome; IT - Information Technology; NR - Not reported; VBHC - Value-Based Healthcare; VBIC- Value-based Integrated Care.

2.3.9.2 Frameworks

Value frameworks were essential in healthcare as they facilitate decision-making and enhance patient outcomes (Table 13). For instance, a reimbursement framework for orphan drugs identified 19 key factors and advocated separating costs from benefits to improve transparency (Paulden et al., 2015).

In the realm of radiation oncology innovation, the formulation of a VAF uncovered various definitions and classification systems, underscoring the necessity for standardisation (Vandemaele et al., 2023). Predictive tools in healthcare were assessed to support clinical decision-making in oncology and cardiovascular diseases (Miracolo et al., 2021). Furthermore, VBHC facility design frameworks drew on insights from the United States of America and Japan to boost outcomes and efficiency (Zhou et al., 2022).

Overall, VAFs in healthcare were highly contextual, utilising various methodologies - such as incremental cost-effectiveness ratios and multi-criteria assessments - to deliver thorough evaluations (Seixas et al., 2019).

Table 13 - Frameworks category CIMO results

		Intervention	
		Types	**Key factors**
Context	**Medical conditions or specialities**	- Framework Decision-Making for Orphan Drugs Reimbursement: 19 factors identified as influencing the reimbursement decision, categorized into value-bearing and cost-determining factors and a new framework is suggested to separate costs from benefits to achieve greater transparency and societal alignment (Paulden et al., 2015). - Creation of a VAF for Radiotherapy Innovations: seven different definitions and fifteen classification systems exist for innovations in radiation oncology, highlighting the need for standardisation (Vandemaele et al., 2023). - Predictive Tools to Improve Health Outcomes: seven major categories were identified, ranging from regression models to advanced machine learning models. Performance is measured using Area Under the Curve- Receiver Operating Characteristic curves, with a focus on enhancing clinical decision-making, especially in oncology and cardiovascular diseases, aiming to improve surgical outcomes and patient survival (Miracolo et al., 2021).	- Influences on stakeholder preferences on Framework decision-making for Orphan Drugs reimbursement: key influences include rescue rules, equity, and rights (Paulden et al., 2015).. - Critique of existing Framework decision-making for Orphan Drugs reimbursement: issues identified with the existing framework include double-counting and cost mismanagement (Paulden et al., 2015).
	Healthcare system(s) or Healthcare organisation(s)	- Framework for VBHC facility design: integrates time, space, and behaviour and the insights are drawn from The United States of America (focus on outcomes, reducing hospital stays, and minimising nurse stress) and Japan (emphasis on disaster preparedness, spatial efficiency, and ageing population needs) (Zhou et al., 2022)	- VAF: definitions and measurements of value vary significantly; value attributes are often consolidated into a single index for decision-making and lack of patient and public engagement (M. Zhang et al., 2022). - Use of the Triple Aim Framework as a VAF: there is no consensus on the impact and balance of the Triple Aim's goals and literature on its implementation at the health system level remains limited (Kokko, 2022).
	Healthcare Technologies	NR	- Value Assessment: Value assessment is highly contextual, employing diverse approaches (Seixas et al., 2019). - Cost-Effectiveness Measures on Value Assessment: incremental cost-effectiveness ratios are predominantly used, though limitedly (Seixas et al., 2019). - Multi-Criteria Approaches on Value Assessment: there is a growing reliance on multi-criteria assessments (including PROM) to provide a more comprehensive evaluation (Seixas et al., 2019). - Cost Considerations on Value Assessment: despite these developments, cost considerations remain inconsistent (Seixas et al., 2019).
			Outcomes
Mecha	**Systematic review**	Structured Data Extraction (Vandemaele et al., 2023) Thematic Mapping (Zhou et al., 2022)	Structured Data Extraction (Seixas et al., 2019; M. Zhang et al., 2022) Framework-Based Analysis (Kokko, 2022)

Scoping review	Structured Data Extraction (Miracolo et al., 2021; Paulden et al., 2015)	Structured Data Extraction (Paulden et al., 2015)

Note: CIMO - Context-Intervention-Mechanism-Outcome; NR – Not Reported; PROM - Patient-Reported Outcome Measure; VAF - Value Assessment Framework; VBHC - Value-Based Healthcare.

2.4 Discussion

This discussion builds on the findings of this umbrella review, organizing the analysis around the seven key categories identified in this study. Within each category, the key lessons, impacts, challenges and opportunities of adopting the VBHC model across diverse healthcare systems are critically examined, providing a comprehensive synthesis of the global evidence. VBHC is a multifaceted concept integrating clinical practice, economic considerations, and patient engagement. Implementation requires transforming organizational culture, utilizing advanced data analytics for measuring outcomes and costs and fostering collaboration among multidisciplinary teams.

2.4.1 Robustness of results and quality of evidence

The robustness of the results presented in this umbrella review reflects significant variability in methodological quality, risk of bias, and heterogeneity across the included studies in each thematic category.

In the implementation of VBHC, the consistency of findings is noteworthy, particularly regarding the emphasis on cost and clinical outcome measurement (Denyer et al., 2008; Gunawan et al., 2022; van Staalduinen et al., 2022). However, there is less attention to patient-centred tools such as PROMs and PREMs, highlighting a significant gap in the holistic assessment of value (Marino & Capone, 2024; van Staalduinen et al., 2022). Regional variability, with a stronger focus on PROMs in Europe, further underscores the contextual heterogeneity that must be considered when generalizing these conclusions (Vijverberg et al., 2022).

Regarding the evaluation process, the inclusion of both clinical and patient-reported metrics strengthens performance assessment (Khoo et al., 2024). Nonetheless, reliance on indicators such as Assessing Care for Vulnerable Elders and Resident-sensitive Quality Measures, which are specific to older populations, may limit the applicability of the findings to other contexts and introduce potential bias if these metrics are not robustly validated (Khoo et al., 2024).

Value metrics reveal a broad approach encompassing seven key domains, yet the predominance of process and outcome measures (e.g., 52% and 41% in orthopaedic trauma surgery) highlights a potential methodological limitation by prioritizing clinical impact without an equally detailed evaluation of

supporting structures (Abdalla et al., 2022; DeBaun et al., 2019). The focus on specific conditions, such as cardiovascular and oncological diseases, limits generalization to other clinical areas.

In VBP models, although the detailed identification of KPIs (e.g., 56 indicators in radiology) provides a concrete framework, the heterogeneity in structure and design of models across different organizational and geographical contexts suggests a high degree of variability and potential selection bias in the studies reviewed (Cattel & Eijkenaar, 2020; Leao, Cremers, et al., 2023a).

Cost analysis demonstrates methodological robustness through the use of TDABC, enabling precise and consistent cost measurements (Leusder et al., 2022). However, the dependence of this method on practical implementation and variability in its application across organizations introduce potential bias, while studies comparing surgical and non-surgical interventions may suffer from significant heterogeneity (Indrakanti et al., 2012).

In saving practices, approaches such as VBID and VBPc show significant potential and are supported by solid frameworks like Cost-Effectiveness Analysis (Prieto-Pinto et al., 2020; Takami et al., 2023), but the scarcity of longitudinal data and reliance on self-reported and institutional evaluations may introduce bias and limit the applicability of the findings (Rahmani et al., 2021).

In the reduction of low-value care, well-defined theoretical frameworks (Theoretical Domains Framework, Tailored Implementation for Chronic Disease) contribute to the credibility of the findings (Nilsen et al., 2020; Niven et al., 2015). However, variability in the application of models and limited evidence on the actual implementation of these strategies across healthcare systems reduce the strength of the evidence (Niven et al., 2015; Parker et al., 2022).

The education and skills of professionals are identified as critical factors (Walsh et al., 2020), but the available studies tend to emphasize hospital management competencies with less focus on practical and clinical skills, representing a limitation for practical application and potential focus bias (Stammen et al., 2015).

Finally, in the value models category, while the literature acknowledges the essential role of information systems, paymente models, and co-creation of value (Marino & Capone, 2024; van Hoorn et al., 2024), there is limited evidence regarding the effective integration of the patient perspective and the direct impact of these strategies on care improvement, indicating methodological fragilities and potential bias (Kidanemariam et al., 2023).

2.4.2 Impacts on clinical practice, health policies, and guideline development

The summary of the impacts identified per category was the following:

Implementation

- Clinical practice: VBHC implementation showed positive effects on guideline adherence, reduction of unnecessary procedures, better surgical outcomes, and improved clinician efficiency (Fernández-Salido et al., 2024; Kidanemariam et al., 2023; Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023; Parker et al., 2022). PROMs/PREMs enhance communication and clinical-patient engagement (Kidanemariam et al., 2023; Leao, Cremers, et al., 2023b).
- Health policies: Policies should support VBHC adoption with a focus on measuring outcomes and costs, institutional leadership, and multidisciplinary team integration (Denyer et al., 2008; Marino & Capone, 2024; van Staalduinen et al., 2022).
- Guidelines: PROMs/PREMs implementation should be recommended as part of ongoing patient-centred outcome monitoring (Kidanemariam et al., 2023; Leao, Cremers, et al., 2023b).

Value Metrics and Evaluation Process

- Clinical practice: Tools such as scorecards, benchmarking, and clinical indicators contribute to continuous quality improvement, better clinical decisions, and more efficient resource use (He et al., 2023; Khoo et al., 2024).
- Health policies: Policymakers must consider hospital structural factors (size, academic status, location) when applying penalties or incentives (Renee Rutter & Park, 2020).
- Guidelines: Performance metrics selection must be aligned with validated measures and include both clinical and patient-reported outcomes (van Elten et al., 2023).

Payment

- Clinical practice: VBP models align clinical incentives with better outcomes but may risk demotivation if poorly designed (Leao, Cremers, et al., 2023a).
- Health policies: Public policies should promote hybrid models such as shared savings or bundled payments, with clear, measurable incentives (Cattel & Eijkenaar, 2020; Leao, Cremers, et al., 2023a, 2023b).
- Guidelines: Recommendations on payment models should include quality criteria and proven economic impact (Cattel & Eijkenaar, 2020; Leao, Cremers, et al., 2023a).

Cost Analysis and Saving Practices

- Clinical practice: TDABC improves cost allocation accuracy and supports cost-effective clinical decision-making (Etges et al., 2020; Leusder et al., 2022).

- Health policies: Policies must encourage the adoption of full-cycle cost accounting methods to support strategic financial decision-making (Leusder et al., 2022).
- Guidelines: TDABC and other cost-assessment tools should be recommended in guidelines to promote sustainable and efficient care (Etges et al., 2020).

Low-Value Care

- Clinical practice: De-implementation strategies such as clinical decision support and multicomponent interventions effectively reduce low-value care, especially in cardiology and menopause-related practices (Colla et al., 2017; Niven et al., 2015; Parker et al., 2022).
- Health policies: Policies should integrate mechanisms for discontinuing low-value practices based on risk/benefit analysis, not just cost (Colla et al., 2017).
- Guidelines: Guidelines should include "do-not-recommend" sections based on evidence of low clinical value (Nilsen et al., 2020; Niven et al., 2015).

Education and Skills

- Clinical practice: Professionals trained in VBHC report greater satisfaction and engagement, although a lack of institutional support may lead to burnout (Silveira Bianchim et al., 2023).
- Health policies: Ongoing training and institutional support are needed to develop leaders and managers skilled in value-based health (Walsh et al., 2020).
- Guidelines: Training guidelines should include health economics, patient preferences, and reflective practice (Stammen et al., 2015).

Value Models and Frameworks

- Clinical practice: Using structured models improves coordination and outcomes, with evidence of better care access and follow-up (van Hoorn et al., 2024).
- Health policies: Health systems should support integrated value models with adequate Information Technology (IT), reimbursement systems, and leadership (van Hoorn et al., 2024).
- Guidelines: Value-based frameworks should be used to redesign clinical pathways and support value-driven decisions (van Hoorn et al., 2024).

2.4.3 Challenges in the Implementation of VBHC

The challenges identified per category were the following:

Implementation (and Health System Organization)

- Misalignment between the development of PROMs/PREMs and their hospital-level implementation hampers full execution of the VBHC agenda (Leao, Cremers, et al., 2023b).

- Lack of fully developed models, particularly in areas like cancer care, limits consistent adherence to value-based principles (Gunawan et al., 2022).
- Limited adoption of VBHC as an integrated organizational strategy; many institutions have yet to systematize the approach (van Staalduinen et al., 2022).
- Contextual factors (e.g., hospital characteristics and external variables), such as location, teaching status, and patient populations, negatively impact program performance (Renee Rutter & Park, 2020).
- Low prioritization of patient partnership - most studies emphasize consultation rather than shared leadership (van Elten et al., 2023).

Value Metrics and Evaluation Process

- Challenges in transitioning from volume to value-based care, including organizational unpreparedness for Integrated Practice Units, difficulty in outcome measurement, bundled payments for chronic conditions, and multisite coordination (Gunawan et al., 2022).
- Performance systems often overlook failures, focusing solely on successful implementations, which hinders institutional learning (van Elten et al., 2023).
- Underuse of accurate financial methods like microcosting and infrequent reporting of mortality metrics (Zanotto et al., 2021).

Payment

- Financial, organizational, and cultural barriers complicate the implementation of VBP models (Leao, Cremers, et al., 2023b).
- Complexity and inexperience with payment models demand behavioural, procedural, and infrastructure changes (Leao, Cremers, et al., 2023a).
- Negative impacts: some models may reduce staff motivation and ownership, ultimately affecting outcomes (Leao, Cremers, et al., 2023a).

Cost Analysis and Savings Practices

- Limited and inconsistent literature on cost-effectiveness, due to diagnostic diversity and varied assessment methods (Indrakanti et al., 2012).
- Challenges in implementing TDABC, while effective, its success depends on correct execution (Leusder et al., 2022).

Low-Value Care

- Insurer restrictions may hinder the implementation of de-implementation strategies (Colla et al., 2017).

- Variable effectiveness of interventions; approaches such as provider/patient education and pay-for-performance programs showed mixed results (Colla et al., 2017).

  Education and Skills

- There are negative impacts on professionals, including burnout and loss of focus, especially when organizational support is lacking (Silveira Bianchim et al., 2023).
- Lack of management competencies aligned with VBHC, such as knowledge in health economics and value-based decision-making (Walsh et al., 2020).

  Value Models and Frameworks

- Cultural resistance to collaborative work among stakeholders and active patient involvement (van Hoorn et al., 2024).
- Limited integration between VBHC and Patient-Centred Care - most VBHC studies focus on institutional/provider perspectives, neglecting patient views (Kidanemariam et al., 2023).

2.5 Future research

This research agenda, described in Table 14, aims to create a strategic pathway for advancing knowledge in VBHC by identifying key priorities from seven analysed categories. It offers a coherent framework for future research while promoting interdisciplinary collaboration, methodological innovation, and practical applications.

Table 14 - Future research agenda by categories

Category	Future Research
Implementation	Evaluate the effectiveness of PROMs in promoting patient-centred care. Study the impact of digital infrastructure on the collection and use of value metrics. Investigate how organisational and patient characteristics influence VBHC outcomes. Understand the effects of partial VBHC adoption and its consequences for the value agenda. Assess strategies to reduce organisational resistance and improve interdepartmental coordination. Explore the relationship between staff engagement and burnout in the context of VBHC.
Value Metrics and Evaluation	Develop standardised metrics that integrate clinical quality, financial outcomes, and patient satisfaction. Investigate how hospital characteristics and external factors affect performance and outcomes. Analyse limitations of administrative databases in capturing PROMs and PREMs effectively. Assess the impact of subjective variables such as physician-patient communication and caregiver burden. Examine how current indicators may be biased by comorbidities and patient frailty. Develop performance monitoring models that include both successes and failures. Conduct longitudinal studies tracking VBHC implementation and stakeholder engagement.
Payment Models	Evaluate motivational effects (both positive and negative) of VBP models. Study barriers to adopting VBP systems, especially in diverse implementation contexts. Analyse how program design (scope, goals, incentives) influences effectiveness. Investigate organisational impacts of transitions to global and risk-based payment models.

Category	Future Research
Cost Analysis and Savings Practices	Investigate the adoption and effectiveness of TDABC across systems. Assess the alignment between therapeutic value and pricing, particularly through health technology assessments integration. Study the feasibility and impact of implementing VBPr in low- and middle-income countries.
Low-Value Care	Develop evidence-based de-adoption frameworks with strong economic foundations. Investigate the real-world impact of initiatives like *Choosing Wisely* in different healthcare systems. Analyse how systemic and cultural factors influence the persistence of low-value practices. Study the role of clinical decision support systems in reducing low-value care utilisation.
Education and Skills	Explore the effectiveness of educational programmes that teach health economics and value preferences. Investigate gaps in digital literacy and their impact on VBHC implementation. Develop interprofessional training models integrating leadership, management, and patient-centred values.
Value Models and Frameworks	Analyse limitations of current models in capturing patient perspectives on value. Study variations in the definition of "value" across different systems and cultures. Evaluate the impact of predictive tools and multi-criteria assessment methodologies in clinical decision-making. Investigate how to meaningfully engage stakeholders in defining and evaluating healthcare value.

Note: PREM – Patient-Reported Experience Measure; PROM - Patient-Reported Outcome Measure; TDABC - Time-Driven Activity-Based Costing; VBP - Value-Based Payment; VBPr - Value-Based Pricing; VBHC - Value-Based Healthcare.

2.6 Limitation

While we have ensured this umbrella review's quality by following the PRISMA guidelines, it is critical to acknowledge several limitations. Firstly, as mentioned before, our research strategy concentrated exclusively on search terms found in the titles of included articles, which may have led to the exclusion of relevant studies that address health value in less direct language. This restriction could diminish the comprehensiveness of our findings, as many significant works might have enhanced our discussion. Additionally, by only considering studies published in academic journals, we introduced a potential for publication bias, which could distort the results in favour of studies perceived as more impactful. Furthermore, given the evolving nature of the VBHC concept, there is an ongoing need for additional research to capture new insights and developments. This highlights the necessity for a more systematic approach to consolidating knowledge in this complex field. As a result, future research endeavours should address these limitations to strengthen the robustness and applicability of the findings.

Moreover, we observed some disciplinary gaps in the included studies. For instance, none of the studies specifically focused on digital health, even though digital technologies are increasingly important for enabling and scaling VBHC. This absence indicates a missing perspective that may restrict the overall scope of our synthesis, especially considering how often we reference digital innovations in our discussion.

2.7 Conclusion

In conclusion, this umbrella review consolidated global evidence on VBHC, emphasising its transformative potential in optimising healthcare delivery through improved patient outcomes and cost efficiency. The findings highlight a dynamic interplay of organisational, financial, and patient-centred factors, demonstrating both the opportunities and challenges associated with VBHC implementation. While its benefits are well-documented, contextual variations, structural complexities, and measurement difficulties present ongoing hurdles that require adaptive strategies and sustained collaboration. Moving forward, context-specific implementation frameworks, robust outcome measurement, and stakeholder engagement will be essential to maximising the value and sustainability of healthcare systems adopting VBHC principles.

3

The Importance of Health Information Systems in Value-Based Healthcare Initiatives: A Scoping Review

3.1 Introduction[2]

The VBHC concept has been launched and promoted as the new approach to address the challenges presented by the costs in the healthcare sector (Porter & Teisberg, 2006). According to this concept, value is no longer measured by the volume of services, but by the results obtained in healthcare provision (Porter, 2010). Measuring health outcomes and costs is an essential element in the VBHC process. Measurement of results allows teams to know they are succeeding and provides the data needed to improve care and efficiency (Teisberg et al., 2020). Typically, the desirable and relevant patient level outcomes were measured from both the patient perspective (e.g., PROMs and PREMs) and clinical outcome perspective (Porter, 2010).

In 2013, Porter and Lee defined a strategy for VBHC transformation based on six points (Porter & Lee, 2013): (1) the organization should operate in integrated practice units; (2) costs and outcomes should be measured for every patient; (3) transition to bundled payment for the care cycle; (4) integration of care delivery across separate facilities; (5) integration of care delivery across separate facilities; (6) building and enabling a suitable IT platform. According to these authors, for the strategy to be successful, it is important that several of these points advance simultaneously.

This transformation may be regarded as a complex socio-technical intervention that requires organisational readiness for change among healthcare professionals (Heijsters et al., 2022). According

[2] This chapter is co-authored with José Crispim and is published as (Moreira & Crispim, 2024)

to van Staalduinen et al. (2022), there is ambiguity in the implementation of VBHC, which hinders the sharing of best practices or comparison between healthcare organizations. In practice, each hospital has its own way and preference for translating the principles of VBHC into practice, based on what is feasible within the specific hospital and healthcare system (Heijsters et al., 2022). This value agenda provides initial guidance on the implementation of VBHC, but it is still insufficient in terms of detailed information on how to practically implement VBHC in a healthcare organization, as highlighted by Daniels et al. (2022). Recently, several authors have described the implementation of value-based initiatives (e.g., Cossio-Gil et al. (2021)). Unfortunately, little is known about the factors that made these implementation efforts successful or not (Daniels et al., 2022).

Despite the differences the roadmaps published for VBHC implementation generally comprises 5 stages: preparation, design building, implementation, and improvement (e.g. Cossio-Gil et al. (2021) or Heijsters et al. (2022)). In building and implementation stage health informatics and information systems play a decisive role for data gathering and data analysis. Value-based initiatives utilize the EHR as the primary source of data (Zanotto et al., 2021). An EHR can be defined as "a repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users" (Häyrinen et al., 2008, p. 293). This digital repository aims to provide continuous, efficient, quality, and integrated medical care with retrospective, concurrent, and prospective information (Uslu & Stausberg, 2021). The EHR is also a requirement for transitioning to Alternative Payment Models (APMs) (Opelka et al., 2018), which have been increasingly important in the adoption of the VBHC concept.

A literature review on common enablers and barriers in health information systems (Bogaert et al., 2021) identified five main barriers related to these systems: (1) data fragmentation (fragmentation of sources, access, and utilization); (2) barriers to EHR implementation; (3) lack of governance; (4) legal issues; (5) lack of qualified human resources. Enablers, on the other hand, refer to potential solutions to address these barriers.

Previous reviews have focused on the design (e.g., Eijkenaar (2012), drivers of costs (Chee et al., 2016), cost measurement (Leusder et al., 2022), measuring success (Damberg et al., 2014), economic evaluation (Heider & Mang, 2020), and the identification of factors that facilitate or inhibit the design and implementation of VBHC (Leao, Cremers, et al., 2023b). This scoping review provides an overview of the information and technology issues that influence the success of VBHC models with a focus on EHR. Therefore, we addressed the following research question: *What facilitators and barriers related to the healthcare information systems are described in studies related to the implementation of VBHC?*

3.2 Methodology

We conducted a scoping review in accordance with the methodology of the JBI (Peters et al., 2020; Tricco et al., 2018), searched the electronic databases: EMBASE and PubMed in the time frame of 2012-2023. In the methodological search strategy, we used a combination of terms related to VBHC ("VBHC," "value-based health care," "value-based healthcare," "value based"), implementation contexts ("initiatives," "implementation," "case study"), and digital health systems ("EHR," "electronic health record," "healthcare information system," "health informatics," "information technology platform") to ensure comprehensive retrieval of studies addressing the implementation of VBHC initiatives supported by health information technologies. Further details are provided in *Appendix B.1* and *B.2*.

With respect to study eligibility, the inclusion criteria followed were: having the full text available; being within the VBHC domain; belonging to the IT domain; focusing on implementation; being conducted in healthcare organizations; being empirical, original research or reviews; and being written in English. Regarding the study selection, both reviewers independently screened all articles included in this study. Eligible studies were selected for full-text reviews. Consensus was reached through discussion between the two reviewers. The included studies were those that utilized EHR to obtain their data and mentioned facilitating or barrier points in relation to its use. Studies that did not mention facilitators or barriers regarding the data used in their study were excluded. The data extraction process began with the collection of information, which was performed independently by the two reviewers. When uncertainties arose, consensus was reached through discussion between the two reviewers. The data extraction process began with recording the general characteristics of the studies, such as the origin country year of publication, the healthcare field and the care setting. The data analysis was conducted in accordance with the study's research question, and three categories: data, data analysis, and resources or infrastructure - emerged from the conventional content analysis performed. Topics related to these categories were categorized as facilitators or barriers to the use of healthcare information systems in VBHC initiatives.

3.3 Results

The initial database search identified 147 references. The title/abstract screening resulted in 76 full text articles. After screening these, we selected 24 papers. Descriptive features of the studies are shown in Table 15, and the complete data extraction table can be found in the *Appendix B.3.*

Table 15 - Studies characteristics

Studies Characteristics		References	N	*Total*
Origin Country	Belgium	(Wyffels et al., 2023)	1	*24*
	Europe	(Cossio-Gil et al., 2021)	1	
	Netherlands	(Daniels et al., 2022; Heijsters et al., 2022; van Egdom et al., 2019)	3	
	Spain	(Varela-Rodríguez et al., 2022)	1	
	United Kingdom	(Burnhope et al., 2022; Gabriel et al., 2019)	2	
	The United States of America	(Abdulla et al., 2012; Ahn et al., 2019; Chatfield et al., 2019; Danilyants et al., 2019; Ebinger et al., 2018; Featherall et al., 2018; Glotzbach et al., 2018; Golas et al., 2018; Gray et al., 2019; Hernandez et al., 2019; S. L. Parker et al., 2017; Patel et al., 2023; Peard et al., 2019; Pelt et al., 2017; Piña et al., 2022; Williams et al., 2019)	16	
Publication Year	2012	(Abdulla et al., 2012)	1	*24*
	2017	(S. L. Parker et al., 2017; Pelt et al., 2017)	2	
	2018	(Ebinger et al., 2018; Featherall et al., 2018; Glotzbach et al., 2018; Golas et al., 2018)	4	
	2019	(Ahn et al., 2019; Chatfield et al., 2019; Danilyants et al., 2019; Gabriel et al., 2019; Gray et al., 2019; Hernandez et al., 2019; Peard et al., 2019; van Egdom et al., 2019; Williams et al., 2019)	9	
	2021	(Cossio-Gil et al., 2021)	1	
	2022	(Burnhope et al., 2022; Daniels et al., 2022; Heijsters et al., 2022; Piña et al., 2022; Varela-Rodríguez et al., 2022)	5	
	2023	(T. A. Patel et al., 2023; Wyffels et al., 2023)	2	
Healthcare Field	Cardiology	(Burnhope et al., 2022; Ebinger et al., 2018; Glotzbach et al., 2018; Golas et al., 2018; Piña et al., 2022; Wyffels et al., 2023)	6	*24*
	Endocrinology	(Abdulla et al., 2012)	1	
	General practice	(Chatfield et al., 2019)	1	
	Gynaecology	(Danilyants et al., 2019)	1	
	Hospital	(Cossio-Gil et al., 2021; Daniels et al., 2022; Heijsters et al., 2022; Varela-Rodríguez et al., 2022)	4	
	Integrated Practice Unit	(Hernandez et al., 2019; van Egdom et al., 2019; Williams et al., 2019)	3	
	Oncology	(T. A. Patel et al., 2023)	1	
	Orthopaedics	(Ahn et al., 2019; Featherall et al., 2018; Gabriel et al., 2019; Gray et al., 2019; S. L. Parker et al., 2017; Pelt et al., 2017)	6	
	Urology	(Peard et al., 2019)	1	
Payment Model	APM	(T. A. Patel et al., 2023; Piña et al., 2022)	2	*24*
	Bundled Payment	(Gray et al., 2019)	1	
	Not Determined	(Abdulla et al., 2012; Ahn et al., 2019; Burnhope et al., 2022; Chatfield et al., 2019; Cossio-Gil et al., 2021; Daniels et al., 2022; Danilyants et al., 2019; Ebinger et al., 2018; Featherall et al., 2018; Gabriel et al., 2019; Glotzbach et al., 2018; Golas et al., 2018; Heijsters et al., 2022; Hernandez et al., 2019; S. L. Parker et al., 2017; Peard et al., 2019; Pelt et al., 2017; van Egdom et al., 2019; Varela-Rodríguez et al., 2022; Williams et al., 2019; Wyffels et al., 2023)	21	
Value Initiative	Experience-based co-design	(Heijsters et al., 2022)	1	*24*

Studies Characteristics		References	N	*Total*
	IT value programs	(Ebinger et al., 2018; Golas et al., 2018; Varela-Rodríguez et al., 2022)	3	
	Redesign initiative	(Abdulla et al., 2012; Featherall et al., 2018; Gabriel et al., 2019; Gray et al., 2019; Pelt et al., 2017; Piña et al., 2022; Williams et al., 2019; Wyffels et al., 2023)	8	
	Traditional value-based program	(Ahn et al., 2019; Burnhope et al., 2022; Chatfield et al., 2019; Cossio-Gil et al., 2021; Daniels et al., 2022; Danilyants et al., 2019; Glotzbach et al., 2018; Hernandez et al., 2019; S. L. Parker et al., 2017; Patel et al., 2023; Peard et al., 2019; van Egdom et al., 2019)	12	

Note: APM - Alternative Payment Models; IT - Information Technology.

In the selected studies, the description of the implementation of various initiatives demonstrated how critical Health Information Systems are, i.e., what their indispensable requirements are for the success of a VBHC model (with emphasis to the EHR). The analysis of the articles led to the organization of the findings into three main categories: data (closely related to its existence, collection methods, and quality), data analysis (emphasizing the need for this competence within organizations), and resources available within organizations or provided by third parties (with exclusive reference to IT infrastructures and human resources with knowledge in IT and data analytics). Table 16 presents the primary facilitating factors and barriers described in the studies.

Table 16 - Healthcare information systems facilitating factors and barriers reported in VBHC initiatives

	Facilitating topic	Barrier's topic
Data	- Structured data (Abdulla et al., 2012) - Accurate data (outcomes, cost) (Ebinger et al., 2018; Glotzbach et al., 2018; S. L. Parker et al., 2017) - Real-time data (outcomes, cost) (Daniels et al., 2022; Ebinger et al., 2018; Heijsters et al., 2022; Varela-Rodríguez et al., 2022) - Baseline data (Gabriel et al., 2019) - Detailed data (S. L. Parker et al., 2017) - Central repository with all data (Varela-Rodríguez et al., 2022) - Definition of the form and responsibility of data records (Varela-Rodríguez et al., 2022) - Adapting data needs and data analysis to the particular context of each institution (Varela-Rodríguez et al., 2022) - Using an app to collect patient-reported data (Cossio-Gil et al., 2021) - Clearly collected and monitored data through an integrated system (combination of cases, clinical, and patient-reported outcomes) (Heijsters et al., 2022)	- Lack of data availability (real-time; medical records; cost; outcome measures) (Ahn et al., 2019; Danilyants et al., 2019; Featherall et al., 2018; Golas et al., 2018; Peard et al., 2019; Wyffels et al., 2023) - Lack of data accuracy (Burnhope et al., 2022; Danilyants et al., 2019; Pelt et al., 2017; Varela-Rodríguez et al., 2022; Williams et al., 2019) - Lack of baseline data (Pelt et al., 2017) - Data transcription errors (Burnhope et al., 2022; Danilyants et al., 2019; Hernandez et al., 2019; Williams et al., 2019) - Double data recording (for both clinical and research)(Varela-Rodríguez et al., 2022) - Bias on medical information (Varela-Rodríguez et al., 2022) - Primary source of origin other than the data in the system (Varela-Rodríguez et al., 2022) - Clinical information not collected by the attending physician (Varela-Rodríguez et al., 2022) - Lack of direct integration of data from analytical equipment (Varela-Rodríguez et al., 2022)

	Facilitating topic	Barrier's topic
		- Subjective data (symptoms or experience) not being entered by patients into the system (Varela-Rodríguez et al., 2022) - Lack of specific electronic forms for clinical data collection (Varela-Rodríguez et al., 2022) - Lack of definition on the data collection protocol and regulation (Varela-Rodríguez et al., 2022) - Data collection done in different ways (Golas et al., 2018; Varela-Rodríguez et al., 2022)
Data Analysis	- Fast analysis for quick decision-making (Abdulla et al., 2012; Cossio-Gil et al., 2021) - Detailed analysis (individual patient level, outcomes, costs (Abdulla et al., 2012; S. L. Parker et al., 2017) - Support for decision-makers to prevent inefficiencies or wastefulness (S. L. Parker et al., 2017; Varela-Rodríguez et al., 2022) - Standardization, interoperability, and comparison of outcomes and indicators (Burnhope et al., 2022; Cossio-Gil et al., 2021) - Data related to the experience of professionals to strengthen the project (Varela-Rodríguez et al., 2022) - Prospective analysis with standardized protocols (Ebinger et al., 2018) - Improved outcomes (Cossio-Gil et al., 2021; S. L. Parker et al., 2017) - Retrospective analysis (Ebinger et al., 2018) - Generation of dashboards (Cossio-Gil et al., 2021; Varela-Rodríguez et al., 2022) - Accessibility of data to different professionals (Varela-Rodríguez et al., 2022) - Easy and systematic data extraction (Daniels et al., 2022) - Support the implementation and development of risk-adjusted models based on outcomes (T. A. Patel et al., 2023)	- Limited data from one or two institutions (Ahn et al., 2019; Peard et al., 2019; Pelt et al., 2017) - Lack of access to data (outcome measurement or costing information) (Cossio-Gil et al., 2021; Gabriel et al., 2019) - Lack of international normalization and standardization of reported outcome measure (Heijsters et al., 2022; Varela-Rodríguez et al., 2022) - Lack of data transformation, converting data sources to a more desirable output forma (Cossio-Gil et al., 2021; Varela-Rodríguez et al., 2022) - Difficulty in comparing data due to the blinded, enterprise-wide nature of data retrieval (Gray et al., 2019)
Resources	- Automated data extraction (Daniels et al., 2022) - Quick implementation of EHR (Chatfield et al., 2019) - Performing the necessary intervention on the EHR (Chatfield et al., 2019) - Strong support from IT teams (Chatfield et al., 2019; Varela-Rodríguez et al., 2022) - Specialized human resources (Data-IT expert, consultant VBHC) (Ebinger et al., 2018; Heijsters et al., 2022; Varela-Rodríguez et al., 2022) - Saving time for healthcare professionals (Ebinger et al., 2018) - IT infrastructure (Ebinger et al., 2018; T. A. Patel et al., 2023) - Trained healthcare professionals in the EHR system to apply it in practice (Heijsters et al., 2022) - Adequate tools for data recording that ensure confidentiality and data quality (Piña et al., 2022; Varela-Rodríguez et al., 2022)	- Lack of automated data extraction (Ahn et al., 2019; Burnhope et al., 2022) - Lack of optimization of computer systems (Hernandez et al., 2019) - Lack of IT infrastructure (Hernandez et al., 2019; Williams et al., 2019) - Lack of necessary resources (Gabriel et al., 2019) - Time-consuming and barrier-laden data capture process (Gabriel et al., 2019) - Deficient organisational workflows (Heijsters et al., 2022; T. A. Patel et al., 2023) - Lack communication between hospital network members (Cossio-Gil et al., 2021) - Interoperability of different data sets (Glotzbach et al., 2018; Wyffels et al., 2023) - Absence of payment of the communication platforms like EHR portals (Piña et al., 2022)

	Facilitating topic	Barrier's topic
	- User-friendly communication tool linked to the EHR to collect patient reported outcomes (Piña et al., 2022; van Egdom et al., 2019)	- Fragmentation of communities and tools (Varela-Rodríguez et al., 2022)

Note: EHR - Electronic Health Record; IT - Information Technology; VBHC - Value-Based Healthcare.

Regarding data category, the described implementation experiences emphasize the need to have quality data that is structured but allows some customization by organizations, rigorous, reliable, detailed, collected over time to enable longitudinal studies, in real-time, easily accessible, and shareable (suggesting the creation of a central repository to be shared by the group of institutions involved in the VBHC initiative). On the barriers side, these experiences emphasize organizational problems such as lack of data, data collection protocols, insensitivity to the need for data collection tools, lack of awareness of routine information collection practices, and issues with access. They also highlight failures of healthcare professionals who do not collect complete information (clinical, cost-related, etc.) or fail to accurately transcribe information, raising concerns about potential data reliability. In this regard, it is suggested that primary sources (patients, physicians, and other healthcare professionals directly involved in patient care) be responsible for recording the data.

Regarding data analysis, the main reported difficulties are related to the lack of data or access to them (due to belonging to different organizations), the lack of standardized data that requires conversions and limits confidence in their quality and accuracy. As a result, there is an awareness of the need for automated data collection that instils confidence in the results of the analysis. Facilitating factors reported in data analysis include awareness of the importance of data-driven decision-making, the speed it enables in decision-making, and therefore the recognition of the need for personalized dashboards that facilitate information interpretation by professionals without requiring an expert. However, the presence of an expert analyst to assist healthcare professionals in using indicators is still welcome. It was also reported that the creation of care pathways built in the electronic information system will enable easy extraction of systematically noted data and provide real-time outcomes and process indicators specific to a particular patient group.

Regarding resources, infrastructure and human resources dominate the reports. In terms of infrastructure, barriers arise from the lack or inadequacy of technological platforms, fragmentation of data collection and communication tools. In terms of human resources, barriers stem from the scarcity of experts in optimization, e-dashboard, and EHR portals. Other barriers arise from the diversity of organizations involved and organizational weaknesses in terms of organization and protocol creation. The most reported facilitating factors are the perception of the need for such resources to adhere to VBHC

initiatives, the presence of IT platforms, IT workflows, and adequate tools, IT competencies, and human resources to support implementation (consulting, support in technology usage, and data entry/analysis), training and engagement of professionals and patients as the source of data. Leadership and the existence of a specific budget for this type of project are also reported as crucial for success.

3.4 Conclusion

This study has demonstrated that health information systems are crucial for VBHC implementation initiatives. EHRs emerge as a means of data collection and a source for analysis, playing a fundamental role in ensuring the trust and ease of use of information. The engagement of healthcare professionals and patients in utilizing EHRs is indispensable to meet the reporting requirements imposed by these programs, without excessively burdening professionals with administrative tasks. The conventional content analysis approach allowed for the categorization of findings into data, data analysis, and resources, enabling the identification of facilitators and barriers within each category during the implementation of these models. It is worth noting that, among the selected studies, the follow-up and continuous improvement, seen as the final stage of implementing these models (e.g., Cossio-Gil et al. (2021) and Heijsters et al. (2022)), did not emerge as a category in our analysis. This may indicate that we are still in an early stage of introducing these types of models into healthcare systems due to deficient organizational readiness among stakeholders.

The primary limitation experienced in this study relates to the article selection process, as many articles use the designation of VBHC without being directly related to the adoption of VBHC models. Furthermore, not all studies describing the implementation of this model explicitly mention their association with VBHC, which may have led to the exclusion of some studies reporting experiences in adopting these types of models. Lastly, it is important to note that the majority of reported experiences originate from the United States of America, driven by their healthcare system and the increased motivation of payers (e.g., Medicare) to apply VBHC principles.

4

A Multiple Criteria Framework for Value-Based Assessment of Health Care Services Applied to a Radiology Case

4.1 Introduction[3]

A radiology department (either a department of a larger medical facility or an independent organization) aggregates a set of health care resources shared across all levels of health care delivery and medical specialties. Radiology has been viewed as an adjunct to quality care, but not a primary contributor to value. Much of the literature in the area describes image acquisition and diagnostic accuracy rather than the contributions to the health outcomes of patients (A. Brady et al., 2020). In a hospital, radiology is typically seen as a centre of costs and volumes, and its budget is more dependent on the decisions taken in previous years than on the value the department creates. Although several studies have documented the value added by radiology (e.g., Sarwar et al., 2015), its precise contribution to the health care value chain remains uncertain (Fuchsjäger et al., 2020).

Studies on the implementation of VBHC models in radiology departments are scarce and those available have been conducted in the United States of America. The existing studies have highlighted that the significant lack of specific quality indicators and the disconnection between the available indicators and costs (which are fundamental for payment or reimbursement) have limited the availability of information thus affecting the implementation of more developed VBHC models. This gap has been referred to independently of the model implemented (for example, in radiology, it was mentioned when a merit-based incentive payment (Rosenkrantz et al., 2020) or a bundled payment (Hughes et al., 2017) system was implemented), the medical specialty (it was, for example, noted in cardiology (Wyffels et al.,

[3] This chapter is co-authored with Nazaré Rego and José Crispim and is published (Moreira et al., 2025).

2023)), or the department/hospital at stake (for example, Daniels et al., 2022; Heijsters et al., 2022). The development, testing, and validation of meaningful improved quality indicators require significant effort and resources. In health care services that are already burdened and have limited resources, this can perpetuate the reporting of irrelevant quality indicators (Chen et al., 2017). These gaps emphasize the need for specific and relevant VBHC indicators that improve the quality of care and reliably identify practice variation.

VBHC seeks to place patients at the centre of the care model (Fuchsjäger et al., 2020), aiming at encouraging the improvement of results for patients, therefore centred on quality instead of quantity. Within VBHC, value should always be defined around the customer (patient), not the supplier (health care or technology provider), as the latter tends to follow a strictly economic perspective (Porter, 2010). This expanded concept of value desirably encompasses efficiency, safety, patient compliance, and satisfaction (Porter, 2010), and is crucial to achieving goals such as access and equity (Porter & Teisberg, 2006). As such, VBHC is inherently multidimensional and can vary from patient to patient (or other stakeholders) and in time. Patients may assign different weights to outcomes in the hierarchy (Porter, 2010), i.e., valuation requires comprehensive frameworks that allow for customization based on preferences (Reed et al., 2019). The inputs for value definition (costs and benefits) vary widely across the relevant stakeholders (health professionals, patients, payers, caregivers, hospital administrators, etc.) (Sheckter et al., 2019). "Active and continual multi-stakeholder engagement [...] is needed to sustain positive feedback loops allowing VBHC to adapt, scale-up and spread in a new context, preventing it from fading [...]" (Ramos et al., 2021, p. 9). The customization of value-based models is indispensable because "no single framework with a predefined set of weighted variables can reflect the needs of disparate stakeholder groups or even the inevitable heterogeneity within a particular group" (Dubois & Westrich, 2019, p. 979). Usually, when the hospital board of directors uses the profit obtained at the department to assess contribution to the hospital, only the perspective of some stakeholders is considered. This traditional business model has a limited ability to improve value (i.e., patient health outcomes) (Kamal et al., 2018). A recent literature review on VBHC implementation initiative concluded that a major gap related to the generalized inability to measure outcomes that matter to patients remains (Zanotto et al., 2021). This means that ambiguity and complexity inherent to VBHC have not yet been tackled (Walraven et al., 2021). MCDA methods can be used to handle ambiguity and to combine value attributes into a single measure that facilitates value interpretation (Neumann & Cohen, 2015). Tools that address the multidimensionality of the VBHC from a multi-stakeholder systems-based perspective (i.e., that account

for the impacts of actions in the various components of the system) and are easiest to understand and implement are needed.

Health care VAF (i.e., tools that combine methods and indicators to determine heath care value) have emerged as tools to assist decision-makers in assessing the relative value of services and treatments (Dubois & Westrich, 2019). Typically, these frameworks (e.g., Augustovski et al., 2021) have identified indcators, but their full implementation (i.e., collecting data, calculating the indicators, and determining and interpreting value) has not been described, probably because their implementation needs a built-in capability to collect and analyse outcome and costing data (Strazzabosco, 2020).

Most VBHC frameworks (e.g., IVI-RA, ICER, ACC-AHA, ESMO, etc.) have been created to support economic evaluations among decision-makers concerning drugs or technology (Boscolo et al., 2020; Slomiany et al., 2017). Recent reviews concluded that VBHC frameworks or VAF have:

1) mostly attempted to support the negotiation between payers and the pharmaceutical industry (Boscolo et al., 2020);
2) focused on the financial implications of alternative treatments, with emphasis on the price of treatments selection (Boscolo et al., 2020);
3) been almost always based on cost-effectiveness analysis (by admitting the use of multicriteria methods, IVI-RA was an exception) (Boscolo et al., 2020);
4) tended to aggregate multiple value attributes into a single index for decision-making;
5) been applied in specific treatments (e.g., Diabetes Mellitus, Rheumatoid Arthritis) instead of to all areas of a health care service (Dubois & Westrich, 2019);
6) had, in general, very limited or missing patient or public engagement in the development process (M. Zhang et al., 2022);
7) been predesigned tools that do not collect the voice of the patients at the point of care (Dubois & Westrich, 2019);
8) not admitted customization (only IV-RA does) (Dubois & Westrich, 2019); and
9) been complex and lacked transparency, which has limited reproducibility (Dubois & Westrich, 2019).

In summary, three main gaps have been identified in the literature related to value-based initiatives: (1) they do not explicitly evaluate value (Wheeler et al., 2018); (2) they are complex (which limits their reproducibility) and do not admit customization (van Staalduinen, van den Bekerom, et al., 2022); and (3) at operationalizing value, they do not address the concerns of the various, sometimes conflicting, involved perspectives (Wheeler et al., 2018). This study aimed to develop a complete,

comprehensive, and customizable VAF that considers the different perspectives of several different stakeholders and measures the effects of an action in the value from those perspectives.

4.2 Methodology

4.2.1 Research design

This study adopted a MCDA bottom-up, 3-step methodological process (Figure 3) for building a value-based assessment framework. The study applied qualitative and quantitative methods under the scope of a single case study: the radiology department of the second biggest hospital in Portugal (that provides direct assistance to a population of around 300,000 people), and operates 24/7 for emergencies and operates, and 11hours/day, 6 days a week for scheduled exams. Approximately 115 professionals (i.e., radiographers, radiologists, administrators, and receptionists) work in the department; in 2019, the department performed more than 484,000 exams (on average, 1327 exams per day) of different types (conventional radiology, ultrasounds, tomographs and biopsies, magnetic resonances, interventional radiology, etc.), using 33 pieces of equipment.

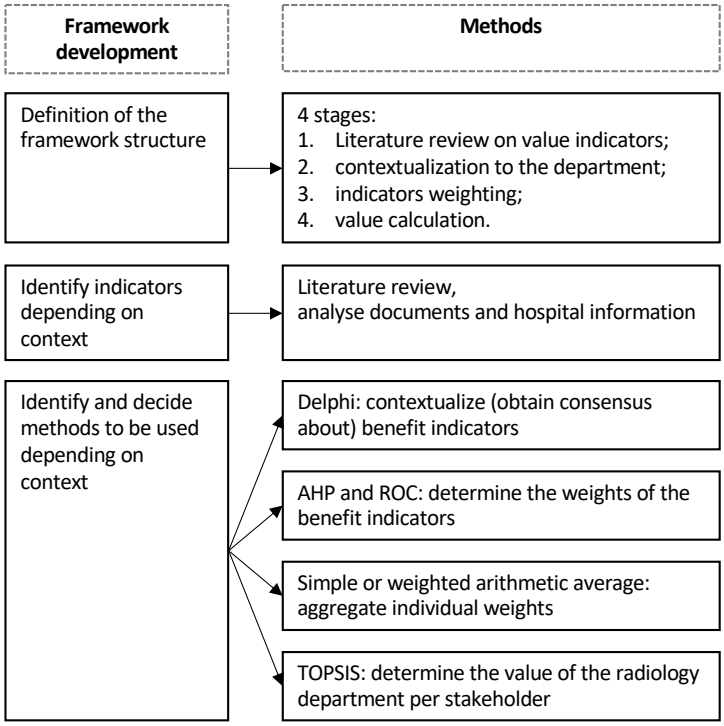


Figure 3 - MCDA framework-building methodological process

Data were collected through questionnaires, and quantitative information was collected from the hospital databases. Costs in Portuguese NHS hospitals follow a top-down approach. Therefore, to assess the costs of a given department, we have to rely on the institution's central accounting with the limitation that only average costs per patient are known. This approach limits the internal management of the organization since production centres and cost centres are not uniformly defined. For example, the radiology department and the administrative department contribute to the production of other departments (e.g., cardiology) but are seen only as cost sources. The department's costs include direct costs (i.e., consumables, personnel, subcontracting, depreciation of assets, etc.), and indirect costs that arise from shared services (e.g., administrative). In this study, we considered the total annual cost value attributed to the service as recorded in the hospital's central accounting. The framework proposed incorporates several statistical tests, and multicriteria decision-making methods, as described in the sections below.

4.2.2 Literature review

The study started with a scoping review of the literature published from 2014 to 2021 following JBI's Population (or participants), Concept, Context (PCC) (Peters et al., 2020) and PRISMA-ScR (Tricco et al., 2018) guidelines (*Appendix C.1)* aimed at answering the question *What benefit indicators are available for radiology services?* - The concept of interest was benefit indicators, and the context was radiology services (Peters et al., 2020). Thus, the inclusion criteria were: focusing on value; in radiology; and identifying benefit indicators. We considered literature from 2014 onwards because this was the year when published research started synthesizing metrics related to radiology (e.g., in terms of quality (Kumara et al., 2003), or performance-based payment (Boland et al., 2017). Only original research published in peer-reviewed journals was considered. Medline (through PubMed), Scopus, and Web of Science were searched for ("value" OR "value-based" OR "value-added") AND ("measurement" OR "measurements" OR "metric" OR "metrics" OR "measure" OR "measures") AND ("radiology department" OR "imaging department" OR "radiology departments" OR "imaging departments") in titles, abstracts, or keywords. Only documents written in English were considered. After duplicates were removed, the abstracts of the remaining studies were read, and their full texts were skimmed in order to select a final set of studies that were fully and carefully read. The purpose of the scoping review was descriptive and the analysis registered, for each article in the dataset, the benefit dimensions or indicators identified in a data extraction table prepared for that purpose.

The indicators and categories identified in the literature *(Appendix C.2)* were then synthesized and adapted to the radiology department, which involved various opinion exchanges among the researchers, a senior expert, and the professionals of the department.

4.2.3 Delphi method

Delphi (Linstone & Turoff, 1975) is a method to organize and structure an expert discussion aiming to generate insights on controversial topics with limited information (Beiderbeck et al., 2021). It assures the anonymity of participating experts who are invited to assess and comment on questions related to a specific research topic across multiple discussion rounds (Keeney et al., 2001). After each round, experts can review the aggregated results and reconsider their assessment based on the added information.

The Delphi method was used to develop and validate the framework. The collection and analysis of the expert opinions were used to 1) select the final set of indicators and their weights (Carrera et al., 2024) and 2) to assess the framework's ability to consistently guide the process for which it was designed and meet the operational needs of users (Mauco et al., 2020).

The questionnaire (that was developed for this study to include a synthesis of the indicators identified in the literature review and adapted to the radiology department) is composed of two parts *(Appendix C.3)*: (1) benefit indicators organized per categories, and (2) categories of benefit indicators. In the first round, we used rating scales, and, in the second, we turned to rank-order questions.

In this study, it was decided that the experts would be members of two groups of stakeholders: internal (radiographers and the administrators of the department) and external (patients or their caregivers and prescribing physicians). For internal stakeholders, the criteria considered were: belonging to a professional group of the radiology service and having at least 2 years of working experience in radiology. External participants were required to know the department well (i.e., persons with sporadic contacts were excluded - invitations were sent to persons with higher interactions with the department).

The internal participants were: (1) six radiographers (out of 62), 73% female, 12 years of experience on average (range: 2 to 26 years); and (2) 2 qualified administrators (out of 2), including a radiologist (other biographic details about this group cannot be provided due to confidentially issues). The external participants were: (1) 20 patients aged between 20 to 73 years old (average 42 years), 45% undergraduate; 55% female; and (2) four prescribing physicians (two orthopedists, 1 internal medicine doctor, and one general practitioner; any hospital specialist doctor can prescribe so the total number of

prescribing physicians is difficult to estimate), three of whom female, all with 3 years of experience. The sample can be considered representative of the department.

In the analyzing phase, there was a quantitative analysis of the answers. The consensus among participants was assessed using Kendall W (Kendall, 1977). Face validity (i.e., the ability to be understandable and relevant for the targeted population (Krabbe, 2017)) and content validity (i.e, ensuring that the indicators measure what they are intended to measure (Hinkin, 1995)) of the indicators were assured by incorporating experts' feedback obtained through the Delphi method: (1) in the first round, for each indicator, the questionnaire had a field where respondents could signal they could not understand it *(Appendix C.3)*; in case the field was selected (none did), the respondent would be contacted by email to give further details on the issue; (2) the rounds were used select the most (exclude the least) appropriate indicators to measure value.

4.2.4 MCDA methods

In a MCDA-based methodological process, the choices with the highest impact on the overall decision outcomes relate to model building (including methods selection) and selection of the assessment criteria (Angelis & Kanavos, 2017). The selection of the benefit indicators (criteria) was decided using Delphi. MCDA methods were used to convert the participants' subjective assessments of the relative importance of the benefit indicators (within each category), and of the different benefit categories to weights, to aggregate the individual indicators, and ultimately to determine the value of the department. Several possible MCDA methods could have been used; the specific ones to be used were chosen considering the specificities of each stakeholder type in terms of availability, knowledge about the department, and ability to understand the method.

To calculate the benefit weights two different approaches were followed: (1) Analytic Hierarchy Process (AHP) (R. W. Saaty, 1987), for internal participants; and (2) Rank-Order Centroid (ROC) (Barron & Barrett, 1996), for external participants. AHP is more demanding given its complexity, and time needed to fulfil information. AHP has been widely applied (and validated) in many research fields because its underlying tree structure eases the understanding of the decision-making problem (Pereira & Bamel, 2023).

The internal participants performed pairwise comparisons across criteria using Saaty's 9-point scale (R. W. Saaty, 1987), which can be quite time-consuming (for n criteria, n(n-1)/2 comparisons are required). Given the multiple comparisons, inconsistencies were checked. ROC is an approximate

weighting method that, from a simple rank of criteria (obtained through Delphi), uses the weights table of (Barron & Barrett, 1996) to determine weights.

To aggregate the individual weights, again, two approaches were used: (1) a weighted arithmetic average, assuming different levels of expertise, for internal participants; and (2) a simple arithmetic average, for external participants, assuming that all participants had the same level of expertise. For internal stakeholders, the Delphi results showed a non-negotiable group decision-making situation (T. L. Saaty & Vargas, 2007) (i.e., there was no consensus, and participants were unwilling or unable to revise their judgments), forcing the use of an additional technique: the majority rule of Scala (Scala et al., 2016) based on Principal Component Analysis (PCA) (Hair et al., 2010). This statistical procedure divides the group of experts into groups and determines weights for each group. Such weights, assumed as different levels of expertise, were used to determine the final weight vector. Alternative methods can be found in (Wasim et al., 2023). Tucker's congruence coefficient is used as a measure of compatibility between two decision makers, and it is directly based on their judgments rather than their priority vectors, unlike previous compatibility indices such as Garuti or Saaty coefficients (Amenta et al., 2021). Its calculation is important for determining the level of compatibility between decision-makers and identifying the decision makers with greater influence.

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang & Yoon, 1981b) was used to determine the value of the radiology department. Using this method, the indicators were ranked relative to an ideal value (the shortest distance to the ideal solution and the farthest to the negative ideal solution) (Hwang & Yoon, 1981a).

For each indicator, the radiology department defined the ideal (and anti-ideal) benchmarks that it aimed at reaching (e.g., for the indicator F8: *Number of hours of training about radiation protection*, an ideal of 165 hours/year and an anti-ideal of 0 hours/year were defined). Taking these benchmarks into account, the observed value of the indicator (e.g., for F8, 45 hours, in 2019) was standardized to a 0 (worst value possible) – 1 (best value possible) scale.

A final overall benefit value for each stakeholder type was determined by aggregating the weighted standardized values of the indicators into the benefit value of the corresponding categories (in the 0-1 scale) and then aggregating the weighted categories.

4.3 Results

The main result of this study was the VAF (its stages are described in Table 17). The following components of the framework or other results should be highlighted: (1) a comprehensive list of indicators

of the value of radiology (Table 18) that synthetizes those proposed in the literature; (2) a description of the framework implementation in a real case study (with the identification of major obstacles for adoption); and (3) the operationalization and interpretation of the value of a radiology department.

Table 17 - Stages of the department VAF

Stage #1 - Identification of existing indicators
Inputs: Bibliographic databases, search terms, document eligibility criteria
Activities a) Review the literature and synthetize existing indicators. Eventually, add indicators from other sources of information. b) Decide the types of stakeholders that will be involved, and the list of participants.
Outputs: List of indicators about measuring value, organized in categories
Stage #2 - Select the indicators to assess benefits of the department
Inputs: List of indicators organized by categories (from Stage #1); possible indicator inclusion/exclusion rules, and a questionnaire in a web platform
Activities a) Decide the inclusion/exclusion rules to be used according to context or stakeholder type. b) Create a questionnaire with the indicators and decide the type of scale to be used (e.g., 5-point Likert scale) c) Run Delphi method; in each round: c1) check the list of indicators and add/exclude if necessary; c2) summarize the results and check the level of consensus; c3) if necessary, provide a synthesis of the results to the participants and re-run the questionnaire (adapted by considering previous results).
Outputs: List of indicators to be use by each group of participants (representing different stakeholder) to assess the department
Stage #3 - Determine a customized benefit/quality expression
Inputs: Final lists of indicators (one per stakeholder type) organized in categories; list of potential MCDA methods
Activities a) Consider the specificities of each stakeholder type in terms of availability, knowledge and understandability in order to decide which MCDA methods to choose. b) Apply the MCDA method to each stakeholder type to obtain the weights of indicators and categories weights. c) Aggregate participants' weights into a unique weight through a group decision technique.
Outputs: List of indicators and categories weights per stakeholder type; benefit expression.
Stage #4 - Determine the value of the department
Inputs: Final lists of indicators (with weights) for each stakeholder type organized in categories; data about the department. Procedure to compute value (in this study, TOPSIS).
Activities a) Collect information: a1) about each indicator in order to quantify the benefit expression; a2) to calculate the total cost. b) Compute value using procedure (TOPSIS).
Outputs: Current value (and space for improvement - distance to ideal) of each indicator and category by stakeholder type; an overall appraisal of the value of the department by stakeholder type.

Note: MCDA - Multiple Criteria Decision Analysis; TOPSIS - Technique for Order of Preference by Similarity to Ideal Solution; VAF - Value Assessment Framework.

4.3.1 Stage 1 – value (benefit) indicators identification

The VAF starts with the identification of benefit indicators from the literature, followed by their synthetization, and adaptation to the service at stake (in the studied case, the radiology department).

A detailed analysis of the literature showed similar categories and indicators recommended by different authors - e.g., the same category in different studies (Heller, R. E. et al., 2017; Sarwar et al., 2015), the same indicator in different studies but in different categories (Boland et al., 2017; Sarwar et al., 2015), or the same indicator and identical categories in different works (Boland et al., 2017; European Society of Radiology (ESR), 2017). Most studies (namely Boland et al., 2017; Heller, R. E. et al., 2017; Rao & Levin, 2011; Sarwar et al., 2015) were conducted by researchers affiliated in the United States of America, where the topic has been more developed. Only the study conducted by the ESR originated in Europe.

The literature review resulted in the identification of 160 indicators *(Appendix C.2)*. After synthetization, 56 were maintained for internal stakeholders and 46 for external stakeholders (Table 18). (The number of indicators to be presented to the external stakeholders was lower because those that were so specific that the external stakeholders would not fully understand them were excluded).

Table 18 - Categories and indicators to be selected by the stakeholders

Categories	**Internal** (Administration and Radiographers)		**External** (Patients and prescribing Physicians)	
ACCESSIBILITY OF THE SERVICE (the way or the process of arriving to receive the service provided at the department)	A1	Number of time slots available for exams appointments		A1
	A2	Average time for the next exam appointment time slot (days)	Time elapsed from the prescription until the exam is scheduled	A2
	A3	Average time from ordering the exam to scheduling it	N/A	-
	A4	Percentage of tests scheduled and performed at a time and place that is the most convenient for the patient		A3
	A5	Percentage of examinations and other complementary examinations scheduled for the same day		A4
ADEQUACY OF EXAM PRESCRIPTION (the prescribed exam is the most appropriate for the evaluation / study intended in accordance with the condition of the patient)	B1	Percentage of exams prescribed according to the reference guidelines/ protocols		B1
	B2	Percentage of duplicate, unnecessary or redundant prescribed exams		B2
	B3	Number of times radiologists participate in multidisciplinary meetings (discussion of cases of patients with other medical specialties) in a given period of time (e.g., a year)		B3
	B4	Percentage of exam prescription with adequate clinical information		B4
EXAM PROCESS (from the arrival	C1	Average waiting time until the start of the exam (days)		C1
	C2	Average time of exam duration (minutes)		C2

Categories	**Internal** (Administration and Radiographers)		**External** (Patients and prescribing Physicians)	
until the departure of the patient from the Radiology Department, during which the images of the radiological examination are taken)	C3	Average time between taking the exam and completing the report (days)		C3
	C4	Average time between the patient's arrival until the patient leaves the radiology department (minutes)	N/A	-
	C5	Average time of equipment not working (between 2 patients) (minutes)		C4
	C6	Percentage of patients who received information about the exam / procedure to be performed		C5
	C7	Percentage of patients who received reminder calls (text message, phone call, etc.) and attended the exam		C6
	C8	Average time elapsed between leaving a ward and arriving at the radiology equipment, in the case of inpatients.	N/A	-
	C9	Percentage of examinations performed according to the protocols established		C7
	C10	Number of interactions between the radiologist and the patient		C8
REPORT (medical description, in text, of the images taken, document where possible diagnoses are pointed out or other tests to complement the patient's evaluation are suggested)	D1	Percentage of reports peer-reviewed (by other radiologists)		D1
	D2	Percentage of reports that meet established standards		D2
	D3	Percentage of peer-reviewed reports with a false positive		D3
	D4	Percentage of reports that have the recommendations in the appropriate field		D4
	D5	Frequency of error feedback to radiographers and / or to radiologists		D5
	D6	Percentage of reports made by a radiologist with a subspeciality		D6
	D7	Percentage of examinations in which the report was not made	N/A	-
	D8	Percentage of days with a 24-hour Radiologist coverage		D7
	D9	Average time for report availability to the patient (days)		D8
	D10	Average time to critical results reporting (minutes)	N/A	-
	D11	Percentage of patients who consulted their report	N/A	-
	D12	Percentage of patients to whom the report was explained and understood		D9
	D13	Average time to reporting of results of exams requested by the emergency department (minutes)	N/A	-
RESULTS (either from the result obtained with the diagnosis or from the satisfaction with the service provided).	E1	Percentage of prescribing physicians who found the examination information useful		E1
	E2	Percentage of exams that change the diagnosis or treatment		E2
	E3	Percentage of exams that prevented the need of more expensive or invasive procedures	N/A	-
	E4	Percentage exams that reduced inpatient length of stay	N/A	-
	E5	Percentage of satisfied patients		E3
	E6	Percentage of prescribing physicians satisfied	N/A	-
	E7	Percentage of satisfied radiologists		E4
	E8	Percentage patients that were surveyed through satisfaction questionnaires		E5
	E9	Number of meetings between the radiology department and patient organizations		E6

Categories	Internal (Administration and Radiographers)		External (Patients and prescribing Physicians)	
SAFETY (everything that jeopardizes the patient's well-being as well as the measures taken to prevent or reduce the damage, namely protective measures against radiation)	F1	Percentage of exams with adverse events or incidents occurring during the exam		F1
	F2	Availability of procedures to communicate critical results		F2
	F3	Percentage of critical exams delivered		F3
	F4	Percentage of examinations with radiation dose registration and monitoring		F4
	F5	Existence of diagnostic protocols that involve the choice of tests that do not use radiation	Existence of protocols for exams	F5
	F6	Presence of lower-radiation examination options within the Computed Tomography imaging protocols	N/A	-
	F7	Percentage of examinations performed using lower-dose Computed Tomography imaging protocols	N/A	-
	F8	Number of hours of training about radiation protection		F6
	F9	Percentage of examinations with appropriate safety checks were carried out prior to the patient's arrival		F7
	F10	Percentage of exams with complications due to the exam		F8
CONTRIBUTION TO THE INSTITUTION (the way the Radiology Department participates or adds to the institution it belongs to)	G1	Number of administrative meetings per year	Time spent on administrative tasks (hours/week)	G1
	G2	Number of leadership positions on institution / hospital committees		G2
	G3	Average time spent on administrative issues of the institution / hospital (minutes/week)	N/A	-
	-	N/A	Percentage of respondents of patients' satisfaction questionnaire that reveal concern about containing costs	G3
	G4	Number of marketing events to promote the health system		G4
	G5	Number of certifications achieved by the department		G5
	-	N/A	Number of professionals that seek to continue professional education	G6
	-	N/A	Number of professionals involved in research and innovation	G7

Note: N/A = Not applicable (not selected when the synthesis of indicators from the literature was performed).

4.3.2 Stage 2 – value (benefit) indicators selection

The benefit indicators to assess the service were selected through Delphi. In the case study, the following undesired situations occurred in the first round: (1) lack of consensus in all four groups of participants *(Appendix C.4)*; (2) with the exception of the two administrators, all participants considered all indicators as 'important' or 'very important'; and (3) the lists of indicators was considered too large by the participants. As a consequence, the following adaptations were made: (1) round two was started, and, instead of asking the participants to state the importance of the indicators, a forced ranking scale was used for prioritizing them: we asked the participants to rank the indicators and the categories from the

most to the least important; and (2) considering the participants' comments, indicator inclusion/exclusion rules were introduced: radiographers suggested that only the four best-scored indicators in each category were selected (a total of 28 indicators); administrators suggested that only the indicators with an average score of 'important' or 'very important' were selected (21 indicators); and patients and physicians suggested to rewrite and regroup some indicators (43 indicators were selected) (only the selected benefit indicators were considered for indicator weight calculation in Step 1 of *Appendix C.5*). From the first to the second round, 6 out of the initial 20 participant patients abandoned the study. A third round was needed due to a lack of consensus; nevertheless, almost no changes occurred. Because of that, it was decided to stop the Delphi. Three patients abandoned the study from the second to the third round, having 11 patients completed all the rounds. At this stage, it was considered that each stakeholder type's indicators and preference hierarchies were determined based on the rankings provided by the participants.

When the Delphi results showed a non-negotiable group decision-making situation (i.e., consensus could not be obtained) as was the case with internal stakeholders in this study, it is possible to conduct complementary analyses to understand which of the "decision-makers" assume a more predominant role, for example, using Tucker's congruence coefficient (Table 19). Based on the preference responses given by each participant (for 28 indicators, in the case of radiographers, and 21 indicators, in the case of administrators), the congruence coefficient indicates which participants have an opinion about the indicators more similar to that of other participants (coefficient close to 1) or completely divergent (coefficient close to -1). It is possible to observe the dispersion among participants, and it seems that majorities can be formed among 3 groups (PR2, PR3, and PR4); (PR5, PR6); and PR1. After this validation of the non-negotiable situation, the internal participant weights were determined using Scala's approach (Scala et al., 2016) (details available in Step 2, *Appendix C.5*). For radiographers, the weights were 0.116 for PR1, 0.245 for PR2, 0.143 for PR3, 0.191 for PR4, 0.101 for PR5 and 0.204 for PR6.

Table 19 - Congruence coefficients of internal participant pairs

Internal Stakeholders	Pair of participants	Tucker's congruence coefficient $\varphi_{kk'}$	Evaluation
Internal health professionals	´PR1 - PR2	0.458	Fair direct compatibility
	´PR1 - PR3	0.373	Poor direct compatibility
	´PR1 - PR4	0,100	Very poor direct compatibility
	´PR1 - PR5	(-)0.460	Poor inverse direct compatibility
	´PR1 - PR6	0.294	Very poor direct compatibility
	´PR2 - PR3	0.836	Excellent direct compatibility
	´PR2 - PR4	0.855	Excellent direct compatibility

Internal Stakeholders	Pair of participants	Tucker's congruence coefficient $\varphi_{kk'}$	Evaluation
	´PR2 - PR5	0.267	Very poor direct compatibility
	´PR2 - PR6	0.223	Very poor direct compatibility
	´PR3 - PR4	0.668	Good direct compatibility
	´PR3 - PR5	0.415	Poor direct compatibility
	´PR3 - PR6	0.529	Fair direct compatibility
	´PR4 - PR5	0.524	Fair direct compatibility
	´PR4 - PR6	0.212	Very poor direct compatibility
	´PR5- PR6	0.583	Good direct compatibility
Administrators	´G1 - G2	0.332	Very poor direct compatibility

4.3.3 Stage 3 – computation of weight of categories and indicators

Table 20 presents the weights of the categories (also in the dashboard, Figure 4) and indicators; these weights show the importance that participant groups assigned to benefit categories and indicators. *Appendix C.5* (steps 1 to 3) presents examples of the calculations needed to obtain the weights in the table. Contribution to the institution was the least important category for all participants. For internal participants, *Accessibility of the service* was considered less important. However, for external participants, it was one of the most important categories jointly with *Adequacy of Exam Prescription*. *Safety* was important for administrators, patients, and radiographers, but not so much for prescribing physicians. Only one benefit indicator, *Percentage of exam prescription with adequate clinical information*, was consensual: it was considered the most important in the category *Adequacy of exam prescription* by all participant groups.

Table 20 - Weights of the categories and indicators

		Radiographers	Administration	Patients	Physicians
ACCESSIBILITY OF THE SERVICE	P1	0.0571	0.0576	0.1957	0.2174
ADEQUACY OF EXAM PRESCRIPTION	P2	0.1768	0.1999	0.2644	0.2395
EXAM PROCESS	P3	0.1853	0.0779	0.1304	0.1115
REPORT	P4	0.1602	0.1767	0.0983	0.1561
RESULTS	P5	0.1875	0.2071	0.073	0.1431
SAFETY	P6	0.1867	0.2808	0.2156	0.0841
CONTRIBUTION TO THE INSTITUTION	P7	0.0464	0	0.0226	0.0484
ACCESSIBILITY OF THE SERVICE (P1)	A1	**0.0976**	N/S	**0.3163***	0.2500
	A2	0.1952*	**0.8528**	0.2064*	**0.4583**
	A3	N/S	N/S	0.2784*	0.1562
	A4	0.3200	**0.1472**	**0.1988***	**0.1354**
	A5	**0.3871**	N/S	N/A	N/A
ADEQUACY OF EXAM PRESCRIPTION (P2)	B1	0.2068	0.3698	0.3087	0.3646
	B2	0.2273	**0.1965**	**0.1572**	0.1562
	B3	**0.1999**	N/S	0.1723	**0.0833**
	B4	**0.3660**	**0.4336**	**0.3617**	**0.3958**

		Radiographers	Administration	Patients	Physicians
EXAM PROCESS (P3)	C1	N/S	N/S	0.1854	0.1605
	C2	N/S	N/S	0.0798	0.0736
	C3	0.3227	0.1763	**0.1855**	**0.2095**
	C4	N/S	0.2020	**0.0462**	**0.0676**
	C5	N/S	0.2002	0.1799	0.1210
	C6	0.1890	**0.2477**	0.0781	0.1405
	C7	**0.1186**	**0.1738**	0.1591	0.1434
	C8	N/S	N/S	0.0858	0.0839
	C9	**0.3698**	N/S	N/A	N/A
	C10	N/S	N/S	N/A	N/A
REPORT (P4)	D1	N/S	N/S	0.1385	0.0778
	D2	N/S	N/S	**0.2343**	0.1190
	D3	0.1374	0.1661	**0.0457**	**0.0409**
	D4	N/S	N/S	0.1232	0.0649
	D5	N/S	N/S	0.0753	0.0710
	D6	N/S	N/S	0.1070	0.0918
	D7	N/S	N/S	0.0659	**0.1972**
	D8	**0.1244**	**0.0946**	0.1011	0.1722
	D9	N/S	N/S	0.1087	0.1652
	D10	0.3654	0.2521	N/A	N/A
	D11	N/S	N/S	N/A	N/A
	D12	N/S	N/S	N/A	N/A
	D13	**0.3727**	0.1980	N/A	N/A
RESULTS (P5)	E1	N/S	**0.4113**	**0.3250**	0.2834
	E2	**0.5221**	N/S	0.2467	**0.3667**
	E3	N/S	N/S	0.2012	0.1444
	E4	0.2940	**0.5887**	0.1306	0.0979
	E5	0.1137	N/S	0.0558	0.0715
	E6	**0.0701**	N/S	**0.0407**	**0.0361**
	E7	N/S	N/S	N/A	N/A
	E8	N/S	N/S	N/A	N/A
	E9	N/S	N/S	N/A	N/A
SAFETY (P6)	F1	N/S	0.2321	0.1414	0.1319
	F2	N/S	**0.0575**	0.1147	0.1702
	F3	N/S	N/S	0.0493	0.0824
	F4	**0.1642**	**0.3683**	0.1566	0.1251
	F5	N/S	N/S	0.1773	0.1470
	F6	N/S	N/S	0.0950	0.0861
	F7	0.2691	N/S	**0.2231**	**0.2319**
	F8	0.2130	N/S	**0.0423**	**0.0253**
	F9	**0.3536**	0.3422	N/A	N/A
	F10	N/S	N/S	N/A	N/A
CONTRIBUTION TO THE INSTITUTION (P7)	G1	**0.1726**	N/S	0.0734	0.1299
	G2	0.2022	N/S	0.1206	0.1520
	G3	0.2219	N/S	**0.0615**	**0.1889**
	G4	N/S	N/S	0.0823	**0.0865**
	G5	**0.4033**	N/S	0.2048	0.1043
	G6	N/A	N/A	**0.2427**	0.1788
	G7	N/A	N/A	0.2146	0.1597
Total indicators		***28***	***21***	***43***	***43***

Notes: Bold green lettering indicates the higher weight in the category; bold red lettering indicates the lower weight in the category; in the last 7 rows, higher weights are shadowed in strong green and lower ones in strong red, intermediate tones signal weight level; N/A= Not applicable (not selected when the synthesis of indicators from the literature was performed); N/S= Not selected (due to inclusion/exclusion criteria); *detail of calculations explained in *Appendix C.5* (step 3) as examples.

4.3.4 Stage 4 – value assessment

The overall benefit of the department was determined using the general TOPSIS formulae. Figure 4 shows part of a proposed value assessment dashboard (at the category level) that includes: at the top, a chart that combines category importance with the benefit value per stakeholder type, determined using the indicators and weights decided by participants, ('department' bars with all indicators or categories having the same (equal) weight were included for comparison purposes); below, in the right, a chart that shows the overall value (benefit) vs. observed clinical cost, €9,819,284 in 2019) of the radiology department per stakeholder type; and, in the left, the contribution of each category for the value per stakeholder type (determined by multiplying the weights by the benefit value per category for each stakeholder type); the aggregation of the value of all categories per stakeholder type is represented in the chart in the right. *Appendix C.5* (step 4) presents the calculations of the value assessment per indicator and category (represented by the right-hand side bars in the chart at the top of Figure 4).

In order to prioritize resource allocation towards improving categories, both the current value and the importance assigned to them should be observed. For example, *Contribution to the institution* could be improved, but it was considered the less important category for all stakeholders; thus, its improvement would only contribute a little to value.

Looking at the overall value of the department, the valuation considering the combination of indicators suitable for the administrators resulted in the higher value (0.710), which may come as no surprise as they may steer the department to the goals they consider important. *Accessibility of the service*, a category important for external stakeholders, had, if their point of view was considered, a margin to be improved (to know where the resources should be directed at, a similar analysis at the indicator level should be made – see *Appendix C.5*). By looking at the dashboard (Figure 4), it can be seen that the department could significantly improve its value (either by increasing benefit or reducing cost).

The main obstacles to the adoption of the framework expressed by the participants were the high number of indicators, time unavailability, and some inability to distinguish between some benefit indicators. The lack of historical data to calculate the indicators was the most important obstacle to framework implementation. On the positive side, the administrators considered that the interpretation of the value as displayed in the proposed dashboard (Figure 4) was easy, and the (lack of) understandability of multicriteria methods was not observed as an obstacle to framework implementation.

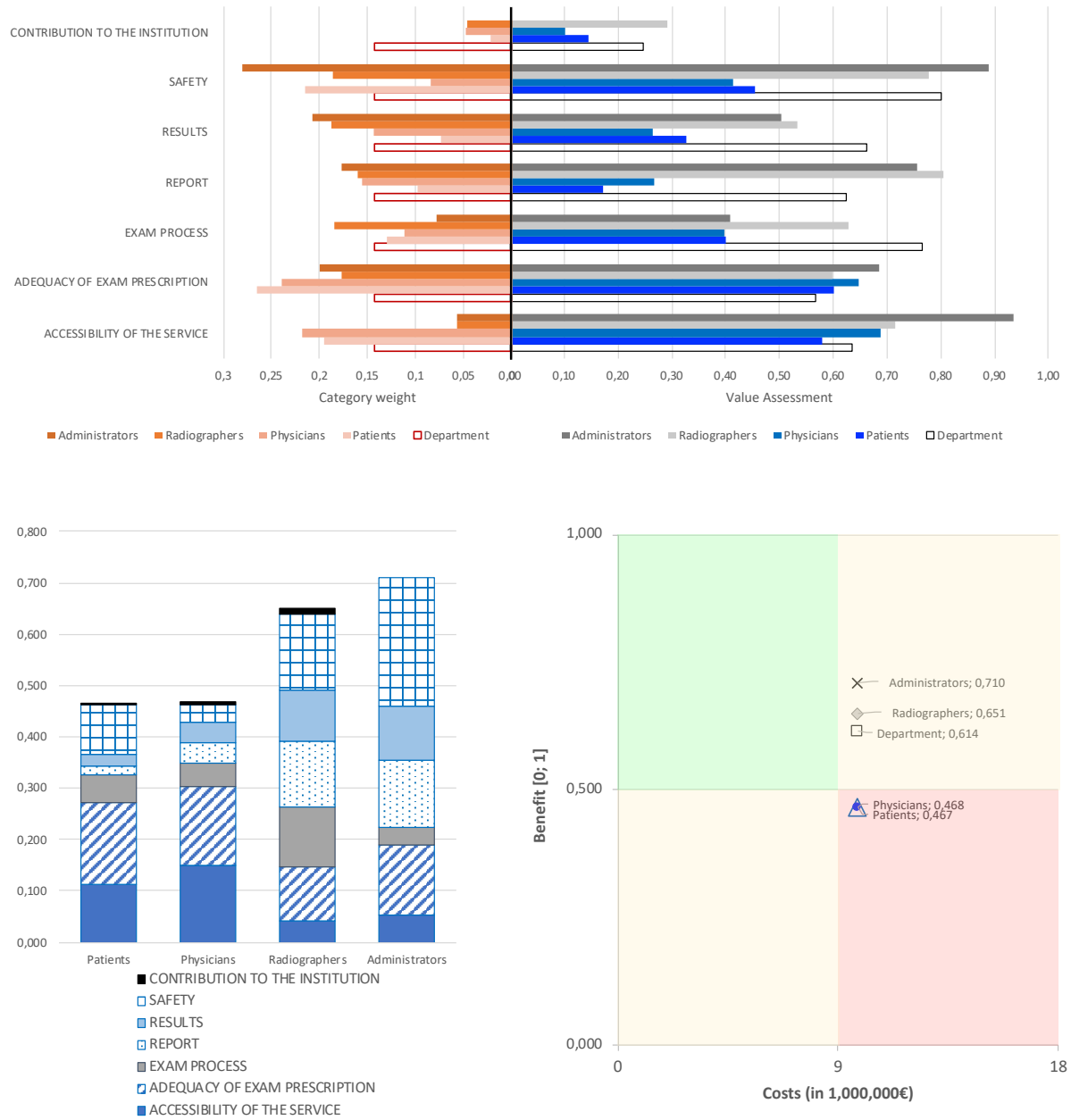


Figure 4 - Value assessment dashboard

4.4 Discussion

This study developed a VAF in a radiology department taking a multi-stakeholder perspective, thus addressing the European Society of Radiology (A. P. Brady et al., 2021) request that meaningful key performance indicators that demonstrate the breadth of radiology contributions to health care more accurately are defined, thus contributing to shorten the gap that existing VBHC models do not acknowledge the central role of radiology to health care (A. Brady et al., 2020).

The number of indicators (and, in the case of administrators, categories) that internal participants considered relevant for value assessment was much lower than that of external participants. Probably, they anticipated that, if the framework is fully implemented in the service, their collaboration will be needed to collect and analyse information and want to be sure that the value assessment process will be simple.

Contradictions in the weights assigned to categories and benefit indicators by different participant groups clearly showed that different stakeholders assign different importance to different value components. Value was higher when an indicator combination oriented towards the goals of internal stakeholders was used; on the other hand, it was lower when the calculations were made from the perspective of external stakeholders. It must be noted that, currently, the decisions and actions of the internal stakeholders have a higher influence on how the service is shaped than those of the external stakeholders. If, from now on, information about the indicators is gathered and computed, it will be possible to see the evolution of value from the perspective of the various stakeholders and there will be more visibility on what external stakeholders value.

The lack of data about the services provided by the department was a major limitation. The data needed for the indicators were not always available or, when available, were aggregated. Consequently, some indicators had to be estimated qualitatively. Thus, the benefit values obtained must be interpreted with caution and primarily serve illustrative purposes. In the future, the department needs to establish systematic processes of data collection supported by information and communication technology to feed the framework. Despite this limitation, obtaining an explicit evaluation of value and addressing the first gap identified in the introduction section was possible.

We did not observe (lack of) understandability of MCDA methods as an obstacle to framework implementation, which somehow gives confidence for future applications. The framework can easily be adapted to other radiology services as the screening of the literature may be used only to update the review and the methods to be used may change in accordance with the circumstances (e.g., stakeholders involved, size of the sample, ease of use or understandability) or to other health care services. The ability to use different indicators and methods in the aggregation and ranking of indicators broadens the framework's potential use in different contexts and addresses the second gap highlighted in the introduction section.

As far as we are aware, this was the first study to determine the value of a hospital department. Nevertheless, it is possible to compare the features of the proposed VAF with those of other frameworks. The literature about frameworks to determine the value of drugs has discussed topics like usability,

different stakeholder perceptions about definitions of value, validity, patient-centred care, impact on stakeholders' actions, and uncertainty and gaps in data. In terms of usability, there have been hesitations about applying value frameworks in practice because stakeholders do not understand how to apply them and how to extract value from the frameworks' inputs (Slomiany et al., 2017). The framework proposed in this study has the advantage of being flexible and adapting to the characteristics of involved stakeholders because assessment methods are selected taking into account their ability to understand and use them.

Stakeholders' different definitions of value have limited the application of VAF when in practice due to silo-specific approaches (Boscolo et al., 2020). The proposed framework selects the indicators to be used from a large portfolio of indicators (from the literature), common to all stakeholders, in order to obtain a unifying notion of value that eases communication among stakeholders.

Concerning validity issues, value frameworks should: (1) contain relevant and reasonable criteria for prioritizing the different types of benefit; (2) be transparent about the evidence/benefits to be (or not) used and how they will be analysed and evaluated, and about issues related with conflicts of interest, and (3) have wide applicability, and facilitate reproducibility (Cherny et al., 2015). The proposed framework complies with all these requirements.

In what concerns patient-centred care, none of the frameworks analysed in the review by Slomiany et al. (2017) considered the perspective of individual patients; and, in their review, M. Zhang et al. (2022) concluded that patients or the public were rarely or only superficially engaged in the development process of VAF. This study involved patients in the selection of the benefit indicators to be considered to assess the value of the radiology department and their weight. By engaging different perspectives (i.e., those of patients, physicians, radiographers, and administrators) in operationalizing value, we contribute to narrowing the third gap noted in the introduction section.

Interpretation of value was one of the biggest concerns in this study and the reason why we expressed the results in a scale that is easy to understand and eases comparisons. As long as the meaning of the output(s) of the framework is understood by the various stakeholders, decision-makers have an opportunity to shape their communication or clinical strategies (Slomiany et al., 2017). Nevertheless, the use of data on a single year may limit the interpretability of the matrix that compares benefit to cost in the dashboard. With the addition of more data, it will be possible to analyze the evolution of both the benefit and cost.

Uncertainty and gaps in data have frequently been referred to as major limitations in the literature about value frameworks (e.g., Mandelblatt et al., 2017). This study faced similar difficulties and the

implementation that was attempted highlighted the need to plan information flows and stocks to feed the indicators.

4.5 Conclusion

The main objective of this study was to develop a framework to determine and interpret the value of a hospital department (the radiology service) considering the perspectives of multiple stakeholders. Three major research gaps related to value-based initiatives have been identified: (1) not explicitly determining value, (2) being complex (which limits reproducibility) and not admitting customization; and (3) not addressing the various and sometimes conflicting concerns of involved stakeholders. The proposed customized framework contributes to tightening these gaps.

A set of alternative methods (selected to fit the knowledge of the participants, data availability, and the level of accuracy needed) were used to estimate indicators, aggregate individual perspectives, and determine the overall value. Using the concept of distance to determine the gap between ideal and current benefit helps prioritize alternative management improvement initiatives.

The application of the framework to a real case uncovered the lack of quality of the available data. The development of methods to measure value is also a motivation to enhance meaningful data collection.

Future research developments of this study should follow the following two directions: (1) reinforcing the empirical validation of the indicators to be incorporated in the framework (enhancing the reproducibility of the framework); and (2) empirically studying the incorporation of the framework in the information system of institutions (e.g., addressing usability issues).

5

Value-Based Payment Capability Maturity Model: A Conceptual Framework

5.1 Introduction[4]

Global interest in VBHC has grown significantly, reflecting a shift in how care is delivered and financed (Vijverberg et al., 2022). However, the definition of value in healthcare remains contested, owing to its inherently multidimensional nature that extends beyond clinical outcomes to include patient-centredness, empowerment, and shared decision-making (Antoñanzas et al., 2016; Marzorati & Pravettoni, 2017). Porter's value agenda (Porter & Lee, 2013) remains foundational but has been critiqued for offering limited guidance on how to operationalize outcomes, address cultural change, or provide a comprehensive transition strategy from volume to value (van der Nat, 2022). In this context, VBP models have become central to the implementation of VBHC. These models aim to realign financial incentives with quality and efficiency by tying payment to performance metrics (Conrad, 2015; Liao et al., 2020). Various VBP models, ranging from bundled payments to shared savings and population-based schemes, have differed in scope, design, and risk-sharing mechanisms (Conrad et al., 2016; Joynt Maddox et al., 2017). Although VBP models have demonstrated improvements in clinical outcomes and cost-efficiency, implementing them is complex and often hindered by institutional factors (Ellis Hilts et al., 2022), administrative burden, stakeholder resistance (Leao, Cremers, et al., 2023a; Milad et al., 2022), and potential inequities (Khazanie & Ho, 2019). Frameworks have been proposed to guide VBP implementation in diverse contexts, including oral health (Riley et al., 2019), state-level policy environments (Tobey et al., 2022), and healthcare system-wide reforms (Lighter et al., 2023). Yet, the absence of a unified, consensus-based framework limits the translation of evidence into scalable practice.

[4] This chapter is co-authored with Nazaré Rego and José Crispim and has been submitted to a peer-reviewed journal.

To move beyond fragmented analyses and toward strategic advancement in VBHC financing, a structured framework is necessary to assess organizational capabilities and guide the implementation of VBP models. In this context, the development of a VBP-CMM is essential for healthcare systems, particularly hospitals, to effectively transition from volume-based to value-based care.

The foundational structure for most maturity models is the CMM, originally developed to help organizations select improvement strategies by assessing process maturity and identifying critical development areas (Paulk et al., 1993). The proposed VBP-CMM is theoretically driven as it is not based on primary empirical data but rather on a structured synthesis of findings from the published scientific literature on VBP models. Grounded in a systematic scoping review (ScR) of this evidence, the model organizes key capabilities into progressive maturity levels, providing a conceptual roadmap for healthcare institutions seeking to adopt or enhance VBP approaches. The ScR maps all available evidence from the literature published with the aim of answering the following question: What are the key elements and capabilities related to the design, implementation, and governance of VBP models? The ScR was conducted following the JBI's Population, PCC guidelines (Peters et al., 2020) and is reported through the PRISMA-ScR guidelines (Tricco et al., 2018).

Maturity models assess the evolution of processes, capabilities, and technologies within organizations, promoting gradual and systematic improvements. Most maturity models have been designed in the context of information systems. These models are often generic and thus misaligned with the specificities of the healthcare sector, such as regulation, clinical integration, and sensitive data management (Foshay & Kuziemsky, 2014; Kim & Namkoong, 2025; Moreira et al., 2024). Assessing maturity in complex domains, such as healthcare, requires adapted models that can act as intermediaries between general abstractions and practical applications (Brooks et al., 2015).

A few healthcare-specific maturity models are emerging: (1) the Digital Health CMM (Kim & Namkoong, 2025), developed to overcome the limitations of traditional models such as CMM integration, which mainly prioritize technical metrics, including interoperability and data management; this model integrates communication, engagement, and governance as central domains, promoting a more holistic assessment of digital health maturity; (2) a maturity model to evaluate the maturity of omnichannel strategy adoption in healthcare services (Moreira et al., 2024) to guide institutions toward sustainable and effective omnichannel implementation, a continuous process requiring monitoring, strategic adjustments, and integration across strategy, processes, systems, data, and people; (3) a maturity model to assess the implementation of circular economy practices in operating rooms (Sgambaro et al., 2025);

(4) maturity model framework for integrated virtual care to support remote patient monitoring (Sinn et al., 2022); and 5) a maturity model to assess business intelligence (Brooks et al., 2015).

Studies on maturity models in healthcare have predominantly been conceptual, except for Sgambaro et al. (2025), who provide exploratory empirical evidence by applying the model in a real-world context. That application required adaptation to the setting through partnerships with clinicians, managers, and frontline teams.

Although the application of maturity models in healthcare has been growing, in alignment with digital transformation and the need for sustainability, a model for VBHC implementation has not been available yet. The proposed theoretical CMM is comprehensive, integrating a data collection instrument with a fuzzy multi-criteria method for data aggregation, as demonstrated through an illustrative example. It offers a robust foundation for further research, practical validation, and policy development in healthcare payment reforms.

5.2 Methodology

5.2.1 Search strategy

This study explores published structured frameworks and models for designing and implementing VBP models. It outlines the key components, development phases, core activities, essential capabilities, resources, and other elements involved in both the design and execution of these models. The research is based on a ScR conducted to map the existing literature to develop a theoretical CMM. The search strategy followed the PRISMA-ScR (Tricco et al., 2018) (Tricco et al., 2018) and the JBI's PCC guidelines (Peters et al., 2020) (Population → Healthcare organizations/hospitals; Concept → Competencies, maturity, capability models; Context → VBHC / VBP) (*Appendix D.1)*. ScRs are well-suited for systematically identifying, evaluating, and synthesizing relevant literature in emerging fields, such as VBP.

The literature search was performed across three databases: PubMed, Scopus, and Web of Science, using the terms "value-based payment," "healthcare," and "conceptual model," adapted as needed for each database. Studies were included if they examined the structure, development, implementation, or evaluation of VBPs or APMs (*Appendix D.2*).

Both conceptual frameworks and empirical analyses addressing components, processes, resources, or capabilities relevant to the design and operationalization of VBPs were considered, regardless of the healthcare setting, including primary care, emergency services, and hospice care. Only studies published between 2015 and 2025 and written in English were included, including peer-reviewed

publications and analytical grey literature. Articles focused exclusively on fee-for-service models, opinion pieces without empirical or conceptual analysis, and studies not substantively addressing key elements of VBPs or APMs design and implementation were excluded. Study selection began with screening titles and abstracts for relevance, followed by full-text eligibility assessment independently performed by two reviewers.

Classification was also independently conducted, with disagreements resolved through joint discussion and consensus. A PRISMA flow diagram summarizes the study selection process (*Appendix D.3*). Data extraction was undertaken systematically using a standardized template capturing key study attributes, including bibliographic details, study aims, identified VBP components, required resources, core capabilities, and steps involved in design and implementation (*Appendices D.4 - D.5)*. Relevant elements were identified from explicit statements and contextual evidence, sometimes inferred from methodological descriptions or conceptual frameworks. The principal investigator performed the initial data extraction, which the other authors reviewed. Any discrepancies were resolved through collaborative discussion until complete consensus was reached.

5.2.2 Thematic analysis

Thematic analysis is a widely utilized method for examining qualitative data, characterized by systematically identifying, analysing, and reporting recurring patterns or themes within a dataset (Braun & Clarke, 2006). While commonly applied to empirical data such as interviews or focus groups, thematic analysis has also been effectively employed for analysing scientific literature in constructing theoretical models, owing to its flexible and interpretative nature. Braun & Clarke (2006) describe thematic analysis as a method that facilitates the descriptive summarization of data and the deeper interpretative understanding of its meanings through code selection and theme development emerging from the sources under analysis. A theme is a "patterned response or meaning" pertinent to the research question and from the data.

It is important to distinguish between themes and categories: while categories serve to organize the manifest content of the data descriptively, themes require a higher level of abstraction and integration, revealing more comprehensive and interpretative meanings (Nowell et al., 2017). A main feature of thematic analysis is its epistemological flexibility, allowing it to be applied across various theoretical and methodological frameworks (Clarke & Braun, 2017). This versatility is particularly suitable for integrative and systematic reviews, especially in contexts that aim to develop conceptual models or analytical frameworks, such as maturity models.

The identification of themes is not contingent on the frequency of occurrence of an idea, but instead on its analytical relevance and capacity to elucidate the research question (Nowell et al., 2017). The conducted inductive approach emphasizes themes emerging directly from the data without being constrained by pre-existing theoretical frameworks (Varpio et al., 2020). This approach is particularly advantageous when the objective is to capture a broad and spontaneous range of meanings and is well-suited for identifying capabilities to be validated through maturity model development. Each theme must encompass internally consistent data and be sufficiently distinct from others to justify its separation (Attride-Stirling, 2001).

In the present study, coding was performed based on the capabilities necessary for managing the design, implementation, and governance of VBPs models. These capabilities were organized into themes and subthemes designated as focus areas and key components, respectively. The coding process, along with the definition of themes (focus areas) and subthemes (key components), was an iterative and independent process conducted by two reviewers.

5.3 Literature review results

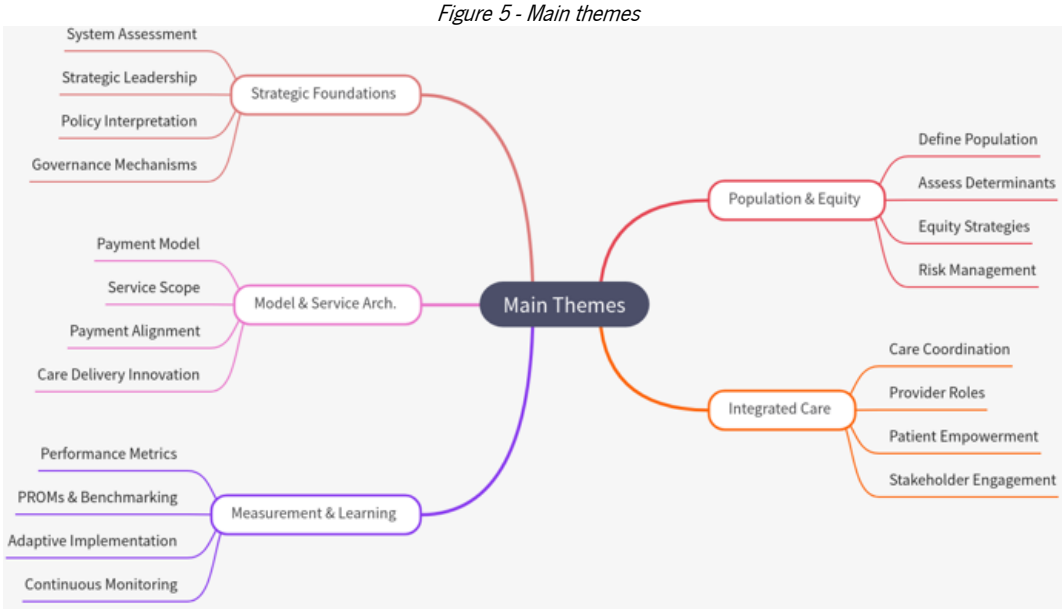
5.3.1 Main themes

From the literature review, three main insights emerged: core activities and capabilities, and VBPs components. Following a thematic analysis, we synthesized five main themes (Figure 5):

1. Strategic foundations: activities such as conducting system and organizational assessments and setting reform objectives (Cattel et al., 2020; Kannarkat et al., 2020) highlight the foundational role of strategic direction; key capabilities emphasize the importance of strategic leadership, governance, and policy interpretation (Conrad et al., 2016; Leao et al., 2024) components such as contextual foundations, participatory governance, and incentive alignment further underscore the necessity of aligning payment reforms with broader health policies, leadership priorities, and accountability structures.
2. Population and equity: activities include defining target populations, assessing social determinants, and implementing risk adjustment mechanisms (Cattel et al., 2020; Halder et al., 2020); capabilities in patient empowerment, education, and patient-centred care coordination highlight how equity is operationalized at the patient level (Harish et al., 2017); components such as equity strategies and population risk management emphasize the need to reduce disparities and ensure tailored interventions (Kannarkat et al., 2023; Riley et al., 2019).

3. Model and services architecture: activities such as defining the scope of services, designing payment architecture, and developing pilot programs (Hayen et al., 2015; K. Patel et al., 2016) reflect the technical and organizational design dimension; capabilities in payment innovation and reform-driving strengthen the architecture theme by enabling iterative and adaptive redesign (Conrad et al., 2016); components including innovative care delivery, payment model alignment, and cost-effective innovation illustrate how reform depends on aligning financial structures with redesigned care pathways (Gratale et al., 2022; Riley et al., 2019).
4. Integration of care: activities include defining providers' roles and aligning payment with delivery reforms (Howard et al., 2024; Lighter et al., 2023); capabilities related to evidence-based clinical practice, condition-based care management, and patient-centred coordination reinforce the importance of embedding clinical practice into payment reforms to strengthen integrated delivery; care coordination stands out as the most frequently cited component (Cattel et al., 2020; Harish et al., 2017), reflecting the centrality of multidisciplinary collaboration and partnerships.
5. Measurement and learning: activities such as defining and operationalizing quality metrics, creating performance scoring systems, and enabling public reporting (Lighter et al., 2023; Nowak, 2016) show the operational mechanisms of evaluation; capabilities such as adaptive implementation, organizational learning, and design thinking reinforce the dynamic and iterative character of payment reform, enabling continuous refinement in response to contextual challenges (Conrad et al., 2016; Shajari Pour Mousavi et al., 2017); components like quality measurement, performance benchmarking, accountability mechanisms, and cost efficiency illustrate the multidimensional nature of evaluation, spanning patient outcomes, resource allocation, and transparency (Cattel et al., 2020).

Figure 5 - Main themes



5.3.2 Core Activities, Components, and Capabilities for Value-Based Payment Models

The literature highlights that the successful development and implementation of VBP models rely on an articulated set of core activities, structural components, and organizational capabilities. A total of 28 core activities were identified, with the most prominent being system and organizational assessment (Cattel et al., 2020; Conrad et al., 2016; Gratale et al., 2022; Halder et al., 2020; Kannarkat et al., 2023; Leao et al., 2024) and the definition of quality and performance metrics (Howard et al., 2024; Lighter et al., 2023; Nowak, 2016; K. Patel et al., 2016). Other critical activities include analysing implementation drivers, defining the target population and scope of services, designing the payment model architecture, and planning the reform's execution (Cattel et al., 2020; Conrad et al., 2016; Gratale et al., 2022; Harish et al., 2017; Kannarkat et al., 2023; Lighter et al., 2023).

Complementarily, the literature identifies 17 key components to sustain VBP models. Among the most recurrent are care coordination (Cattel et al., 2020; Gratale et al., 2022; Harish et al., 2017), equity strategies (Kannarkat et al., 2023; Riley et al., 2019), payment model alignment (Kannarkat et al., 2023; Riley et al., 2019), and quality measurement through validated indicators such as PROMs (Cattel et al., 2020; Riley et al., 2019). Other components highlight the importance of participatory governance, stakeholder engagement, accountability mechanisms, and the promotion of cost-effective innovation (Conrad et al., 2016; Gratale et al., 2022; Harish et al., 2017; Lighter et al., 2023).

These activities and components are sustained by critical capabilities spanning strategic, organizational, clinical, and patient-centred dimensions. Strategic leadership and governance emerged as the most frequently mentioned capability, stressing vision, goal alignment, and reform leadership (Conrad et al., 2016; Howard et al., 2024; Leao et al., 2024). Other capabilities include adaptive implementation and organizational learning (Conrad et al., 2016; Leao et al., 2024), the use of design thinking for iterative model refinement (Halder et al., 2020; Shajari Pour Mousavi et al., 2017) and stakeholder-aligned strategies and engagement (Harish et al., 2017; Leao et al., 2024). Evidence-based clinical practice, patient-centred care coordination, and patient empowerment were also highlighted as determinants of success (Halder et al., 2020; Harish et al., 2017). For more details, see *Appendix D.6.*

5.4 Value-Based Payment Capability Maturity Model

5.4.1 Maturity model structure

The proposed VBP-CMM can support organizations (particularly hospitals) in systematically building and advancing the capabilities needed for effective VBPs reforms. This model serves as a framework to assess current capability levels and guide structured progression, focusing on continuous improvement in strategic, organizational, clinical, and patient-oriented dimensions of VBP implementation. Our comprehensive ScR provided a foundation for structuring the CMM around four core elements: maturity focus areas, key implementation factors, maturity capabilities, and maturity progression levels. It also guided the design of our model within a phased implementation framework (Figure 6) that comprises the following main phases: (1) the structure model (focus areas, key components, and capabilities), (2) the data collection instrument, and 3) the capabilities assessment tool (aggregation methods and levels of maturity). The VBP-CMM main structure resulting from the thematic analysis is presented in Figure 7.

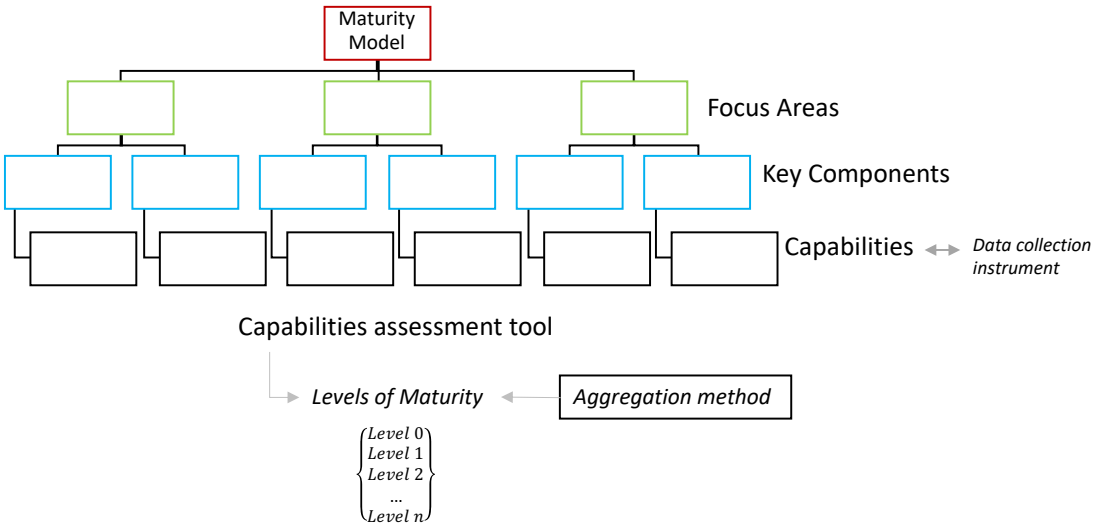


Figure 6 - Maturity model structure

Following the identification of themes in the literature, these were organized into five focus areas and 23 key components. A focus area is a well-defined partition of a functional domain: (1) *Strategic Foundations and Governance* incorporates high-level (strategic) decisions related to the development of strategy, governance, and value creation practices; (2) *Population and Equity-Centred Design* includes multilevel (strategic and operational) decisions aimed at aligning payment and care delivery models with the needs of the population, promoting equity, population risk focus, and user-centeredness; (3) *Model*

and Service Architecture incorporates multilevel (strategic and operational) decisions that shape how payment models and healthcare services are structured, financed, and adjusted with a focus on value; (4) *Integrated Care Delivery* involves clinical and organizational decisions related to the coordinated, continuous, and efficient delivery of healthcare services; and *Measurement, Evaluation, and Learning* involves operational decisions that systematically use data and evidence to monitor, evaluate, and learn from organizational performance.

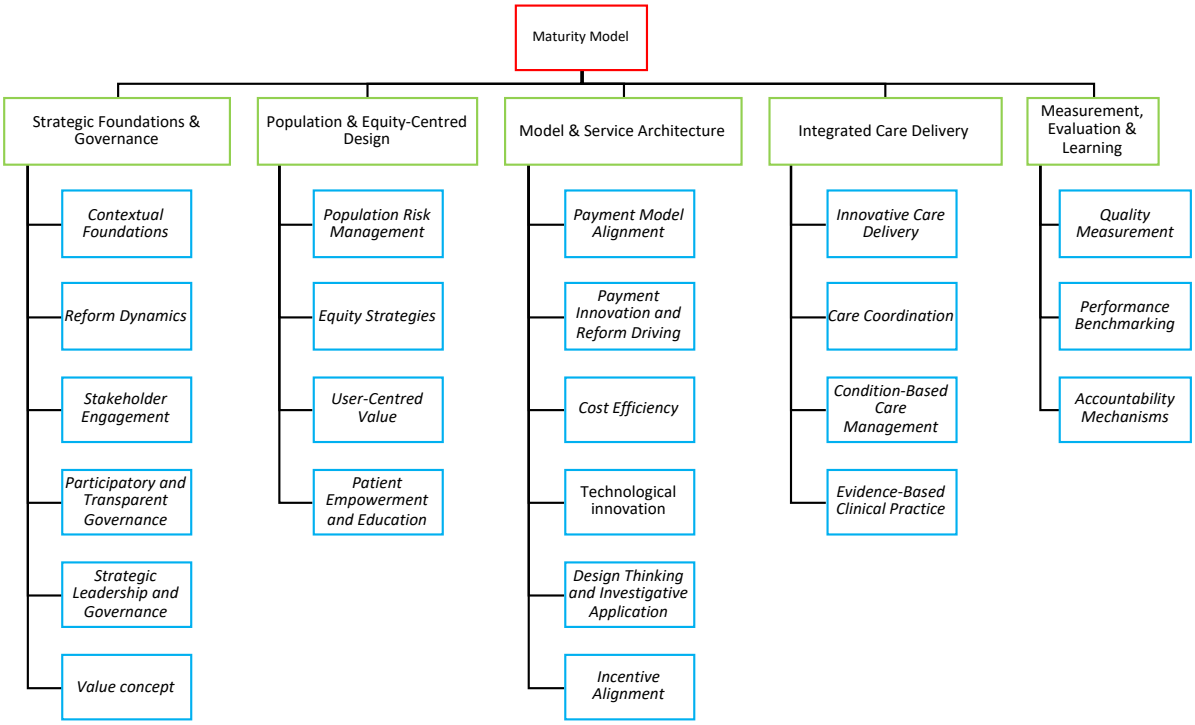


Figure 7 - VBP Maturity Model

Each maturity key component functions as a specific indicator, assessed based on its level of implementation within the corresponding focus area. Consequently, these key components form the foundation of the maturity assessment elements used in the evaluation tool. The allocation of key components to the focus areas ensures that each area is associated with a set of capabilities (Table 21). The level of implementation of these 27 capabilities determines the value of the respective key factor and, through a final aggregation process, the overall maturity stage of the organization.

Table 21 - Maturity Model Structure

Focus Area	Key Component	Capability	References
1. Strategic Foundations and Governance	Contextual Foundations	Interpreting social, political, and economic contexts shaping payment models.	(Conrad et al., 2016; Kannarkat et al., 2023)
		Strategic policy interpretation to inform reform alignment.	(Conrad et al., 2016)
	Reform Dynamics	Leading adaptive implementation and promoting organizational learning.	(Conrad et al., 2016; Leao et al., 2024)
	Stakeholder Engagement	Aligning stakeholder strategy and fostering multisectoral engagement.	(Harish et al., 2017; Leao et al., 2024)
	Participatory and Transparent Governance	Promoting participatory governance through inclusive decision-making structures.	(Harish et al., 2017)
		Establishing transparent governance with mechanisms for monitoring and improvement.	(Lighter et al., 2023)
	Value Concept	Defining value from user perspectives and ensuring active user involvement.	(Conrad et al., 2016; Kannarkat et al., 2023)
	Strategic Leadership and Governance	Setting vision, aligning goals, and driving strategic transformation in payment reform.	(Conrad et al., 2016; Howard et al., 2024; Leao et al., 2024)
2. Population and Equity-Centred Design	Population Risk Management	Assessing medical and social risks to effectively target populations.	(Gratale et al., 2022)
	Equity Strategies	Designing inclusive payment systems to reduce disparities and promote social equity.	(Kannarkat et al., 2023; Riley et al., 2019)
	User-Centred Value	Using person-centred definitions of value, including experience, quality, cost, and outcomes.	(Conrad et al., 2016; Kannarkat et al., 2023)
	Patient Empowerment and Education	Engaging patients through education to support informed decision-making and self-management.	(Harish et al., 2017)
3. Model and Service Architecture	Payment Model Alignment	Designing and implementing value-based population payment structures.	(Kannarkat et al., 2023; Riley et al., 2019)
		Aligning financial mechanisms with care delivery reforms.	(Conrad et al., 2016; Lighter et al., 2023)
	Incentive Alignment	Structuring payment incentives to support value-based, flexible care delivery.	(Kannarkat et al., 2023)
	Cost Efficiency	Planning resource allocation and investing in preventive and high-value care.	(Cattel et al., 2020)
	Technological Innovation	Selecting and implementing innovations that improve outcomes at lower cost.	(Cattel et al., 2020)
	Design Thinking and Investigative Application	Applying design thinking to develop and refine payment models.	(Halder et al., 2020; Shajari Pour Mousavi et al., 2017)
	Payment Innovation and Reform Driving	Conceptualizing and leading payment reform initiatives.	(Conrad et al., 2016)
4. Integrated Care Delivery	Innovative Care Delivery	Redesigning care pathways to improve coordination, access, and integration with social services.	(Gratale et al., 2022; Riley et al., 2019)
	Care Coordination	Implementing multidisciplinary, patient-centred care coordination strategies.	(Cattel et al., 2020; Gratale et al., 2022; Harish et al., 2017)

Focus Area	Key Component	Capability	References
		Delivering case management adapted to individual needs.	(Harish et al., 2017)
	Condition-Based Care Management	Managing care based on specific conditions using standardized clinical pathways.	(Halder et al., 2020)
	Evidence-Based Clinical Practice	Applying clinical guidelines and evidence to enhance outcomes and quality.	(Halder et al., 2020)
5. Measurement, Evaluation and Learning	Quality Measurement	Defining, applying, and monitoring clinical and PROMs.	(Cattel et al., 2020; Riley et al., 2019)
	Performance Benchmarking	Using peer-based performance comparisons to guide improvement.	(Lighter et al., 2023)
	Accountability Mechanisms	Enabling performance monitoring, public reporting, and continuous evaluation in system-wide learning.	(Lighter et al., 2023)

Note: PROM - Patient-Reported Outcome Measure.

5.4.2 Capabilities - data collection instrument

We developed a questionnaire to assess the degree of implementation of the 27 capabilities derived from the literature *(Appendix D.7).* This list of capabilities should be adapted to the specific context. For example, the first two questionnaire items can be adapted to the context as follows:

Contextual Foundations (Conrad et al., 2016; Kannarkat et al., 2020)

Q1 - Our organization regularly analyses social, political, and economic factors that affect payment models, i.e., we have capabilities in:

- Defining the strategic vision and reform priorities.
- Deciding how to adapt payment models to local political, regulatory, and economic realities.
- Creating governance structures and accountability mechanisms.

Q2 - Leadership demonstrates capabilities in interpreting public policy and integrating it into organizational strategy, i.e., we have capabilities in:

- Engaging and allocating roles to stakeholders in decision-making.
- Determining how institutional context (e.g., healthcare system maturity) influences the timeline and scope of reform.
- Establishing an adaptive, learning-oriented organizational culture.

The scales used to collect the information may vary, ranging from agreement or percentage scales to more elaborate ones that capture the underlying uncertainty, such as fuzzy numbers. Below, we present the assessment tool based on the CMM questionnaire for two example scales: (1) percentage, and (2) fuzzy linguistic numbers of the Z-number type.

5.4.3 Capabilities' assessment tool

5.4.3.1 Linguistic Z-number

Natural language is frequently employed to represent real-world information precisely because of its inherent imprecision, characterized by both fuzziness and partial reliability. Fuzziness pertains to using soft, non-binary constraints in the valuation of variables, whereas partial reliability concerns the degree of confidence in the knowledge or intuition from which such information is derived. To jointly address these two dimensions of uncertainty, Zadeh (2011) proposed the Z-numbers, which formalize uncertain information as an ordered pair Z = (A, B), where A expresses the constraint (i.e., the fuzzy restriction on a variable) and B is the reliability of A. Importantly, Z-numbers do not merely consist of two independent fuzzy sets; instead, they represent a structured framework incorporating an underlying probability distribution that links the two elements, thereby representing human reasoning under uncertainty. Building on this framework, Wang et al. (2017) introduced the linguistic Z-number (LZN), in which both A and B are expressed in qualitative linguistic terms rather than quantitative values. For instance, a Z-number applied to a capability might take the form ("Established"; "very likely"), indicating that the capability at stake is considered well-developed, and there is a high level of confidence in this judgement. This approach enables experts to provide evaluations grounded in domain knowledge without the burden of precise quantification, thereby aligning the model more closely with real-world expert judgement. The use of LZNs in a maturity model supports evaluators in expressing the perceived existence of capabilities within an organization and the degree of confidence in these perceptions. While a percentage score facilitates straightforward aggregation of responses, it does so at the cost of granularity and contextual adaptation. In contrast, Linguistic fuzzy numbers offer richer informational content but introduce higher computational complexity, particularly during the aggregation phase. This trade-off underscores the practical relevance of LZNs in improving the interpretability and decision-making value of models dealing with uncertain or subjective expert input.

5.4.4 Maturity levels

Regarding the maturity levels for classifying organizations and guiding future decisions and investments in capabilities, we suggest five levels (Table 22): (1) Initial; (2) Value definition; (3) Design; (4) Implementation; (5) Scaling and Integration. This number of levels is common in similar maturity models; for example, in the few maturity model identified in healthcare, the levels ranged from 4 (Sinn et al., 2022) to 7 (Kim & Namkoong, 2025). Having a larger number of levels enables a more refined

evaluation, capturing progression, but it can also introduce greater complexity and benchmarking challenges. Table 24 proposes sets of capabilities required for each maturity level (i.e., the specific capabilities an organization should demonstrate to be classified at a given maturity level).

Table 22 - Maturity levels

Maturity Level	Development Phase	Capability Focus	Key Characteristics
Level 1 – Initial	Stakeholder Insight and Context Analysis	*Emerging Awareness and Contextual Understanding*	- Initial stakeholder engagement is ad hoc - Basic understanding of the healthcare system context - Capabilities are recognized but not yet applied systematically
Level 2 – Value definition	Problem Definition and Value Proposition Clarification	*Clarification of Needs and Strategic Intent*	- Problems and opportunities are clearly defined - Value propositions aligned with stakeholder priorities - Capabilities inform strategy and goal setting
Level 3 – Design	Strategic Co-Design and Conceptual Modelling	*Collaborative Model Development and Systems Thinking*	- Active co-design with stakeholders - Application of systems thinking - Capabilities are used to design conceptual models reflective of healthcare delivery complexity
Level 4 – Implementation	Model Structuring and Pilot Implementation	*Prototyping, Testing and Early Implementation*	- Operational frameworks developed and tested - Pilots implemented in controlled settings - Capabilities applied in practice with early performance monitoring.
Level 5 – Scaling and Integration	Full-Scale Deployment and System Integration	*Institutionalization, Policy Alignment and Sustainable Transformation*	- Full system integration of VBP models - Capabilities embedded in governance, financing, and delivery - Ongoing evaluation and continuous learning mechanisms in place.

Note: VBP- Value-Based Payment.

Two approaches can be considered to determine the organization's level:

a. the implementation of the capabilities determines the value of the respective key component; through a final aggregation process (the arithmetic mean is the simplest), the overall maturity stage of the organization is calculated. In this approach, an organization could design, implement, and govern a VBP model even if a complete achievement of the capabilities does not exist; or
b. to advance to the next level, specific capabilities are completely achieved (as suggested in Table 23).

Table 23 - Capability-to-Maturity Level Mapping

Dimension	Key Component	Capability	L1	L2	L3	L4	L5
Strategic Foundations and Governance	Contextual Foundations	Interpreting social, political, and economic contexts	x	x	x	x	x
		Strategic policy interpretation for reform alignment			x	x	x
	Reform Dynamics	Leading adaptive implementation and learning			x	x	x
	Stakeholder Engagement	Aligning strategy and fostering engagement			x	x	x
	Participatory and Transparent Governance	Promoting inclusive decision-making structures			x	x	x
		Establishing transparent governance					x
	Value Concept	Defining value from user perspectives		x	x	x	x
	Strategic Leadership and Governance	Setting vision, aligning goals, driving transformation					x
Population and Equity-Centred Design	Population Risk Management	Assessing medical and social risks			x	x	x
	Equity Strategies	Designing inclusive systems for equity		x	x	x	x
	User-Centred Value	Using person-centred definitions of value			x	x	x
	Patient Empowerment and Education	Engaging patients through education	x	x	x	x	x
Model and Service Architecture	Payment Model Alignment	Designing VBP structures			x	x	x
		Aligning financial mechanisms with care			x	x	x
	Incentive Alignment	Structuring incentives for flexible care				x	x
	Cost Efficiency	Planning for preventive and high-value care			x	x	x
	Technological Innovation	Selecting innovations to improve outcomes			x	x	x
	Design Thinking and Investigative Application	Applying design thinking in model development			x	x	x
	Payment Innovation and Reform Driving	Leading payment reform initiatives				x	x
Integrated Care Delivery	Innovative Care Delivery	Redesigning care pathways and integration				x	x
	Care Coordination	Multidisciplinary, patient-centred coordination			x	x	x
		Case management adapted to needs			x	x	x
	Condition-Based Care Management	Managing care with standardized pathways			x	x	x
	Evidence-Based Clinical Practice	Applying evidence and guidelines			x	x	x
Measurement, Evaluation and Learning	Quality Measurement	Applying and monitoring PROMs and outcomes		x	x	x	x
	Performance Benchmarking	Using performance comparisons				x	x
	Accountability Mechanisms	Monitoring, reporting, and evaluation in system-wide learning					x

Note: PROM - Patient-Reported Outcome Measure; VBP - Value-Based Payment.

5.4.5 Illustrative example

To illustrate the example, despite we consider all questionnaire in the calculations, we only showing the questions (Table 24) regarding the Focus Area (8 out of 27): Strategic Foundations and Governance for the weighted aggregate value of the 10 experts scores (the full results are available in the supplementary material), using a) LZN and b) a percentage scale to indicate the degree of the capabilities (admitting that the organization could implement a VBP despite having a complete capabilities achievement). For more details *Appendix D.8, D.9, D.10,* and *D.11.*

Table 24 - Illustrative example

Focus Area: Strategic Foundations and Governance					
Required Capabilities	**LZN**	δ_c^+	δ_c^-	**Closeness Coefficient**	**Percentage (%)**
Key Component: Contextual Foundations					
Q1 - Interpreting social, political, and economic contexts shaping payment models.	(0.34,0.43,0.58),(0.38,0.63,0.83)	1,25	0,82	0,394	51,43
Q2 - Strategic policy interpretation to inform reform alignment.	(0.46,0.59,0.72),(0.58,0.83,0.98)	0,82	1,00	0,549	64,29
Key Component: Reform Dynamics					
Q3 - Leading adaptive implementation and promoting organizational learning.	(0.46,0.65,0.80),(0.40,0.65,0.85)	0,96	1,11	0,536	70
Key Component: Stakeholder Engagement					
Q4 - Aligning stakeholder strategy and fostering multisectoral engagement.	(0.43,0.58,0.73),(0.38,0.58,0.75)	1,13	1,07	0,487	64,29
Key Component: Participatory and Transparent Governance					
Q5 - Promoting participatory governance through inclusive decision-making structures.	(0.57,0.72,0.80),(0.35,0.60,0.83)	0,94	1,16	0,552	75,71
Q6 - Establishing transparent governance with mechanisms for monitoring and continuous improvement.	(0.48,0.67,0.80+),(0.40,0.65,0.83)	0,95	1,14	0,544	71,43
Key Component: Value Concept					
Q7 - Defining value from user perspectives and ensuring active user involvement.	(0.36,0.55,0.70),(0.48,0.70,0.83)	1,05	1,01	0,491	61,43
Key Component: Strategic Leadership and Governance					
Q8 - Setting vision, aligning goals, and driving strategic transformation in payment reform.	(0.52,0.67,0.78),(0.58,0.83,0.98)	0,72	1,10	0,604	71,43
...	...	...	...	...	...
			Average	**0.51**	**65,98**

Note: LZN - Linguistic Z-number

To demonstrate the use of a percentage scale in the responses, we began by transforming the artificial data (questionnaire answers) expressed in the linguistic terms of the fuzzy value component into a scale from 1 to 7, which was later extended (proportionally) to 1 to 10, so that a 1-100% scale was obtained. The aggregation of the responses was carried out through a weighted average based on each expert's weight. The final average yielded 65.98%, corresponding to a maturity level of 3 - Design. In turn, considering uncertainty and reliability in the responses using the Z-TOPSIS approach resulted in a lower outcome of 0.51, corresponding to level 2 – Value definition. In the case of following an approach where progression to the next level only occurs when specific capabilities are achieved, all respondents (as we assume they are managers with deep knowledge of the organization) must assign at least the linguistic term E – Established for the capability to be considered present. In this example, advancing to level 2 requires that the capabilities expressed in questions 1 and 12 already exist within the organization. The responses to question 1 were Q1= {Expert1: A – Advanced, Expert2: I – Initial, Expert3: R – Refined, Expert4: I – Initial, Expert5: D – Developing, Expert6: E – Established, Expert7: I – Initial, Expert8: E – Established, Expert9: NE – Nonexistent, Expert10: D – Developing}, which is sufficient to place the organization at maturity level 1: Initial.

The approach to follow to interpret the results should be selected carefully. Each organization should choose the approach that best reflects its reality: a more restrictive approach, which considers advancement in the maturity levels only if specific capabilities are present, or a more flexible one, which proceeds with the implementation of the models even if some capabilities are still weak. In any case, knowledge about the organization's capabilities is obtained.

5.5 Conclusion

The proposed VBP-CMM significantly contributes to systematizing and guiding healthcare organizations through the transition from volume-based to VBP systems. The model is structured around five critical focus areas and twenty-three key components that span strategic, operational, clinical, and patient-centred dimensions. Each component is a specific capability indicator, enabling a granular evaluation adaptable to the organization's context. Furthermore, the model operates across five progressive maturity levels, from initial awareness to complete integration, supporting continuous improvement based on defined capabilities.

The VBP-CMM incorporates a data collection instrument and methods for information analysis, such as fuzzy linguistic numbers, which enhance the CMM's applicability in the face of uncertainties inherent to the assessment process. The possibility of adopting either a flexible or restrictive approach to

maturity level progression enables different organizational realities to find the model a practical and realistic tool. In this sense, the VBP-CMM facilitates the measurement of an organization's existing capabilities and shapes strategic decisions for institutional development, reinforcing the alignment between financing, care delivery, and the value generated for patients. In summary, the proposed model offers a valuable operational structure to guide healthcare systems toward institutionalizing value-based reforms, promoting sustainable, equitable, and outcome-focused transformation.

The main limitations of this study stemmed from: a) the difficulty in selecting the final set of articles due to the broad range of topics within value-based studies; although the followed methods aimed at identifying all relevant studies, there is a possibility that some important study may have been left out of our screening; b) in an attempt to develop a theoretical maturity model that could serve as a comprehensive foundation for the management of VBP models (i.e., regardless of geographic region or the nature and type of healthcare organization), and intending to keep the statements as close as possible to those presented by their original authors, we may have incurred a high degree of generalization (vagueness) in the definition of the capabilities; and c) there may have been some interpretation bias when analysing the literature.

Finally, beyond the obvious future research in applying this maturity model to healthcare organizations, our analysis derived a Research Agenda by Category:

1. Implementation: a) Evaluate the effectiveness of the CMM in promoting value-based initiatives; b) Investigate how organizational and patient characteristics influence CMM capabilities development; c) Assess strategies to reduce organizational resistance; d) Analyse how systemic and cultural factors influence VBP adoption.
2. Metrics and Evaluation: a) Develop detailed capability standardized metrics; b) Analyse the limitations of administrative databases in capturing value effectively; c) Examine how professionals' and patients' testimonies may bias current indicators; d) Conduct longitudinal studies tracking maturity model implementation and stakeholder engagement; e) Evaluate the impact of multi-criteria assessment methodologies in decision-making.
3. Maturity Models: a) Study barriers to adopting capability acquisition models, especially in diverse implementation contexts; b) Analyse how model design (scope, goals, incentives) influences effectiveness; c) Study alternative ways to capture and aggregate information within multi-criteria and fuzzy methodologies.
4. Cost Analysis: Study the feasibility and impact of implementing a maturity model as a process of capabilities development.

5. Education: a) Investigate gaps in health literacy and their impact on maturity model implementation; b) Develop interprofessional training models; c) Investigate how to meaningfully engage stakeholders in defining and evaluating value initiatives.

6

Operationalising Value-Based Payment: A Decision-Support Framework for Health System Reform

6.1 Introduction[5]

Health systems face growing pressure to achieve better outcomes with constrained resources (Lindner & Lorenzoni, 2023; P. C. Smith et al., 2023). This paper develops and validates a decision-support framework to help policymakers design and sequence VBP model that strengthen efficiency and system performance (Kreutzberg et al., 2024; Lindner & Lorenzoni, 2023; P. C. Smith et al., 2023), while recognising that the notion of "value" in healthcare remains multidimensional, extending beyond clinical outcomes to encompass patient-centredness (Antoñanzas et al., 2016; Landon et al., 2021; Marzorati & Pravettoni, 2017).

For policymakers and healthcare managers, the multidimensional nature of VBHC complicates translating normative principles into concrete policy choices for performance measurement, resource allocation, and payment reform (P. C. Smith et al., 2023). Despite its prominence in policy discourse, the literature offers limited guidance on sequencing reforms and aligning governance and incentives to operationalise value in complex health systems, leaving decision-makers with persistent design uncertainty (de Mattia et al., 2024; Khalil et al., 2025; P. C. Smith et al., 2023).

Improving efficiency has become a central priority for health systems. With limited resources, policymakers seek to achieve better outcomes without increasing costs, linking value-based reform and productivity, especially relevant (Lindner & Lorenzoni, 2023; P. C. Smith et al., 2023). When carefully designed, VBP models can encourage more efficient resource use while preserving quality and equity (de Silva Etges et al., 2023; Kreutzberg et al., 2024; Vlaanderen et al., 2019).

[5] This chapter is co-authored with José Crispim and has been submitted to a peer-reviewed journal.

Payment reform is arguably the most powerful lever for VBHC, yet it poses a difficult balancing act for policymakers. They must define quality and efficiency while navigating payment structures that carry very different incentives and risks (Rosenthal & Dudley, 2007). While VBP aims to link payment to quality and patient outcomes (Cattel & Eijkenaar, 2020; Conrad et al., 2016; Liao et al., 2020), the design of these models involves high-stakes choices about performance targets and risk-sharing that can alienate providers and derail reform efforts if misaligned (Joynt Maddox et al., 2017).

Moving to VBP is not a simple technical swap; it demands profound behavioural and structural changes across the entire system (Leao, Cremers, et al., 2023c). While these models can improve efficiency, their impact on professional satisfaction and patient experience remains mixed (Leao, Cremers, et al., 2023b; Milad et al., 2022). Furthermore, persistent hurdles, from administrative complexity to the risk of worsening health inequities, continue to stall the scale and sustainability of these reforms (Conrad, 2015; Khazanie & Ho, 2019; Robertson-Cooper et al., 2017). Success is highly sensitive to specific design features (Cattel & Eijkenaar, 2020; Leao, Cremers, et al., 2023c), yet without clear guidance on how to sequence and integrate them, policymakers face a high-stakes transition without a roadmap.

In response, various frameworks have emerged to guide VBP design, ranging from specific clinical domains to broader policy contexts (Cattel et al., 2020; Conrad et al., 2016; Leao et al., 2024; Lighter et al., 2023; Panturu et al., 2025; Riley et al., 2019; Tobey et al., 2022). While these contributions offer valuable insights, they remain dispersed across different settings and disciplines. For a policymaker, this fragmentation is a serious hurdle: it leaves them without a single, consensus-based roadmap to support the coherent design, piloting, and scaling of VBP models. Without an integrated perspective, moving from a theoretical payment concept to a functioning system-wide reform remains a disjointed and risky process.

This study addresses this gap by developing a consolidated framework to support structured decision-making in VBP design. Our approach focuses on the practicalities of sequencing, readiness, and capacity, guided by two questions: (1) *what characterises the core components of VBP models?* and (2) *how are these elements integrated into an implementation sequence?* By synthesising evidence through a participatory process, we provide a tool for leaders to align resources and anticipate hurdles (Leao, Cremers, et al., 2023b). Methodologically, a scoping review established the evidence base, which was then validated through an expert survey to ensure the framework's readiness for policy action.

6.2 Methodology

This study adopts a two-stage design to develop a framework for VBP design and implementation, prioritising conceptual coherence and content validity. The research proceeds in two sequential phases:

a scoping review to map the core components of VBP models, followed by a targeted expert survey to validate and refine the resulting framework. This approach combines evidence synthesis with design thinking principles (Thompson & Schonthal, 2020) to structure a phase-based framework that is both theoretically grounded and operationally sequenced for decision-making.

6.2.1 Scoping Review

To map the conceptualisation and operationalisation of VBP and APMs, we conducted a scoping review following PRISMA-ScR guidelines (Tricco et al., 2018). This review builds on the same search and data extraction process used in Chapter 5, although the present study addresses a different analytical objective and uses a subset of the extracted variables. The analysis focuses on identifying key components, organisational requirements, and implementation processes. Searches were performed in PubMed, Scopus, and Web of Science using terms such as "value-based payment" and "conceptual model" *(Appendices D.1 and D.2*).

Studies were included if they addressed any aspect of VBP or APMs, including conceptual models examining components, processes, resources, or organisational competencies relevant to payment design and implementation. Diverse healthcare contexts were considered to maximise conceptual coverage rather than representativeness. Only English-language publications from 2015 to 2025 were included, and studies lacking substantive engagement with VBP design elements were excluded. Screening involved title/abstract and full-text review by two independent reviewers, with disagreements resolved by consensus.

Data extraction used a standardised template covering VBP components, organisational capabilities, and implementation steps (*Appendices D.4* and *D.5*). A hybrid thematic analysis (Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006; Nowell et al., 2017) was applied to identify core development phases and activities, which directly informed the survey items.

6.2.2 Expert opinion

To refine and validate the framework, we conducted a targeted survey with experts purposively selected from the scoping review authors based on demonstrated expertise in VBP design and implementation, prioritising conceptual adequacy over statistical representativeness(Hasson et al., 2000; Okoli & Pawlowski, 2004) *(Appendix E.1)*. The survey followed a single-round format; ethical approval and informed consent were obtained *(Appendix E.2)*.

The questionnaire covered VBP components and resources, using the Stanford Design Thinking model (Altman et al., 2018; Liedtka, 2015) to organise the six implementation phases: Empathise, Define, Ideate, Prototype, Test, and Implement. Quantitative items were complemented by open-ended questions to capture contextual insights. We analysed responses using frequencies, modes, and means, defining consensus as moderate (60% to <80%) or strong (≥80%) (Diamond et al., 2014). These results, supported by qualitative feedback, were synthesised into heatmaps and tables to finalise the framework.

In addition to the primary validation tasks, exploratory analyses were conducted to examine whether expert characteristics, such as professional role, years of experience, and degree of involvement in VBP implementation, were associated with differences in how framework elements were prioritised and interpreted. These analyses were descriptive in nature and intended to provide contextual insight rather than formal hypothesis testing.

6.3 Results

6.3.1 Study Selection and Publication Characteristics

Of 284 initial records, 14 studies were included in the review: 12 identified through three database searches and 2 through reference tracking. Details of the study selection process and the distribution of the included literature are provided in *Appendix D.3 and E.3 - Figure 13*.

6.3.2 VBP comprehensive framework

The scoping review synthesised the structural elements of VBP models into an integrated framework, with its phase-based structure. This structure captures the interconnections between development phases, organisational capabilities, and required resources, providing a scaffold for sequential decision-making (Figure 8).

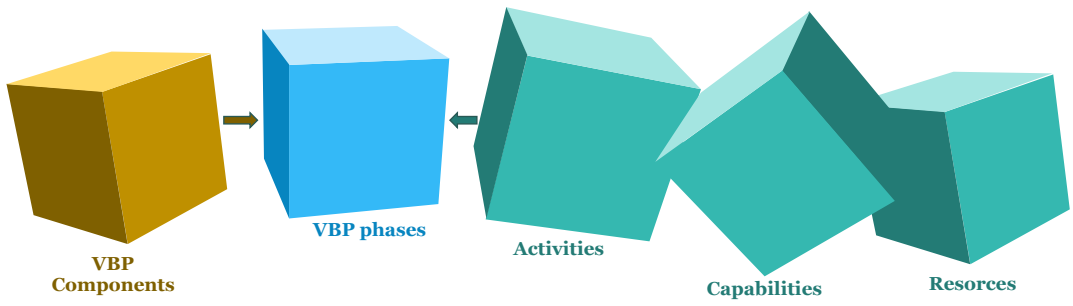


Figure 8 - Phase-based structure of the VBP framework
Note: This figure shows how development phases, organisational capabilities, and resources are aligned to support sequential decision-making

The resulting model identifies six iterative phases intended to support context-specific and operationally feasible VBP strategies (Table 25). The framework distinguishes six phases and organises decisions temporally, from the early definition of value and populations to subsequent testing, learning, and system integration.

Table 25 - Description of the Six Phases in the Development and Implementation of a VBP Model

Phase	Title	Description	#	References
1	Stakeholder Insight and Context Analysis	A structured and empathetic analysis of stakeholder needs and the healthcare context, focusing on early engagement and qualitative insights to understand user perspectives and system limitations.	8	(Cattel et al., 2020; Conrad et al., 2016; Gratale et al., 2022; Halder et al., 2020; Harish et al., 2017; Kannarkat et al., 2023; Leao et al., 2024; Riley et al., 2019)
2	Problem Definition and Value Proposition Clarification	Focuses on clearly defining challenges and opportunities in the payment system, with an emphasis on articulating the value proposition using evidence-based criteria aligned with stakeholder priorities.	11	(Cattel et al., 2020; Conrad et al., 2016; Gratale et al., 2022; Halder et al., 2020; Harish et al., 2017; Hayen et al., 2015; Howard et al., 2024; Kannarkat et al., 2023; Lighter et al., 2023; K. Patel et al., 2016; Shajari Pour Mousavi et al., 2017)
3	Strategic Co-Design and Conceptual Modelling	Involves collaborative co-design with stakeholders to develop VBP solutions, using systems thinking to ensure the model reflects the complexity of healthcare delivery.	4	(Conrad et al., 2016; Harish et al., 2017; Kannarkat et al., 2023; Lighter et al., 2023)
4	Model Structuring and Operational Design	Transforms conceptual models into operational frameworks through prototyping and testing, defining structural and financial components to assess feasibility and coherence prior to implementation.	9	(Cattel et al., 2020; Conrad et al., 2016; Gratale et al., 2022; Halder et al., 2020; Hayen et al., 2015; Howard et al., 2024; Kannarkat et al., 2023; Leao et al., 2024; Nowak, 2016)
5	Pilot Implementation and Performance Assessment	Conducts initial implementation in a controlled setting, with formal performance evaluation using predefined metrics to assess effectiveness, usability, and stakeholder satisfaction, enabling iterative improvements.	9	(Conrad et al., 2016; Gratale et al., 2022; Halder et al., 2020; Howard et al., 2024; Leao et al., 2024; Lighter et al., 2023; Nowak, 2016; K. Patel et al., 2016; Shajari Pour Mousavi et al., 2017)
6	Full-Scale Deployment and System Integration	Represents the transition to full-scale adoption, emphasizing institutional alignment, policy integration, and scalability to ensure sustainable, system-wide transformation.	7	(Cattel et al., 2020; Conrad et al., 2016; Hayen et al., 2015; Howard et al., 2024; Kannarkat et al., 2023; Lighter et al., 2023; Nowak, 2016)

Note: VBP – Value-Based Payment.

6.3.3 Core Components of VBP Models

The review identified a set of core components that shape the structure and priorities of VBP models. Elements most frequently highlighted were related to system organisation and accountability, including care coordination, quality measurement, and payment model alignment (Cattel et al., 2020;

Gratale et al., 2022; Harish et al., 2017). The elements, such as user-centred value, stakeholder engagement, and incentive alignment, appear less explicitly, often treated as implicit design assumptions rather than operational features (Conrad et al., 2016; Harish et al., 2017; Kannarkat et al., 2023). The complete set of components and their distribution are detailed in *Appendix D.6 - Table 50.*

6.3.4 Core Activities in VBP

Core activities that support the development and implementation of VBP models were also identified through the literature review. Activities most frequently highlighted focus on system readiness and diagnostic assessment, including organisational capacity analysis and the definition and operationalisation of quality and performance metrics (Cattel et al., 2020; Conrad et al., 2016; Gratale et al., 2022; Halder et al., 2020; Howard et al., 2024; Kannarkat et al., 2023; Leao et al., 2024; Lighter et al., 2023; Nowak, 2016; K. Patel et al., 2016). Other recurrent activities relate to defining target populations, structuring payment models, delineating care scope, and planning implementation processes (Cattel et al., 2020; Gratale et al., 2022; Harish et al., 2017; Howard et al., 2024; Kannarkat et al., 2023; Lighter et al., 2023; K. Patel et al., 2016). Activities such as risk adjustment, payment-care alignment, and leadership alignment are discussed more selectively across studies (Cattel et al., 2020; Conrad et al., 2016; Howard et al., 2024; Lighter et al., 2023; Shajari Pour Mousavi et al., 2017). The complete set of identified activities and supporting sources is reported in *Appendix D.6 - Table 49.*

6.3.5 Core Capabilities Required

This literature review highlights a set of organisational capabilities that support the development and implementation of VBP models. Capabilities most frequently highlighted relate to strategic leadership, governance, and organisational learning, underscoring the importance of system-level direction and adaptive capacity in payment reform (Conrad et al., 2016; Howard et al., 2024; Leao et al., 2024). Design-oriented capabilities, including the application of design thinking and investigative approaches, also feature prominently, supporting iterative development and problem-solving during implementation (Halder et al., 2020; Shajari Pour Mousavi et al., 2017). Other capabilities, such as stakeholder-aligned strategy, patient-centred care coordination, and patient empowerment, are discussed less consistently across studies but remain relevant to effective engagement and delivery (Harish et al., 2017). The complete set of identified capabilities and supporting sources is reported in *Appendix D.6 - Table 51.*

6.3.6 Resources Required for VBP Models

Through the literature review, it was possible to identify a range of resources that support the development and implementation of VBP models, with a strong emphasis on data and information infrastructure. Health data systems and analytical infrastructure are consistently highlighted as foundational enablers that support performance measurement, monitoring, and accountability mechanisms (Cattel et al., 2020; Howard et al., 2024; Leao et al., 2024; K. Patel et al., 2016). Other frequently referenced resources include clinical decision support technologies, integrated team-based care structures, and value-oriented infrastructure and facilities, which facilitate coordination and adaptation across care pathways (Gratale et al., 2022; Halder et al., 2020; Leao et al., 2024; Shajari Pour Mousavi et al., 2017).

By contrast, several resources critical for implementation sustainability receive limited explicit attention in the literature. These include contracting and payer engagement mechanisms (Gratale et al., 2022), patient support service programmes (K. Patel et al., 2016), evidence and innovation platforms (Shajari Pour Mousavi et al., 2017), and risk adjustment tools and methodologies (K. Patel et al., 2016). The complete set of identified resources and supporting sources is reported in *Appendix E.3 – Table 56*.

6.3.7 Expert Validation of Framework Elements

A total of 46 experts were invited to participate in the survey, of whom 10 completed it (response rate: 21.7%). Figure 9 summarises the composition and participation profile of the expert panel. Participants represented diverse professional backgrounds, including health professors, researchers, healthcare managers, policy advisors, and consultants. Primary areas of interest centred on VBP models, patient outcomes measurement, and health policy, with professional experience ranging from three to over eleven years. Most experts reported direct involvement in implementing VBHC-related initiatives.

Across the validation tasks, a consistent pattern emerged: high conceptual consensus on what constitutes a VBP model and how development phases broadly progress, coexisting with greater operational variability in how activities are allocated to phases and how capabilities and resources are linked. This distinction is visible across confidence and agreement patterns and represents a central empirical result, highlighting potential challenges in translating conceptual alignment into operational design. were consistently selected, accompanied by high confidence levels (mean=88.50%, standard deviation (SD)=10.81%; median=90%; interquartile range (IQR)=17.50%). In addition to predefined elements, qualitative feedback emphasised the importance of a supportive provider ecosystem, robust IT infrastructure, and payment mechanisms aligned with VBHC principles.

Experts showed strong alignment regarding the core components of VBP models. Seventeen components were consistently selected, accompanied by high confidence levels (mean=88.50%, standard deviation (SD)=10.81%; median=90%; interquartile range (IQR)=17.50%). In addition to predefined elements, qualitative feedback emphasised the importance of a supportive provider ecosystem, robust information technology infrastructure, and payment mechanisms aligned with VBHC principles.

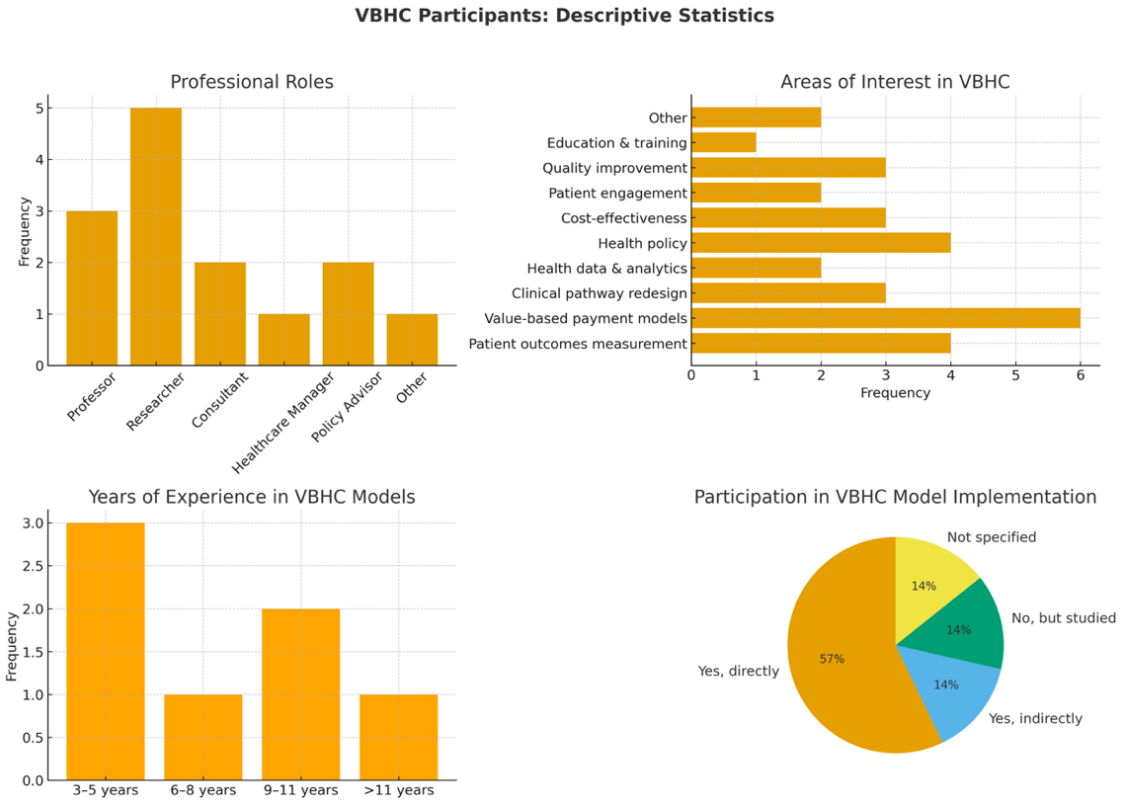


Figure 9 – Expert Profile and Participation Characteristics

Experts noted that payment structures should reflect the actual costs of delivering high-quality care and clearly distinguish between intervention mechanisms and outcome domains such as accountability, patient safety, and patient experience. The full distribution of component selections is reported in *Appendix E.3 – Table 57.*

The scoping review identified the key structural elements of VBP models, including development phases, core components, activities, organisational capabilities, and supporting resources. Organised within a Design Thinking framework, these elements are interconnected across phases. The model distinguishes between enabling resources and capabilities, which support the execution of activities, and VBP components, which define what must be designed and implemented over time to ensure alignment between execution capacity and payment model design. Figure 10 synthesises the framework by linking development phases, priority activities, organisational capabilities, and supporting resources into a single decision-oriented representation.

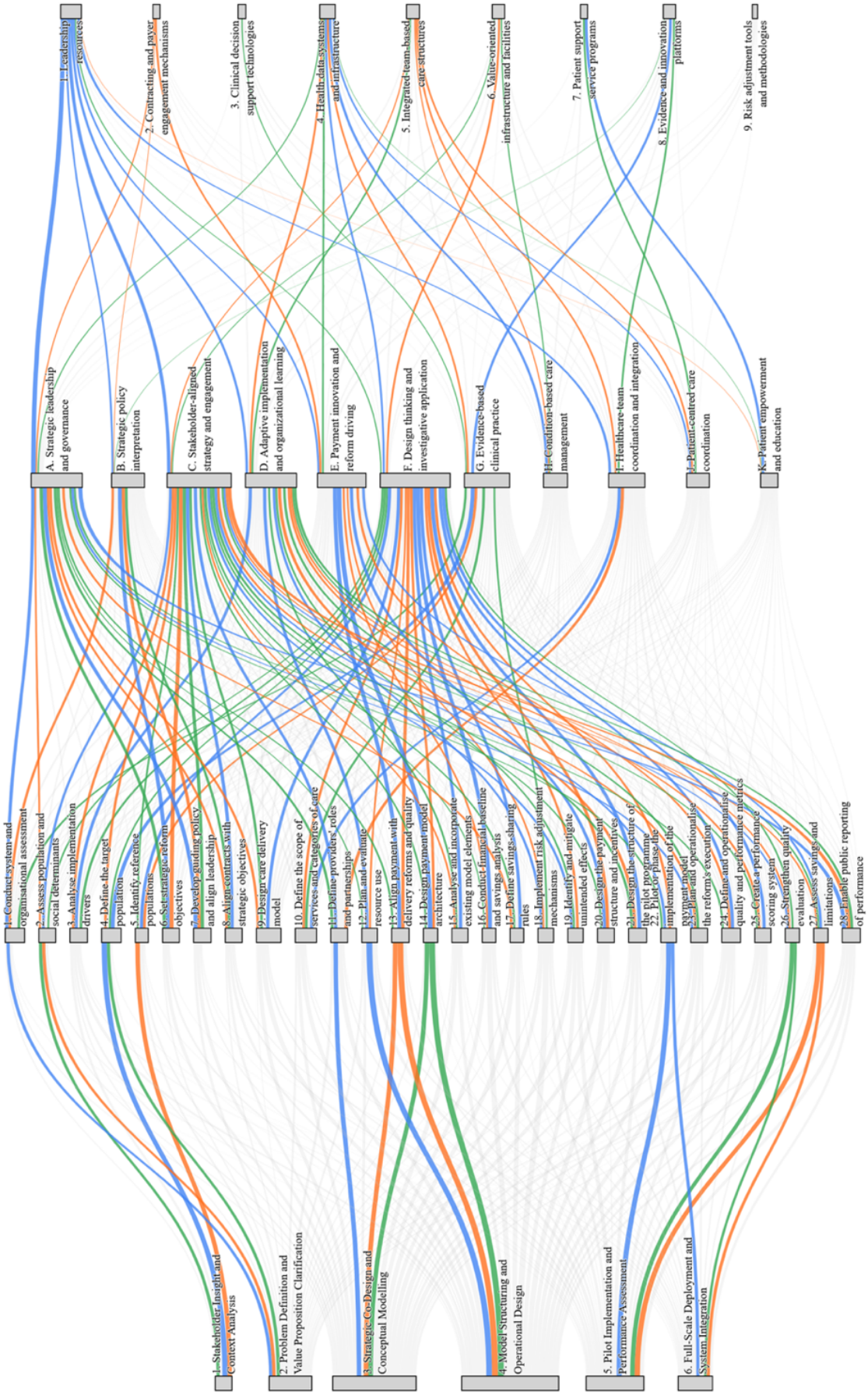


Figure 10 -Phases, activities, capabilities, and resources

The figure illustrates how VBP design emerges from the interaction among these layers, with different configurations becoming prominent at different implementation stages. Early phases are characterised by analytical activities, such as defining target populations and value propositions, supported by data infrastructure and evidence-based practice. Later phases place greater emphasis on governance, learning capabilities, and system integration, supported by leadership resources and contracting mechanisms. Only the most frequently selected linkages are displayed, highlighting dominant patterns and key dependencies rather than exhaustive mappings.

When ordering the framework phases, experts indicated a coherent progression from early analytical stages to full-scale system integration, consistent with the proposed design logic. Phases related to stakeholder insight and problem definition were systematically positioned at the beginning of the sequence. At the same time, pilot testing and system integration were placed later, reflecting an implementation-oriented trajectory. Experts suggested complementary or reinforcing stages, such as post-implementation evaluation, assessment of unintended consequences, or iterative consensus refinement. Confidence in the proposed phase sequencing was high (mean = 88.00%, SD = 12.52%; median = 92.50%; IQR = 21.25%), supporting the robustness of the temporal structure. Detailed ranking results are provided in *Appendix E.3 – Table 58.*

The distribution of activities across phases (detailed in *Appendix E.3 – Figure 14*) indicated a shared understanding of temporal progression, with early phases focused on problem definition and stakeholder analysis, mid-phases on co-design and governance, and later phases on evaluation and learning. Average confidence in phase-activity allocations was moderate (mean=71.11%, SD=21.35%; median=80%; IQR=20%), reflecting broad agreement on direction but flexibility in operationalisation. This combination of shared structure and adaptive variability highlights where policymakers can standardise planning steps and where contextual tailoring is most critical. Open-ended responses underscored the enabling role of IT infrastructure, data analytics, and financial innovation, while cautioning against incentive-driven approaches detached from evidence generation and quality improvement.

Consensus patterns further indicated that specific capabilities play cross-cutting roles across activities, reinforcing the view of VBP as a coordinated change process rather than a sequence of isolated tasks. Detailed mappings of activities to capabilities are reported in *Appendix E.3 – Figure 15*. Across the framework, strategic leadership and governance and adaptive implementation and organisational learning were most frequently linked to coordination, evaluation, and performance assessment, while data-driven analytics and payment innovation featured more prominently in early implementation stages. Evidence-based clinical practice and patient-centred coordination were implemented more selectively, supporting

collaboration and engagement at targeted points. Confidence in activity-capability allocations averaged 71.33% (SD = 21.90%; median = 80%; IQR = 20%).

Associations between capabilities and resources further clarified the enabling structure of VBP implementation. Detailed capability-resource mappings are reported in *Appendix E.3 – Figure 16*. Across the framework, leadership resources and health data systems and infrastructure emerged as cross-cutting enablers. The most substantial alignment was observed between strategic leadership and governance and leadership resources, while health data systems and infrastructure were closely linked to analytical and coordination-oriented capabilities. Confidence in capability-resource allocations averaged 69.43% (SD = 31.71%; median = 75%; IQR = 17.50%). Across survey domains, confidence levels were generally high (median > 75%), indicating strong agreement on conceptual foundations alongside greater caution regarding operational interdependencies. Detailed confidence distributions are reported in *Appendix E.3 – Figure 17.*

Exploratory analyses examined whether expert characteristics influenced how framework elements were prioritised and interpreted. Distinct but complementary perspectives emerged across professional roles, experience levels, and degrees of implementation involvement. Researchers and academics tended to emphasise analytical and equity-related dimensions, while consultants, managers, and policy advisors prioritised care coordination, stakeholder engagement, and governance dynamics. Greater experience and direct involvement in VBP implementation were associated with broader, system-level perspectives encompassing accountability, governance, and later-stage implementation phases. Detailed associations are reported in *Appendix E.3 – Table 59*.

6.4 Discussion

A central finding of this study is the coexistence of strong conceptual consensus on what constitutes VBP and greater operational variability in how its elements are implemented and sequenced. This distinction helps explain why, despite widespread agreement on the principles of value-based reform, VBP initiatives often encounter persistent implementation challenges across health systems.

The framework provides a structured tool for decision-makers to navigate the complexities of VBP design and adoption. By making implementation sequences and critical dependencies, such as data infrastructure, leadership alignment, and incentive structures, explicit, the model enables anticipation of practical challenges. This systematic mapping of requirements and stages enables a more predictable transition from conceptual design to operational integration, supporting a more productive use of organisational, financial, and data resources before full-scale deployment.

Experts demonstrated high consensus around the conceptual foundations of VBP models, such as user-centred value, quality measurement, incentive alignment and payment model alignment, which are recognised as essential for value-based reform (Conrad et al., 2016). The validated six-phase structure reflects this shared understanding by articulating a logical progression for VBP development, aligning with implementation science frameworks that emphasise staged and iterative reform processes (OECD, 2023; Porter & Lee, 2013). Recommendations to incorporate additional evaluative and regulatory-fit phases further underscore the importance of continuous learning and adaptation, as highlighted in the literature on learning health systems (Figueroa et al., 2025; Howard et al., 2024; Leao, Cremers, et al., 2023c).

In contrast, greater variability emerged in the framework's relational and operational layers. While activities were broadly aligned with phases, consensus declined in later stages, such as pilot implementation and performance assessment and full-scale deployment and system integration, where organisational context, data readiness, and stakeholder alignment become critical (de Mattia et al., 2024). This variability does not indicate conceptual weakness; rather, it reflects the context-sensitive nature of operationalising VBP. Organisational capabilities, particularly strategic leadership and governance and adaptive implementation and organisational learning, consistently appeared as cross-cutting enablers, reinforcing evidence that governance capacity and adaptability are prerequisites for sustaining and scaling VBP reforms (de Mattia et al., 2024; OECD, 2023). Similarly, health data systems and infrastructure and leadership capacity emerged as foundational resources, consistent with literature emphasising the role of interoperable data and performance measurement in enabling accountability and improvement (OECD, 2023; Porter & Lee, 2013).

Exploratory analyses further illustrated how professional background, experience, and level of involvement shape priorities and interpretations. These patterns align with broader evidence that stakeholder roles influence how value is defined and pursued (OECD, 2023; Porter & Lee, 2013). Although not statistically inferential, these findings highlight the importance of multi-stakeholder engagement to reconcile conceptual agreement with operational feasibility during VBP design and implementation.

Taken together, the findings indicate that the primary barrier to effective VBP reform is not the absence of incentives, but the misalignment between incentives, organisational capabilities, governance structures, and data infrastructure. The proposed framework addresses this gap by integrating these elements into a coherent, sequenced architecture. It does not prescribe payment levels or incentive formulas, nor does it replace empirical evaluation of impact; instead, it supports structural and sequential decision-making by clarifying what must be in place, and when, for VBP models to function as intended.

For policymakers and healthcare leaders, the framework offers a practical tool to support planning, capacity-building, and governance alignment. In particular, the findings suggest that investments in leadership development, adaptive learning capacity, and robust data systems are as critical as the design of financial incentives themselves for achieving sustainable value-based reform.

The findings also highlight common sequencing pitfalls that undermine the productivity gains from VBP reforms. Introducing financial incentives before data infrastructure is in place, scaling payment models without organisational readiness, or redesigning contracts in the absence of clinical and managerial buy-in can increase administrative burden without improving performance. Evidence shows that the complexity of VBP schemes and lack of organisational experience are inhibitors to practical implementation, as models demand extensive infrastructure, coordination, and stakeholder engagement (Leao, Cremers, et al., 2023b). Moreover, aligning payment reform with organisational capacity and readiness, including governance, data systems, and workforce support, is critical to avoid implementation failure and ensure productive use of resources (Leao et al., 2024). By making such dependencies explicit, the framework helps policymakers anticipate implementation risks and align reform timing with system capacity.

Overall, these exploratory findings indicate that the framework is interpreted through the lens of professional experience and role, reinforcing its flexibility while underscoring the importance of multidisciplinary perspectives. Rather than signalling disagreement, this variation reflects complementary viewpoints that enhance the framework's relevance across diverse decision-making contexts. Viewed collectively, the results show that while the literature provides fragmented guidance on individual elements of VBP design, the validated framework integrates phases, components, activities, capabilities, and resources into a coherent, decision-oriented sequence. The scoping review revealed uneven emphasis across these elements, with greater attention to structural and measurement-related aspects than to engagement and incentive design; however, expert validation confirmed strong consensus on conceptual foundations and overall sequencing alongside variability in operational alignment. This pattern suggests that implementation challenges are less about defining "what" VBP is, and more about coordinating "how" and "when" key elements are activated across system levels. By integrating these insights, the framework clarifies critical dependencies between strategic decisions, organisational readiness, and enabling infrastructure, supporting more informed and coordinated transitions from design to system-wide deployment.

An important implication of the framework concerns its transferability across different health system contexts. While payment instruments, governance arrangements, and institutional constraints

vary across countries, the framework focuses on elements that are largely context-invariant, including the sequencing of decisions, the alignment between incentives and organisational capabilities, and the role of data and governance readiness (P. C. Smith et al., 2023). Rather than prescribing uniform payment models, it supports structured decision-making adaptable to diverse institutional settings. In more centralised systems, the framework may inform system-wide reform planning, whereas in more fragmented systems, it can support coordination across payers, providers, and regulatory levels. Evidence from global scoping reviews indicates that the implementation of VBHC initiatives varies considerably across health systems worldwide, reinforcing the need for adaptation and sequencing strategies that are sensitive to context (Douglas et al., 2025). By emphasising readiness and sequencing, the framework enhances its relevance to international policy debates on productivity and sustainability in health care.

Beyond informing payment reform, this framework highlights how governance, data infrastructure, and organisational learning interact to shape the productive use of health system resources. By clarifying these relationships, it offers policymakers practical guidance for improving system performance and long-term sustainability (Lindner & Lorenzoni, 2023; P. C. Smith et al., 2023).

6.5 Conclusion

Overall, the validated framework offers a practical tool to support policymakers and healthcare leaders in the design, implementation, and refinement of VBP reforms. By structuring VBP development across sequential phases and explicitly linking activities, organisational capabilities, and enabling resources, the framework supports more informed decision-making, clarifies implementation preconditions, and helps avoid reforms driven primarily by financial incentives rather than system readiness and quality improvement goals.

Several limitations warrant consideration. The scoping review may have been influenced by heterogeneity in terminology and conceptual approaches to VBP, which could have shaped the evidence base used to construct the framework. Although the expert panel was intentionally multidisciplinary, its composition and size limit statistical representativeness, reflecting the study's focus on conceptual and practical validation rather than generalisation. Variation in how experts interpreted questionnaire items may also have contributed to response heterogeneity.

Nonetheless, the high levels of convergence and confidence observed among experts strengthen the credibility of the framework as a decision-support tool. Future research should involve broader, more heterogeneous expert participation and triangulation with empirical case studies to assess applicability across contexts further and enhance its contribution to evidence-informed payment reform.

In doing so, the framework supports broader policy efforts to strengthen health system performance and financial sustainability, contributing to ongoing debates on how to improve productivity in publicly oriented health systems without compromising care quality or equity.

7

Conclusion

Health systems worldwide face mounting pressure to improve outcomes while operating under persistent financial and organisational constraints. VBHC has emerged as a central paradigm in addressing this challenge, promising to align health system performance with outcomes that matter to patients. However, despite its normative appeal and growing policy visibility, the implementation of VBHC, and particularly of VBP, has remained conceptually fragmented and operationally inconsistent.

This thesis began from the recognition that the existing literature often treats core elements of value-based reform in isolation. Outcome measurement, patient-reported metrics, information systems, organisational readiness, and payment design are frequently analysed as separate domains. Payment reforms are commonly discussed as discrete instruments, yet insufficient attention is paid to the structural and sequential conditions required for their effective adoption. As a result, policymakers and healthcare organisations face uncertainty when attempting to transition from volume-based to value-based financing models.

The central contribution of this thesis lies in addressing this fragmentation by developing an integrated, multilayered architecture for value-based reform, particularly within hospital payment systems. Rather than asking whether value-based approaches can improve performance, the thesis focuses on how they can be coherently structured, sequenced, and operationalised within complex health systems. Across five interrelated studies, it advances conceptual integration, methodological innovation, and practical guidance for implementing VBP in a manner consistent with sustainability, equity, and multidimensional value creation.

Collectively, the articles construct a progressive pathway: from diagnosing systemic fragmentation (umbrella review), to identifying informational enablers (scoping review), to operationalising value measurement (MCDA framework), to structuring organisational readiness (VBPCMM), and finally to sequencing reform through a validated decision-support framework. The umbrella review consolidates global evidence on VBHC implementation, identifying both its transformative potential and its structural barriers. These include fragmented value metrics, weak integration of PROMs and PREMs, organisational

resistance, insufficient digital infrastructure, and inconsistencies in performance evaluation. The findings reveal that payment reform alone cannot drive value transformation without complementary investments in measurement systems and institutional readiness.

Building on this system-level diagnosis, the scoping review on health information systems highlights the foundational role of data infrastructure in enabling VBHC initiatives. I and analytical capabilities emerge not merely as technical tools but as institutional enablers of accountability, transparency, and performance monitoring. The analysis further suggests that many health systems remain in early stages of VBHC adoption, with limited evidence of structured follow-up and continuous improvement processes.

The multiple-criteria VAF deepens this architecture by operationalising multidimensional value measurement. By incorporating stakeholder perspectives and structured aggregation methodologies, the framework addresses a critical gap in the literature: the absence of explicit and adaptable mechanisms for defining and quantifying value at the organisational level. In doing so, it moves beyond abstract conceptualisations of value and provides a structured approach to reconciling competing priorities across stakeholders.

While the CMM structures internal organisational progression, the decision-support framework situates these capabilities within a broader reform sequence, linking organisational readiness to payment model design and policy implementation. Rather than assuming immediate system capacity for complex VBP implementation, the model recognises staged development across strategic, clinical, operational, and patient-centred domains. This contribution foregrounds sequencing as a missing theoretical and practical dimension in the VBP literature.

Finally, the decision-support framework integrates these elements into a coherent reform trajectory. By structuring VBP development into sequential phases and explicitly linking activities, capabilities, and enabling resources, it provides a practical roadmap for policymakers and healthcare leaders. The framework shifts attention from isolated financial instruments to coordinated structural transformation grounded in measurable outcomes, organisational capability assessment, and phased incentive alignment.

Taken together, the thesis advances the literature in three overarching ways. First, it offers conceptual integration across fragmented disciplinary domains, connecting health economics, management, information systems, and policy analysis into a unified implementation model. Second, it reconceptualises value in payment reform as inherently multidimensional, incorporating clinical outcomes, patient-reported experiences, organisational sustainability, and stakeholder priorities. Third, it

introduces sequencing and capability development as central determinants of reform success, thereby moving beyond instrument-focused debates toward system-level transformation logic.

The policy implications of these findings are substantial. For policymakers, the evidence suggests that VBP reforms should not be introduced as isolated financial mechanisms. Instead, payment redesign must be embedded within a broader institutional strategy that prioritises outcome measurement, data interoperability, organisational readiness, and stakeholder engagement. Premature introduction of complex payment models without adequate capability development may generate unintended distortions and undermine reform objectives.

Moreover, the multidimensional conceptualisation of value advanced in this thesis underscores the importance of integrating PROMs, PREMs, and stakeholder-defined criteria into financing decisions. Payment systems that narrowly prioritise cost containment risk weakening the broader value agenda and may fail to produce sustainable productivity gains. Structured sequencing, combined with capability assessment, can reduce implementation uncertainty and support more adaptive, context-sensitive reform pathways.

Despite these contributions, several limitations should be acknowledged. Much of the thesis adopts conceptual and synthesis-oriented approaches, reflecting both the novelty and fragmentation of the VBHC field. While empirical validation was incorporated through case application and expert consultation, longitudinal and multi-institutional testing of the MCDA framework, CMM, and sequencing model would strengthen external validity. The heterogeneity of terminology within the VBHC and VBP literature also poses challenges for comprehensive synthesis and conceptual precision. Furthermore, data availability and variability in digital maturity across health systems may constrain the immediate scalability of certain framework components. The ambition to develop broadly applicable models necessarily required a degree of abstraction, which may limit contextual specificity in some institutional settings.

Future research should therefore prioritise empirical validation and longitudinal testing of the proposed frameworks across diverse health system environments. Advancing standardised multidimensional metrics that integrate clinical, financial, and patient-reported outcomes remains a key priority, particularly in conjunction with improved digital infrastructure and real-time analytics. Further investigation into organisational behaviour, leadership models, and cultural determinants of capability progression would deepen understanding of readiness dynamics. Finally, continued exploration of participatory and multi-criteria approaches to value definition may enhance the legitimacy and sustainability of value-based financing reforms.

In conclusion, this thesis demonstrates that improving health system productivity through VBP is not merely a matter of redesigning financial incentives. It requires coordinated structural transformation that links measurement, organisational capability, stakeholder alignment, and phased implementation. By moving from fragmented analyses toward an integrated reform architecture, the thesis contributes to a more coherent and operational understanding of how value-based transformation can be institutionalised in publicly oriented health systems. This directly responds to the central research question of how hospital payment models can be designed and operationalised to align financial incentives with multidimensional value under real-world constraints.

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Appendices

A. Appendix to Chapter 2

A.1. Definitions of Value-Based Healthcare-Related Concepts

Table 26 – Primary concepts that define value-based mechanisms in healthcare

Primary concepts	***Definition***
Value Assessment Frameworks	They are tools that measure and communicate the value of health technologies in decision-making. They consider factors like cost-effectiveness, equity, and ethics to evaluate new technologies, aiming to improve healthcare decisions through comprehensive assessments of their impact and value (M. Zhang et al., 2022).
Value-Based Insurance Design	It is a healthcare model that aims to improve health outcomes and control costs by promoting high-value care. It reduces out-of-pocket expenses for highly effective treatments and medications, encouraging adherence while helping to manage overall healthcare costs (Chambers et al., 2014; Krack, 2019; Tang et al., 2014).
Value-Based Integrated Care	It is an approach that improves patient outcomes and experiences while optimising care costs. It emphasises accessible, comprehensive, and coordinated services delivered through multidisciplinary teams. Value-Based Integrated Care aims to align the financial resources spent with the value achieved in healthcare delivery (van Hoorn et al., 2024).
Value-Based Payment	In healthcare is a payment model that improves health outcomes while managing costs. It combines base payments with quality incentives, linking payment to the value of care. Value-Based Payment seeks to enhance care quality and efficiency, but evidence of its effectiveness is mixed (Leao, Cremers, van Veghel, Pavlova, & Groot, 2023; Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023b; Leao, Pavlova, & Groot, 2023).
Value-Based Pricing	It is an economic strategy that determines the price of a good or service based on the perceived value it provides to customers. In healthcare, Value-Based Pricing aims to optimise drug prices by aligning costs with patients' benefits and the treatment's overall value. However, there is no unanimous agreement on the specific value elements or pricing methods that should be used in Value-Based Pricing (Prieto-Pinto et al., 2020; Takami et al., 2023).
Value-Based Procurement	It is an emerging approach to buying medical devices that prioritises not just cost but also quality and patient outcomes, aiming for greater efficiency in healthcare. However, the definition of Value-Based Procurement for medical devices remains somewhat unclear (Rahmani et al., 2021).
Value-Based Purchasing	It is a program that aims to improve healthcare quality and reduce costs by linking provider payments to performance metrics rather than service volume. Reimbursements are adjusted based on patient outcomes and care quality, encouraging providers to enhance efficiency and focus on patient-centred care through performance-based rewards and penalties (Hong et al., 2020)

Primary concepts	*Definition*
Value-Based Reimbursement	It is a payment model that ties reimbursement to the value of a treatment instead of just its cost. As orphan drug development increases, Value-Based Reimbursement aims to ensure sustainable funding by aligning payments with treatment effectiveness and patient outcomes (Paulden et al., 2015).

A.2. Electronic Database Search Strategy and Results

Table 27 – List of Keywords Used in the Umbrella Review

Component 1	Component 2
"Value based"	"Review*"
"Value based care"	"meta-analysis"
"Value based health care"	"overview"
"Value based healthcare"	"State of the-art"
"Value driven"	"synthesis"
"Value health care"	
"Value healthcare"	
"Value-based"	
"Value-based care"	
"Value-based health care"	
"Value-based healthcare"	
"VBHC"	
"Value base management"	
"Value base medicine"	
"Value base payment"	
"Value base reimbursement"	
"Value base financing"	
"Value base model"	
"Value base program"	
"Value base programme"	
"Value-based management"	
"Value-based medicine"	
"Value-based payment"	
"Value-based reimbursement"	
"Value-based financing"	
"Value-based model"	
"Value-based program"	
"Value-based programme"	
"Value-based initiative"	

Component 1	Component 2
"Value based initiative"	

Table 28 – Search Strings and Databases Results for the Umbrella Review

Database: Pubmed			
Steps	Search terms	Filters	Number of results
#1	"value based"[Title] OR "value based care"[Title] OR "value based health care"[Title] OR "value based healthcare"[Title] OR "value driven"[Title] OR "value health care"[Title] OR "value healthcare"[Title] OR "value-based"[Title] OR "value-based care"[Title] OR "value-based health care"[Title] OR "value-based healthcare"[Title] OR "VBHC"[Title] OR "value base management"[Title] OR "value base medicine"[Title] OR "value base payment"[Title] OR "value base reimbursement"[Title] OR "value base financing"[Title] OR "value base model"[Title] OR "value base program"[Title] OR "value base programme"[Title] OR "value-based management"[Title] OR "value-based medicine"[Title] OR "value-based payment"[Title] OR "value-based reimbursement"[Title] OR "value-based financing"[Title] OR "value-based model"[Title] OR "value-based program"[Title] OR "value-based programme"[Title] OR "value-based initiative"[Title] OR "value based initiative"[Title]	No Filters	2.648
#2	"Review*"[Title] OR "meta-analysis"[Title] OR "overview"[Title] OR "state of the-art"[Title] OR "synthesis"[Title]	No Filters	1.273.685
#3	#1 AND #2	From 2006-2024 English, Portuguese	**68**
Database: Web of Science			
Steps	Search terms	Filters	Number of results
#1	"value based" OR "value based care" OR "value based health care" OR "value based healthcare" OR "value driven" OR "value health care" OR "value healthcare" OR "value-based" OR "value-based care" OR "value-based health care" OR "value-based healthcare" OR "VBHC" OR "value base management" OR "value base medicine" OR "value base payment" OR "value base reimbursement" OR "value base financing" OR "value base model" OR "value base program" OR "value base programme" OR "value-based management" OR "value-based medicine" OR "value-based payment" OR "value-based reimbursement" OR "value-based financing" OR "value-based model" OR "value-based program" OR "value-based programme" OR "value-based initiative" OR "value based initiative" (Title)	No Filters	4.795
#2	"Review*" OR "meta-analysis" OR "overview" OR "state of the-art" OR "synthesis" (Title)	No Filters	2.643.067

#3	#1 AND #2	From 2006-2024 English, Portuguese	**98**
Database: Scopus			
Steps	Search terms	Filters	Number of results
#1	TITLE (“value based” OR “value based care” OR “value based health care” OR “value based healthcare” OR “value driven” OR “value health care” OR “value healthcare” OR “value-based” OR “value-based care” OR “value-based health care” OR “value-based healthcare” OR “VBHC” OR “value base management” OR “value base medicine” OR “value base payment” OR “value base reimbursement” OR “value base financing” OR “value base model” OR “value base program” OR “value base programme” OR “value-based management” OR “value-based medicine” OR “value-based payment” OR “value-based reimbursement” OR “value-based financing” OR “value-based model” OR “value-based program” OR “value-based programme” OR “value-based initiative” OR “value based initiative”)	No Filters	6.686
#2	TITLE (“Review*” OR “meta-analysis” OR “overview” OR “state of the-art” OR “synthesis”)	No Filters	2.869.345
#3	#1 AND #2	From 2006-2024 English, Portuguese	**108**
Database: EBSCO			
Steps	Search terms	Filters	Number of results
#1	TI (“value based” OR “value based care” OR “value based health care” OR “value based healthcare” OR “value driven” OR “value health care” OR “value healthcare” OR “value-based” OR “value-based care” OR “value-based health care” OR “value-based healthcare” OR “VBHC” OR “value base management” OR “value base medicine” OR “value base payment” OR “value base reimbursement” OR “value base financing” OR “value base model” OR “value base program” OR “value base programme” OR “value-based management” OR “value-based medicine” OR “value-based payment” OR “value-based reimbursement” OR “value-based financing” OR “value-based model” OR “value-based program” OR “value-based programme” OR “value-based initiative” OR “value based initiative”)	No Filters	2142
#2	TI (“Review*” OR “meta-analysis” OR “overview” OR “state of the-art” OR “synthesis”)	No Filters	1730511
#3	#1 AND #2	From 2006-2024 English, Portuguese	**44**

A.3. PRISMA 2020 Checklist

Table 29 – PRISMA (2020) checklist used to assess reporting compliance

Section and Topic	#	Checklist item	Section Reported
TITLE			
Title	1	Identify the report as a systematic review.	2.1 Introduction
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	1.4 Methodological Approach
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	2.1 Introduction
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	2.2.2 Study Design
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	2.2.3 Literature search
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	2.2.3 Literature search
Search strategy	7	Present the full search strategies for all databases, registers, and websites, including any filters and limits used.	2.2.3 Literature search and Appendix A.2.
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	2.2.4 Eligibility criteria
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	2.2.5 Study Selection
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	2.2.6 Data Extraction
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	-
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each	2.2.6 Data Extraction

Section and Topic	#	Checklist item	Section Reported
		study and whether they worked independently, and if applicable, details of automation tools used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	-
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	2.2.4 Eligibility criteria
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	2.2.6 Data Extraction
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	2.2.6 Data Extraction
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	2.2.6 Data Extraction
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	-
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	-
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	-
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	2.3 Results
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	2.3 Results
Study characteristics	17	Cite each included study and present its characteristics.	2.3 Results
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	-
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	2.3 Results and Appendix A.4
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Appendix A.4

Section and Topic	#	Checklist item	Section Reported
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	2.3 Results
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	2.3 Results
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	2.3 Results
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	-
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	-
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	33-39
	23b	Discuss any limitations of the evidence included in the review.	2.6 Limitation
	23c	Discuss any limitations of the review processes used.	2.6 Limitation
	23d	Discuss implications of the results for practice, policy, and future research.	2.5 Future research
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	-
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	-
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	-
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	ii
Competing interests	26	Declare any competing interests of review authors.	-
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Appendix A

A.4. Data Extraction Table

Table 30 – Summary of Extracted Data for the Umbrella Review

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
(Abdalla et al., 2022)	2022	Hight	Systematic Review	Multiple countries	Observational Studies Experimental Studies Qualitative Studies Quantitative Studies Mixed Methods Studies	37	2B. Metrics	Medical conditions or specialities	Identification of practices	Framework-Based Analysis	Quality measures were categorized into seven themes: survival, quality of life, time to recovery, treatment process disutility, sustainability of health, long-term therapy consequences, and process measures.
(Abubakar et al., 2024)	2024	Hight	Scoping Review	Indonesia	Empirical Studies Non-Empirical Studies	12	1. Implementation	Medical conditions or specialities	Impact of practices	Framework-Based Analysis	The positive impact of VBHC in ophthalmology, reduced healthcare costs, and partial implementation of VBHC were

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											each identified twice.
(Silveira Bianchi m et al., 2023)	2023	Hight	Scoping Review	UK	Observational Studies Experimental Studies Qualitative Studies Quantitative Studies Mixed Methods Studies	43	1. Implementation	Medical conditions or specialities	Identification of practices Description of practices Impact of practices	Structured Data Extraction	PROM implementation is influenced by digital, patient-related, staff, and organizational factors, enhancing communication and symptom awareness while positively impacting health outcomes and clinician efficiency. However, evidence for use in multiple comorbidities, transferability, and cost-effectiveness remains limited, with large-scale studies needed to

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											realize PROMs' full potential in VBHC
(Cattel & Eijkenaar, 2020)	2020	Moderate	Systematic Review	The Netherlands	NR	111	3. Payment	Healthcare system(s) or Healthcare organisation (s)	Description of models Impact of models	Structured Data Extraction	VBP initiatives, though varied in design and payment structures, commonly feature global base payments, explicit quality incentives tied to clinical and patient outcomes, and primary care focus with risk adjustments, leading to lower costs and improved quality
(Chambers et al., 2014)	2014	Moderate	Mixed Methods	The US	Experimental Studies	32	4B. Savings Practices	Medical conditions or specialities	Impact of effects	Framework-Based Analysis	The study found that shifting patients to more effective treatments could significantly reduce adverse

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											outcomes and healthcare costs, with VBID eliminating co-pays for top treatments, leading to improved outcomes and substantial cost savings, primarily from preventing severe complications.
(de Vasconcelos Silva et al., 2022)	2022	Moderate	Systematic Review	Brazil	NR	8	1. Implementation	Medical conditions or specialities	Identification of practices Description of practices	Thematic Mapping	The studies highlight a focus on costs (34%), outcomes (24%), and the VBHC agenda (24%), identifying gaps in fully developed value-based care models for cancer patients and challenges with adherence to the value agenda,

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											while emphasizing the need for structural changes, practical implementation, and contributions to designing value-based care services through synthesizing current practices and key premises.
(DeBaun et al., 2019)	2019	Moderate	Systematic Review	The US	NR	3	2B. Metrics	Medical conditions or specialities	Description of practices	Framework-Based Analysis	Out of 189 quality measures aligned with the Donabedian framework, 7% address structure, 52% focus on processes, and 41% on outcomes, with 12 identified as

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											candidate quality measures.
(Eijsink et al., 2023)	2023	Hight	Scoping Review	The Netherlands	NR	20	1. Implementation	Medical conditions or specialities	Description of practices Impact of practices	Structured Data Extraction	Implementation improved adherence, reduced costs, and enhanced patient experiences with PROMs integration, while challenges included a disconnect between PROMs/PREMs development and hospital implementation, as well as the need for VBHC process improvements, with both aspects being identified eight times.

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
(Etges et al., 2020)	2020	Hight	Systematic Review	Multiple countries	NR	26	4A. Cost Analysis	Medical conditions or specialities	Impact of practices	Structured Data Extraction	TDABC improves cost accuracy, transparency, and resource allocation in healthcare, facilitating the transition to value-based systems and enhancing overall value through better cost management.
(Fernández-Salido et al., 2024)	2024	Hight	Scoping Review	Multiple countries	Qualitative Studies Mixed Methods Studies	12	1. Implementation	Healthcare system(s) or Healthcare organisation (s)	Identification of practices Description of practices Impact of practice	Framework-Based Analysis	The concept of VBHC is consistently defined by emphasizing patient-centred care. Key elements for implementation include leadership, patient involvement, organizational

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											structure, standardization and data, and adequate resources. The outcomes of implementation highlight quality improvement, efficiency and sustainability, increased job satisfaction among staff due to more structured care processes, enhanced collaboration, and improved data quality, with all these aspects being identified ten times.
(He et al., 2023)	2023	Hight	Scoping Review	Multiple countries	Empirical Studies Non-Empirical Studies	48	2A. Evaluation	Healthcare system(s) or Healthcare	Impact of practices	Structured Data Extraction	Most studies demonstrated positive effects of VBHC on

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
								organisation (s)			performance, including improvements in quality, cost savings, and decision-making, although five studies reported neutral or negative outcomes, with these findings identified eleven times.
(Hong et al., 2020)	2020	Hight	Systematic Review	The US	Observational Studies	33	2A. Evaluation	Healthcare system(s) or Healthcare organisation (s)	Impact of practices	Framework-Based Analysis	The Hospital VBPu program has minimal impact on quality, outcomes, and costs, with slight benefits for patient experience and pneumonia mortality, but it negatively affects safety-net hospitals and

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											yields mixed results depending on hospital characteristics and location
(van Hoorn et al., 2024)	2024	Hight	Systematic Review	The Netherlands	Observational Studies Experimental Studies Qualitative Studies Quantitative Studies Empirical Studies Non-Empirical Studies	24	7A. Value Models	Healthcare system(s) or Healthcare organisation (s)	Identification of characteristics Description of Organizational Models Impact of Organizational Models	Framework-Based Analysis	Only one article explicitly defined VBIC. Twelve studies detailed integrated care interventions across multiple levels, showing positive impacts on at least one outcome. Qualitative analysis highlighted improved collaboration, follow-ups, and care accessibility. Key facilitators included supportive IT, payment models, and leadership,

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											while barriers involved IT limitations, payment challenges, and cultural resistance.
(Indrakanti et al., 2012)	2021	Hight	Systematic Review	The US	NR	27	4A. Cost Analysis	Medical conditions or specialities	Description of practices	Structured Data Extraction	Operative interventions generally show better cost-effectiveness than nonoperative care for spinal disorders, but limited literature, diversity in diagnoses, and inconsistent methods highlight the need for future research with uniform cost-utility assessments and well-defined pathology cohorts.

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
(Khoo et al., 2024)	2023	Moderate	Scoping Review	Multiple countries	NR	30	2A. Evaluation	Medical conditions or specialities	Identification of practices Description of practices	Framework-Based Analysis	Outcome measures, including clinical and patient-reported metrics, along with process measures focused on elderly care and quality indicators like Assessing Care for Vulnerable Elders and Resident-sensitive Quality Measures, are essential for performance management, emphasizing physician-level performance and documentation accuracy.
(Kidane mariam	2023	Hight	Scoping Review	The Netherlan ds	Observational Studies	39	7A. Value Models	Healthcare system(s) or Healthcare	Description of Organizational Models	Structured Data Extraction	Evidence on VBHC and patient-centred

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
et al., 2023)					Experimental Studies Qualitative Studies Quantitative Studies Mixed Methods Studies			organisation (s)			care is limited, with most research focusing on quality measures from the perspectives of providers, institutions, and payers rather than patients.
(Krack, 2019)	2019	Hight	Mixed Methods	Germany	Observational Studies Experimental Studies	13	4B. Savings Practices	Healthcare system(s) or Healthcare organisation (s)	Impact of effects	Cochrane Meta-Analysis	VBID programs improved medication adherence, with full coverage having a stronger impact than partial coverage, while educational interventions further enhanced effectiveness, though not always significantly. VBID's effects on adherence remained robust

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											across various scenarios and populations, with these findings identified seventeen times.
(Leao, Cremers, van Veghel, Pavlova, Hafkamp, et al., 2023b)	2023	Hight	Systematic Review	The Netherlands	Qualitative Studies Quantitative Studies Mixed Methods Studies	143	3. Payment	Healthcare system(s) or Healthcare organisation (s)	Identification of characteristics	Structured Data Extraction	Barriers to VBHC span design and development challenges like funding and inadequate outcome measures, implementation issues such as resource constraints and provider opportunism, and applicability concerns including poor care coordination, staff workload, and limited care networks.

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
(Leao, Cremers, et al., 2023a)	2023	Hight	Systematic Review	The Netherlands	Qualitative Studies Quantitative Studies Mixed Methods Studies	166	3. Payment	Healthcare system(s) or Healthcare organisation (s)	Description of models Impact of models	Cross-Tabulated and Framework Analysis	VBP models yield positive effects but can negatively impact organization-reported outcomes, as provider exclusion reduces ownership and motivation; success depends on well-designed incentives and quality measures, with noticeable variability in Pay-for-Performance and shared savings models, while complexity and inexperience hinder implementation by necessitating behavioural, process, and infrastructure changes.

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
(Leusder et al., 2022)	2022	Moderate	Systematic Review	The Netherlands	NR	264	4A. Cost Analysis	Healthcare system(s) or Healthcare organisation (s)	Description of practices	Structured Data Extraction	Cost information is essential for enabling VBHC, with TDABC being the most effective costing method, though its success depends on implementation, while partial care costing, despite its accuracy, is limited for decision-making, highlighting the need to focus on full care cycles and comprehensive cost consideration.
(Marino & Capone, 2024)	2024	Hight	Scoping Review	Italy	Observational Studies Qualitative Studies	14	7A. Value Models	Healthcare system(s) or Healthcare organisation (s)	Description of Organizational Models	Structured Data Extraction	Value co-creation in healthcare relies on the interdependence between organizations and

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
					Quantitative Studies Others						patients, emphasizing collaboration, communication, and active participation to enhance outcomes, patient satisfaction, and well-being in both clinical encounters and preventive health services.
(Miracolo et al., 2021)	2021	Moderate	Scoping Review	UK	NR	198	7B. Frameworks	Medical conditions or specialities	Development of structure Description of structure	Structured Data Extraction	Seven major categories of predictive tools were identified, using techniques from logistic regression to advanced machine learning models, with performance measured by Area Under the Curve-Receiver

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											Operating Characteristic curves. These tools focus on clinical decision-making, particularly in oncology and cardiovascular diseases, to improve surgical outcomes and patient survival.
(Moreira & Crispim, 2023)	2023	Moderate	Systematic Review	Portugal	NR	5	3. Payment	Medical conditions or specialities	Identification of characteristics	Structured Data Extraction	Radiology has 56 Key Performance Indicators organized into seven categories: service accessibility, exam prescription adequacy, exam process, report, results, safety, and contribution to the institution.

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
(G. Parker et al., 2022)	2022	Moderate	Scoping Review	Canada	Qualitative Studies Mixed Methods Studies Empirical Studies	48	5. Low-Value Care	Healthcare practice	Identification of strategies Description of strategies Impact of strategies	Framework-Based Analysis	Ten studies demonstrated effectiveness in reducing low-value care, utilizing determinant frameworks, classic theories, and implementation theories to identify key factors and guide data analysis and implementation, particularly in addressing inappropriate antibiotic use, medications, and imaging practices.
(Paulden et al., 2015)	2015	Hight	Scoping Review	Canada	Empirical Studies Others	43	7B. Frameworks	Medical conditions or specialities	Development of structure	Structured Data Extraction	The study identified 19 decision factors, categorized as value-bearing or

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											cost-determining, with diverse stakeholder preferences influenced by rescue rules, equity, and rights, while critiquing existing frameworks for double-counting and cost mismanagement and proposing a new framework to separate costs from benefits for greater transparency and societal alignment.
(Prieto-Pinto et al., 2020)	2020	Hight	Systematic Review	Colombia	NR	56	4B. Savings Practices	Healthcare system(s) or Healthcare organisation (s)	Description of practices	Structured Data Extraction	Therapeutic value and pricing frameworks globally focus on aligning costs with clinical and economic

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											benefits through health technology assessments, with variations in implementation influenced by local priorities, value perceptions, and economic strategies, including cost-effectiveness, negotiated pricing, and budgetary considerations.
(Rahmani et al., 2021)	2021	Moderate	Scoping Review	Iran	Experimental Studies Quantitative Studies Review Studies and Reports Empirical Studies Others	24	4B. Savings Practices	Healthcare Technologies	Description of practices	Structured Data Extraction	VBPc emphasizes comprehensive evaluation of patient outcomes and economic methods, requiring reliable data, stakeholder collaboration, multidisciplinary efforts, and a

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											focus on total cost, functionality, and value-driven decision-making.
(Reitblat et al., 2021)	2021	Moderate	Systematic Review	The US	Observational Studies Experimental Studies	22	1. Implementation	Medical conditions or specialities	Impact of practices	Structured Data Extraction	Early findings from initial studies indicate promising results, including improved guideline adherence and reduced unnecessary procedures in multidisciplinary clinics, enhanced surgical outcomes, significant cost reductions (69%) with activity-based costing, and mixed outcomes for centralized care integration, with

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											evidence quality assessed using Grading of Recommendations, Assessment, Development, and Evaluations ratings for VBHC.
(Renee Rutter & Park, 2020)	2020	Moderate	Systematic Review	The US	NR	12	2A. Evaluation	Healthcare system(s) or Healthcare organisation (s)	Identification of practices	Structured Data Extraction	Hospital characteristics (size, safety-net status, location, teaching status) and external factors, including patient populations, socioeconomic status, and acuity levels, significantly influence value-based program performance and financial penalties.

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
(Tang et al., 2014)	2023	Moderate	Systematic Review	Japan	NR	8	4B. Savings Practices	Healthcare system(s) or Healthcare organisation (s)	Description of practices	Structured Data Extraction	Drug pricing assessments utilize diverse methods, including cost-effectiveness analysis that integrates costs, Quality-Adjusted Life Years, productivity, and disease factors, alongside alternative approaches focusing on efficacy, rarity, unmet needs, and broader value elements quantified through various methodologies.
[31]	2014	Hight	Systematic Review	Canada	Experimental Studies	10	4B. Savings Practices	Medical conditions or specialities	Impact of effects	Structured Data Extraction	VBID is a healthcare approach aimed at improving medication

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											adherence, which has shown a positive impact on patient adherence; however, the broader effects on clinical outcomes, healthcare utilization, and spending remain uncertain.
(van der Voorden et al., 2023)	2023	Hight	Systematic Review	The Netherlands	Qualitative Studies Quantitative Studies Mixed Methods Studies	21	1. Implementation	Healthcare system(s) or Healthcare organisation (s)	Impact of practices	Thematic analysis	Most studies focused on consultation rather than partnership and shared leadership, with patient engagement improving satisfaction, experience, and care quality while influencing care pathways,

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											outcome validation, and problem-solving.
(van Elten et al., 2023)	2023	Hight	Scoping Review	Multiple countries	Observational Studies Qualitative Studies Quantitative Studies	11	2A. Evaluation	Healthcare system(s) or Healthcare organisation (s)	Identification of practices Description of practices Impact of practices	Structured Data Extraction	Studies predominantly emphasize successful VBHC implementations while neglecting failures. Two main approaches to implementation are identified: top-down (structured) and bottom-up (patient-driven). External influences, particularly from insurers and policymakers, play a significant role in VBHC adoption. Performance tools such as scorecards,

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											benchmarking, and other measures are commonly used. There is a recognized need to study both successful and unsuccessful VBHC cases, with these findings identified thirty-three times.
(van Engen et al., 2022)	2022	Hight	Systematic Review	The Netherlands	Qualitative Studies Quantitative Studies Mixed Methods Studies	45	1. Implementation	Human Resources	Identification of practices Impact of practices	Thematic analysis	Engagement in VBHC leads to positive outcomes like job satisfaction and pride but also negative effects such as exhaustion and focus loss, with organizational support playing a key role in balancing these impacts.

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
(van Staaldui nen et al., 2022)	2022	Hight	Scoping Review	The Netherlan ds	Empirical Studies Non-Empirical Studies	62	1. Implementation	Healthcare system(s) or Healthcare organisation (s)	Identification of practices Description of practices Impact of practices	Structured Data Extraction	Articles varied in their conceptualization of VBHC, and hospitals have not adopted it as an integrative strategy. Measuring outcomes and costs was the most implemented component, resulting in reduced costs, improved satisfaction, and decreased healthcare utilization. Key strategies for successful implementation included education, multidisciplinary teams, and strong leadership,

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											which enhanced physician engagement, with these findings identified thirty-five times
(Vandemaele et al., 2023)	2023	Moderate	Systematic Review	Multiple countries	NR	24	7B. Frameworks	Medical conditions or specialities	Development of structure	Structured Data Extraction	The existence of seven definitions and fifteen classification systems for innovations in radiation oncology highlights the need for standardization.
(Vijverberg et al., 2022)	2022	Hight	Scoping Review	The Netherlands	Observational Studies Experimental Studies Qualitative Studies Quantitative Studies	1242	1. Implementation	Healthcare system(s) or Healthcare organisation (s)	Description of practices Impact of practices	Structured Data Extraction	The number of publications on VBHC has grown, with most originating from North America and primarily consisting of original research. The dominant research focus

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
					Mixed Methods Studies Review Studies and Reports Empirical Studies Non-Empirical Studies						involved quantitative methods and observational studies. The most commonly assessed outcomes were clinical outcomes and costs, while PROMs and PREMs were less frequently analysed. Regional differences emerged, with North America emphasizing clinical outcomes and costs, whereas Europe focused more on clinical outcomes and PROMs. Only 23% of studies assessed implementation, but among them,

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											79% reported success. Measuring outcomes and costs was the most common agenda item, with these findings identified thirty-seven times.
(Walsh et al., 2020)	2020	Moderate	Systematic Review	Ireland	NR	22	6. Education and Skills	Human Resources	Identification of practices	Content analysis	Five key management competencies essential for hospital managers in a VBHC system are leadership skills, healthcare knowledge, business skills, relationship management, and human resource management, along with general

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											management, with these findings identified thirty-eight times.
(Zanotto et al., 2021)	2021	Hight	Systematic Review	Brazil	NR	47	2B. Metrics	Healthcare system(s) or Healthcare organisation (s)	Description of practices	Framework-Based Analysis	Patient-reported outcomes, particularly time to recovery and long-term consequences, were the most frequently reported. Financial measurement relied more on non-microcosting methods, with microcosting approaches being underutilized in both literature and Harvard Business School cases. Mortality metrics were reported less frequently. A

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											significant proportion of studies contributed to value-based financial outcomes, primarily highlighting cost savings, with these findings identified thirty-nine times.
(Zhou et al., 2022)	2022	Moderate	Systematic Review	China	NR	487	7B. Frameworks	Healthcare system(s) or Healthcare organisation (s)	Development of structure	Thematic Mapping	A proposed framework for VBHC facility design integrates time, space, and behaviour, drawing on insights from the United States of America's focus on outcomes, reducing stays, and nurse stress, and Japan's emphasis on

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											disaster preparedness, spatial efficiency, and aging population needs.
(Gunawan et al., 2022)	2022	Moderate	Scoping Review	Indonesia	NR	30	2A. Evaluation	Healthcare system(s) or Healthcare organisation (s)	Description of practices	Framework-Based Analysis	VBHC adoption is limited, focusing mainly on outcome and cost measurement, with challenges in organizational readiness for Integrated Practice Unit, outcome measurement, bundled payments for chronic conditions, IT integration, and multi-site care coordination
(M. Zhang	2022	Hight	Systematic Review	Multiple countries	NR	62	7B. Frameworks	Healthcare system(s) or Healthcare	Description of structure	Structured Data Extraction	Definitions and measurements of value vary significantly, with

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
et al., 2022)								organisation (s)			existing VAFs lacking patient and public engagement, while value attributes are often aggregated into a single index for decision-making.
(Niven et al., 2015)	2015	Hight	Scoping Review	Canada	Observational Studies Experimental Studies Qualitative Studies Quantitative Studies Mixed Methods Studies Others	109	5. Low-Value Care	Healthcare practice	Identification of strategies Description of strategies Impact of strategies	Structured Data Extraction	Articles focused on therapeutic and diagnostic de-adoption, primarily using randomized trials, with de-adoption driven by harm risks and lack of efficacy. "Disinvest" was the most common term used, while 51 citations mentioned barriers and 48 identified

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											facilitators. Eleven articles provided frameworks for de-adoption, and eight listed low-value practices with a prevalence of 16% to 46%. De-adoption efforts showed 88% success in 39 studies, particularly in cardiovascular, arthritis, and menopause-related practices.
(Nilsen et al., 2020)	2020	Moderate	Scoping Review	Sweden	NR	10	5. Low-Value Care	Healthcare practice	Description of strategies	Framework-Based Analysis	Conceptual studies developed frameworks combining process and determinant models for low-value care de-implementation, while empirical

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											studies applied frameworks like Theoretical Domains Framework, Tailored Implementation for Chronic Diseases, and Grol's Process Model to identify key domains and activities. The review highlighted diverse approaches, including new and adapted frameworks, for guiding low-value care reduction.
(Stammen et al., 2015)	2015	Hight	Systematic Review	The Netherlands	Experimental Studies Qualitative Studies	79	6. Education and Skills	Human Resources	Description of practices	Thematic analysis	Key success factors for improving healthcare decision-making include teaching health economics

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											and patient preferences, fostering reflective practice with feedback, and ensuring a supportive environment through collaboration and role models.
(Colla et al., 2017)	2017	Moderate	Systematic Review	The US	NR	108	5. Low-Value Care	Healthcare practice	Description of strategies Impact of strategies	Structured Data Extraction	Clinical decision support and multicomponent interventions were the most effective in reducing low-value services, while clinician and patient education, as well as cost sharing, showed variable effectiveness. Provider report cards and pay-for-performance

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
											yielded mixed results, and insurer restrictions faced challenges.
(Seixas et al., 2019)	2019	Moderate	Systematic Review	Multiple countries	NR	38	7B. Frameworks	Healthcare Technologies	Description of structure	Structured Data Extraction	Value assessment is highly contextual, with diverse approaches, a predominant but limited use of incremental cost-effectiveness ratios, growing reliance on multi-criteria assessments (including patient-reported outcomes), and inconsistent cost considerations.
(Kokko, 2022)	2022	Moderate	Systematic Review	Finland	Mixed Methods Studies Review Studies and Reports	21	7B. Frameworks	Healthcare system(s) or Healthcare	Description of structure	Framework-Based Analysis	There is no consensus on the impact and balance of the Triple Aim

Ref	Year of Publication	Quality assessment	Type of study	Country	Types of studies included in the selected research	Number of articles included in the selected research	Group	Context	Intervention	Mechanism	Outcome
								organisation (s)			framework's goals, and literature on its implementation at the health system level remains limited.

Note: IT – Information Technology; NR – Not reported; PREM – Patient-Reported Experience Measure; PROM – Patient-Reported Outcome Measure; TDABC – Time-Driven Activity-Based Costing; VAF - Value Assessment Framework; VBHC – Value-Based Healthcare; VBIC - Value-Based Integrated Care; VBID – Value-Based Insurance Design; VBP – Value-Based Payment; VBPc – Value-Based Procurement; VBPu – Value-Based Purchasing.

B. Appendix to Chapter 3

B.1. Search Strategy and Database Results

Table 31 - List of Keywords Used in the Scoping Review

Component 1	Component 2	Component 3
"VBHC" "value-based health care" "value-based healthcare" "value based"	"initiatives" "implementation" "case study"	"I" "electronic health record" "healthcare information system" "health informatics" "information technology platform"

Table 32 – Search Strings and Databases Results for Scoping Review

Database: Pubmed			
Steps	Search terms	Filters	Number of results
#1	"VBHC"[Title/Abstract] OR "value-based health care"[Title/Abstract] OR "value-based healthcare"[Title/Abstract] OR "value based"[Title/Abstract]	No Filters	8.457
#2	"Review*"[Title] OR "meta-analysis"[Title] OR "overview"[Title] OR "state of the-art"[Title] OR "synthesis"[Title]	No Filters	513.048
#3	"I" OR "electronic health record" OR "healthcare information system" OR "health informatics" OR "information technology platform"	No Filters	40,658
#4	#1 AND #2 AND #3	From 2012-2023 English	**46**
Database: EMBASE			
Steps	Search terms	Filters	Number of results
#1	TITLE-ABS-KEY ("VBHC" OR "value-based health care" OR "value-based healthcare" OR "value based")	No Filters	38.862
#2	TITLE-ABS-KEY ("initiatives" OR "implementation" OR "case study")	No Filters	3.225.753
#3	TITLE-ABS-KEY ("I" OR "electronic health record" OR "healthcare information system" OR "health informatics" OR "information technology platform")	No Filters	74.109
#4	#1 AND #2 AND #3	From 2012-2023 English	**101**

B.2. Scoping Reviews (PRISMA-ScR) Checklist

Table 33 – Checklist of the PRISMA-ScR used to guide this scoping review

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	42
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1-8
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	42-44
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	43-44
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	-
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	44
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	44
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix B
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	6
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	-
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	45-46
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	45-46
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	-

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	45-49
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	45-49
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	-
Limitations	20	Discuss the limitations of the scoping review process.	49
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	49
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	ii

B.3. Data Extraction Table

Table 34 – Data Extraction Table Used in the Scoping Review

Ref	Origin Country	Publication Year	Healthcare Field	Payment Model	Value Initiative	Facilitating topic	Barrier's topic
(Abdulla et al., 2012)	United States of America	2012	Endocrinology	Not Determined	Redesign initiative	- Structured data - Fast analysis for quick decision-making - Detailed analysis (individual patient level, outcomes, costs	- Lack of automated data extraction
(Ahn et al., 2019);	United States of America	2019	Orthopaedics	Not Determined	Traditional value-based program	NR	- Lack of data availability (real-time; medical – records; cost; outcome measures) - Limited data from one or two institutions
(Burnhope et al., 2022)	United Kingdom	2022	Cardiology	Not Determined	Traditional value-based program	- Standardization, interoperability, and comparison of outcomes and indicators	- Lack of automated data extraction - Lack of data accuracy - Data transcription errors
(Chatfield et al., 2019)	United States of America	2019	General practice	Not Determined	Traditional value-based program	- Quick implementation of EHR - Performing the necessary intervention on the EHR - Strong support from IT teams	NR
(Cossio-Gil et al., 2021)	Europe	2021	Hospital	Not Determined	Traditional value-based program	- Using an app to collect patient-reported data - Fast analysis for quick decision-making - Standardization, interoperability, and comparison of outcomes and indicators - Improved outcomes - Generation of dashboards	- Lack of access to data (outcome measurement or costing information) - Lack of data transformation, converting data sources to a more desirable output forma - Lack communication between hospital network members
(Daniels et al., 2022)	Netherlands	2022	Hospital	Not Determined	Traditional value-based program	- Real-time data (outcomes, cost) - Easy and systematic data extraction - Automated data extraction	NR
(Danilyants et al., 2019)	United States of America	2019	Gynaecology	Not Determined	Traditional value-based program	NR	- Lack of data availability (real-time; medical – records; cost; outcome measures)

Ref	Origin Country	Publication Year	Healthcare Field	Payment Model	Value Initiative	Facilitating topic	Barrier's topic
							- Lack of data accuracy - Data transcription errors
(Ebinger et al., 2018)	United States of America	2018	Cardiology	Not Determined	IIT Programs	- Accurate data (outcomes, cost) - Real-time data (outcomes, cost) - Prospective analysis with standardized protocols - Retrospective analysis - Specialized human resources (Data-IT expert, consultant Value-Based Healthcare) - Saving time for healthcare professionals - IT infrastructure	NR
(Featherall et al., 2018)	United States of America	2018	Orthopaedics	Not Determined	Redesign initiative	NR	- Lack of data availability (real-time; medical records; cost; outcome measures)
(Gabriel et al., 2019)	United Kingdom	2019	Orthopaedics	Not Determined	Redesign initiative	- Baseline data	- Lack of access to data (outcome measurement or costing information) - Lack of necessary resources - Time-consuming and barrier-laden data capture process
(Glotzbach et al., 2018)	United States of America	2018	Cardiology	Not Determined	Traditional value-based program	- Accurate data (outcomes, cost)	- Interoperability of different data sets
(Golas et al., 2018)	United States of America	2018	Cardiology	Not Determined	IT Programs	NR	- Lack of data availability (real-time; medical records; cost; outcome measures) - Data collection done in different ways
(Gray et al., 2019)	United States of America	2019	Orthopaedics	Bundled Payment	Redesign initiative	NR	- Difficulty in comparing data due to the blinded, enterprise-wide nature of data retrieval

Ref	Origin Country	Publication Year	Healthcare Field	Payment Model	Value Initiative	Facilitating topic	Barrier's topic
(Heijsters et al., 2022)	Netherlands	2022	Hospital	Not Determined	Experience-based co-design	- Real-time data (outcomes, cost) - Clearly collected and monitored data through an integrated system (combination of cases, clinical, and patient-reported outcomes) - Specialized human resources (Data-Information – Technology expert, consultant VBHC) - Trained healthcare professionals in the EHR system to apply it in practice	- Lack of international normalization and standardization of reported outcome measure - Deficient organisational workflows
(Hernandez et al., 2019)	United States of America	2019	Integrated Practice Unit	Not Determined	Traditional value-based program	NR	- Data transcription errors - Lack of IT infrastructure - Lack of optimization of computer systems
(S. L. Parker et al., 2017)	United States of America	2017	Orthopaedics	Not Determined	Traditional value-based program	- Accurate data (outcomes, cost) - Detailed analysis (individual patient level, outcomes, costs - Support for decision-makers to prevent inefficiencies or wastefulness - Improved outcomes	NR
(T. A. Patel et al., 2023)	United States of America	2023	Oncology	APMs	Traditional value-based program	- Support the implementation and development of risk-adjusted models based on outcomes - IT infrastructure	- Deficient organisational workflows
Peard et al., 2019;	United States of America	2019	Urology	Not Determined	Traditional value-based program	NR	- Lack of data availability (real-time; medical records; cost; outcome measures) - Limited data from one or two institutions
(Peard et al., 2019)	United States of America	2017	Orthopaedics	Not Determined	Redesign initiative	NR	- Lack of data accuracy - Lack of baseline data - Limited data from one or two institutions
(Piña et al., 2022)	United States of America	2022	Cardiology	APMs	Redesign initiative	- Adequate tools for data recording that ensure confidentiality and data quality - User-friendly communication tool linked to the EHR to collect patient reported outcomes	- Absence of payment of the communication platforms like EHR portals

Ref	Origin Country	Publication Year	Healthcare Field	Payment Model	Value Initiative	Facilitating topic	Barrier's topic
(van Egdom et al., 2019)	Netherlands	2019	Integrated Practice Unit	Not Determined	Traditional value-based program	- User-friendly communication tool linked to the EHR to collect patient reported outcomes	
(Varela-Rodríguez et al., 2022)	Spain	2022	Hospital	Not Determined	IIT Programs	- Real-time data (outcomes, cost) - Central repository with all data - Definition of the form and responsibility of data records - Adapting data needs and data analysis to the particular context of each institution - Support for decision-makers to prevent inefficiencies or wastefulness - Data related to the experience of professionals to strengthen the project - Generation of dashboards - Accessibility of data to different professionals - Strong support from IT - Specialized human resources (Data-IIT expert, consultant VBHC) - Adequate tools for data recording that ensure confidentiality and data quality	- Lack of data accuracy - Double data recording (for both clinical and research) - Bias on medical information - Primary source of origin other than the data in the system - Clinical information not collected by the attending physician - Lack of direct integration of data from analytical equipment - Subjective data (symptoms or experience) not being entered by patients into the system - Lack of specific electronic forms for clinical data collection - Lack of definition on the data collection protocol and regulation - Lack of international normalization and standardization of reported outcome measure - Lack of data transformation, converting data sources to a more desirable output forma - Fragmentation of communities and tools
(Williams et al., 2019)	United States of America	2019	Integrated Practice Unit	Not Determined	Redesign initiative	NR	- Lack of data accuracy - Data transcription errors - Lack of IT infrastructure
(Wyffels et al., 2023)	Belgium	2023	Cardiology	Not Determined	Traditional value-based program	NR	- Lack of data availability (real-time; medical records; cost; outcome measures) - Interoperability of different data sets

Ref	Origin Country	Publication Year	Healthcare Field	Payment Model	Value Initiative	Facilitating topic	Barrier's topic

Note: APM - Alternative Payment Model; EHR – Electronic Health Record; IT - Information Technology NR – Not reported; VBHC – Value-Based Healthcare.

C. Appendix to Chapter 4

C.1. Prisma-ScR Flow Diagram

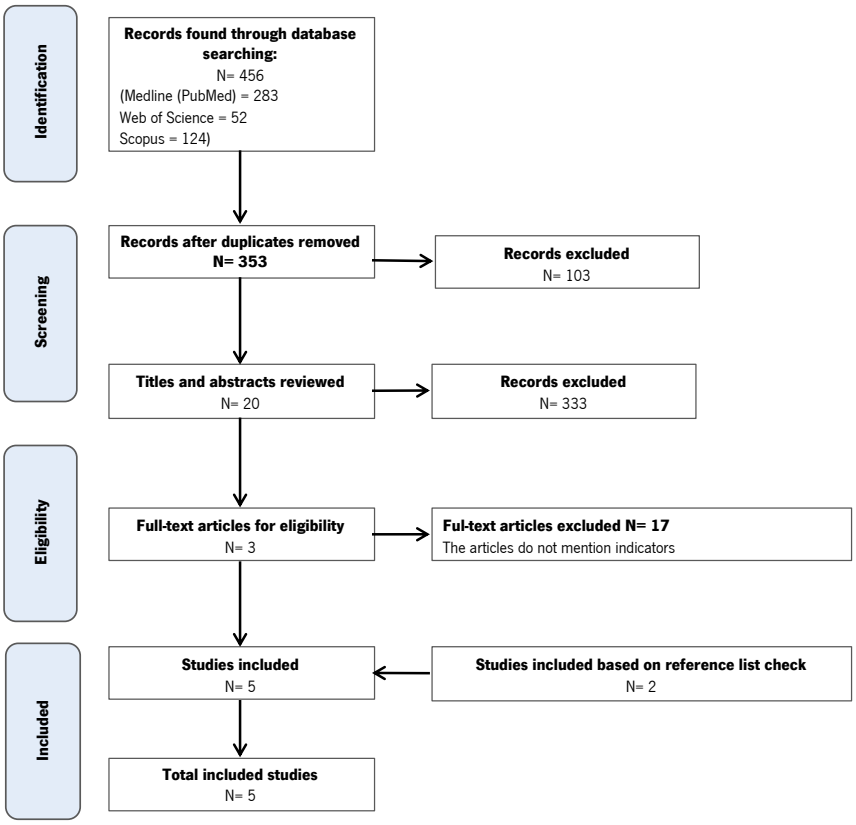


Figure 11 – PRISMA-ScR flow diagram

C.2. Benefit indicators identified in the literature

Table 35 – Value (benefit) indicators for radiology identified in the literature

Study	Category	Indicators
(S. Patel, 2014)	Quality	List Radiology accreditations
		List healthcare quality reporting programs
		Protocols developed/revised
		List individual patient safety metrics (e.g., procedure complications)
		Conference hours
		Examinations with documented technologist feedback
		Radiology-pathology correlations
		Peer-reviewed studies
		Peer-reviewed study agreement (e.g., proportion of concordant evaluations)
		Patient interactions supported by digital health incentive programs
		List national designations (e.g., Image Wisely, Choosing Wisely)

Study	Category	Indicators
		Radiology department policies/procedures updated
		Structured reporting templates developed/revised
		List radiation dose reduction initiatives
	Service	List report turnaround time metrics
		Patient satisfaction survey results
		Hours of patient procedural supervision (e.g., imaging procedures requiring conscious sedation)
		Hours of community support
		Referring provider communications
		Critical test results delivered
		Hours of recruiting
		Committee hours
		Selected examinations interpreted by subspecialty radiologist(s)
		Referring physician satisfaction survey results
		Clinician and patient interactions
		Timeliness of care metrics (e.g., time between screening and diagnostic mammography)
		Examinations provided through financial assistance programs
		Examination results given directly to patients
		Hours of marketing
	Utilization management	List Centres for Medicare & Medicaid Services Hospital Outpatient Quality Reporting Program imaging measure data (www.medicare.gov/hospitalcompare/search.html)
		Reports self-edited by radiologists
		List activities related to cost management and money saved and/or revenue enhancement
		List utilization reviews with results
		List examination outcomes review with results
		List short-term follow-up examination data (e.g., percentage of intermediate-risk diagnostic imaging assessments)
		List mammographic outcomes data
		List population health outcomes data (e.g., lung screening program)
	Professional development	List leadership positions within hospital
		List national/regional positions (e.g. practice guidelines/standards and Appropriateness Criteria Joint Committee)
		List national sponsored practice improvement projects with results
		Hours of executive meetings
		Hours of leadership duties
		Hours of research
		Hours of teaching
		Leadership continuing medical education
		List published articles
		List lectures given
		List presentations given

Study	Category	Indicators
		Hours of national/state radiology activities
(Sarwar et al., 2015)	Process	Turnaround time
		Communication rate
		Equipment idle time
		Percentage of unreported cases
	Performance	Peer review
		Miss rate
		Number of studies interpreted
	Survey	Patient satisfaction
		Referrer satisfaction
	Access	Wait times
		Imaging unit availability
		Staff courtesy
		Scheduling process
	Appropriateness	Decision support software
(Heller, R. E. et al., 2017)	Performance	Evaluation of the radiology report – Establish a departmental standard Percentage of reports using a standardized format (Process)
		Evaluation of the radiology report – Report Review Process to evaluate adequacy of the reports based on established guidelines (Structural)
		Fluoroscopy – Document fluoroscopy time on routine exam (Process)
		Turnaround time Track times for emergency department interpretations (Process)
	Safety	incidence of adverse events or near-misses (e.g., presence of unsafe objects in restricted clinical areas) (Process)
		Contrast extravasation Incidence of contrast extravasation (Process)
		Critical results communication Incidence of documentation of appropriate communication of critical results (Process)
		Improper or unnecessary imaging Incidence of improper or unnecessary imaging (such as wrong patient, wrong exam, wrong site or poor technique) (Process)
		Radiation dose Use of a dose monitoring program (Structural)
		Treatment of contrast reactions Percentage of reactions treated according to protocol (Process)
	Service and Experience	Patient and family satisfaction Results of a satisfaction survey (Process or outcome)
		Clinician satisfaction Results of a satisfaction survey (Process or outcome)
		Radiologist satisfaction Results of a satisfaction survey (Process or outcome)
(Boland et al., 2017)	Imaging appropriateness /stewardship	Compliance with guidelines and appropriateness criteria by specialty and physician
		Adherence to clinical decision support tools
		Identification of duplicate examinations
		Time, frequency of referring physician consultation
		Ease of availability of radiologists for referrer consultation
		Cost savings to institution for avoiding unnecessary imaging
	Patient scheduling	Scheduler response time
		Scheduler customer service feedback (patient experience)
		Time from examination request to patient appointment

Study	Category	Indicators
		Scheduled at convenient time and location to patient
		Time to schedule and perform same-day add-ons
		Impact of expedited examination on length of stay
	Patient preparation	Availability of procedure information to patients (patient survey)
		Number and efficacy of patient reminder calls
		Ease of access to scanning facility
		Time from arrival at suite to scanning
		Staff customer service feedback
		Appropriate safety checks performed before patient arrival (contraindications to examination)
	Protocol	Compliance with departmental (or national) standard protocol
		Radiation dose measurement and benchmarking
		Protocol length
		Cost savings (or earnings) to department for shorter protocols (examination slots available
	Modality operations	On-time scanning
		Time performing scan (room time)
		Overall time from arrival to discharge
		Contrast reactions
		Number and frequency of radiologist-patient interactions/consultations
		Staff and overall customer feedback (patient experience)
		Number of examination slots available (including off hours and weekends)
	Reporting	Adequate history
		Access to relevant collateral data in the electronic medical record
		Adherence to incidental finding criteria
		Frequency of recommendations per procedure
		Percentage of subspecialty reporting
		Structured reporting
		Standard lexicon and language
		Report grammatical or voice recognition error
		Time from examination completion to finalized report
		Is the report actionable?
		Accuracy of report to final diagnosis, including false positives
		Local radiologist 24/7 coverage
	Report communication	Time for report availability to patient
		Time for closed loop critical results reporting by category
		Ease of report access by patient
		Report understood by patient
		Report consultation to patient
	Peer review	Percentage of reports evaluated
		Percentage of missed findings/category percentage false positives

Study	Category	Indicators
		Is the report actionable
		Accuracy of report to final diagnosis
		Adherence to incidental finding criteria
		Frequency of recommendations
		Structured reporting
		Standard lexicon and language
		Report grammatical or voice recognition error
		Recommendations in appropriate field (i.e., recommendation field at end of report)
		Time for closed loop critical results reporting by category
		Frequency of error feedback to technologists and/or radiologists
	Examination outcome	Did the referring physicians find the information useful?
		Did results of imaging change diagnosis or therapy?
		Did use of imaging eliminate need for more invasive/expensive procedures?
		Did use of imaging reduce length of stay?
		Complications
		Patient satisfaction
		Referring physician satisfaction
	Institutional citizenship	Type and frequency of administrative meetings
		Number of institutional leadership/committee positions
		Preparation time for hospital administrative expectations
		Health system marketing efforts
		Number of accreditations
		Referring physician and leadership customer service evaluation
(European Society of Radiology (ESR), 2017)	Appropriateness of requests	Analysis of compliance of requests by referring physicians with (institutionally approved) imaging referral guidelines
		Identification of duplicate studies
		Rejection of unnecessary or redundant studies
		Time and frequency of referring physician consultation
		Ease of availability of radiologists for referrer consultation
	Attention to radiation protection measures	Presence of diagnostic protocols which entail choice of non-ionising examinations whenever possible
		Presence of “low-dose” protocols in all computed tomography equipment
		Percentage of use of such protocols
		Reporting to a radiation dose index registry of all exposures
		Evidence of training programs on radiation protection aspects
	Characteristics of the reports (correct, complete, well understandable, structured and properly used)	(Not detailed by the authors)

Study	Category	Indicators
	Relationships between patients and radiology personnel	Presence within the department of detailed instructions for preparation for the different types of examinations and the percentage of patients receiving them
		Distribution of customer satisfaction questionnaires (and these are better if they have been developed together with patients' representative organizations) and periodic audits based on their results
		Existence of formal relationships between the department and patients' organization's
	Continuous professional education, research and innovation	(Not detailed by the authors)

C.3. Questionnaires

Questionnaire for round 1

Please consider the following categories:

ACCESSIBILITY OF THE SERVICE: the way or the process of arriving to receive the service provided at the department;

ADEQUACY OF EXAM PRESCRIPTION: the prescribed exam is the most appropriate for the evaluation / study intended in accordance with the condition of the patient;

EXAM PROCESS: from the arrival until the departure of the patient from the Radiology Department, during which the images of the radiological examination are taken;

REPORT: medical description, in text, of the images taken, document where possible diagnoses are pointed out or other tests to complement the patient's evaluation are suggested;

RESULTS: either from the result obtained with the diagnosis or from the satisfaction with the service provided;

SAFETY: everything that jeopardizes the patient's well-being as well as the measures taken to prevent or reduce the damage, namely protective measures against radiation;

CONTRIBUTION TO THE INSTITUTION: the way the Radiology Department participates or adds to the institution it belongs to.

Part 1 – Benefit indicators organized by category

6. For the category ACCESSIBILITY OF THE SERVICE (the way or the process of arriving to receive the service provided at the department), please rate the following indicators in terms of their importance for the value (benefit) that the radiology department generates.

		1. Not important	2. Somewhat important	3. Important	4. Very important	5 Extremely important	I did not understand
A1	Number of time slots available for exams appointments						
A2	Time elapsed from the prescription until the exam is scheduled						
A3	Percentage of tests scheduled and performed at a time and place that is the most convenient for the patient						
A4	Percentage of examinations and other complementary examinations scheduled for the same day						

2 to 7. Similar questions were asked for the other categories and corresponding indicators (detailed in Table 18 of the chapter 4).

Part 2 – Categories of benefit indicators

Please rate the following categories of benefit indicators in terms of their importance for the value (benefit) that the radiology department generates.

Categories		1. Not important	2. Somewhat important	3. Important	4. Very important	5 Extremely important	I did not understand
P1	ACCESSIBILITY OF THE SERVICE						
P2	ADEQUACY OF EXAM PRESCRIPTION						
P3	EXAM PROCESS						
P4	REPORT						
P5	RESULTS						
P6	SAFETY						
P7	CONTRIBUTION TO THE INSTITUTION						

Questionnaires for rounds 2 and 3

I. For external participants

Note: The questionnaire uses rank-order scales implemented using a drag-and-drop functionality.

Part 1 – Benefit indicators organized by category

For the category ACCESSIBILITY OF THE SERVICE (the way or the process of arriving to receive the service provided at the department), please rank the indicators from the most important (to be placed on the top) to the least important (to be placed in the last position) for the value (benefit) that the radiology department generates.

A1	Number of time slots available for exams appointments
A2	Time elapsed from the prescription until the exam is scheduled
A3	Percentage of tests scheduled and performed at a time and place that is the most convenient for the patient
A4	Percentage of examinations and other complementary examinations scheduled for the same day

2 to 7. Similar questions were asked for the other categories and corresponding indicators (detailed in Table 2 of the manuscript).

Part 2 – Categories of benefit indicators

Please rank the following categories of benefit indicators from the most important (to be placed on the top) to the least important (to be placed in the last position) for the value (benefit) that the radiology department generates.

P1	ACCESSIBILITY OF THE SERVICE
P2	ADEQUACY OF EXAM PRESCRIPTION
P3	EXAM PROCESS
P4	REPORT
P5	RESULTS
P6	SAFETY
P7	CONTRIBUTION TO THE INSTITUTION

II. For internal participants

In each question, you will be asked to indicate how much you prefer A over B on a scale of 1 to 9 (where 1 is Equally Preferred and 9 corresponds to Extremely Preferred).

For example:

I prefer Yellow to Orange = 1 means *Equally Preferred*, because I like both colours equally;

I prefer Blue to Orange = 9 means *Extremely Preferred*, because I like Blue much more than Orange.

Part 1 – Benefit indicators organized by category

For the category ACCESSIBILITY OF THE SERVICE (the way or the process of arriving to receive the service provided at the department), please select the number corresponding to your degree of preference.

In terms of the value (benefit) generated by the radiology department, I prefer 'NUMBER OF TIME SLOTS AVAILABLE FOR EXAMS APPOINTMENTS' over 'TIME ELAPSED FROM THE PRESCRIPTION UNTIL THE EXAM IS SCHEDULED'

1	2	3	4	5	6	7	8	9
Equally Preferred								Extremely Preferred

Questions with pairwise comparisons were asked for all the pairs of indicators of the seven categories (detailed in Table 18 in Chapter 4).

Part 2 – Categories of benefit indicators

Please select the number corresponding to your degree of preference.

In terms of the value (benefit) generated by the radiology department, I prefer 'ACCESSIBILITY OF THE SERVICE' over 'ADEQUACY OF EXAM PRESCRIPTION'

1	2	3	4	5	6	7	8	9
Equally Preferred								Extremely Preferred

Questions with pairwise comparisons were asked for all the pairs of categories (detailed in Table 18 in Chapter 4).

C.4. Consensus assessment at Delphi first round (Kendall W)

Table 36 – Degree of consensus among stakeholder groups in the first Delphi round measured using Kendall's coefficient of concordance (W)

	Radiographers	**Administration**	**Patients**	**Physicians**
CATEGORIES	0.402	0.500	0.048	0.475
ACCESSIBILITY TO THE SERVICE	0.243	0.658	0.296	0.675
ADEQUACY OF REQUESTS FOR EXAMS	0.187	0.618	0.349	0.164
THE PROCESS EXAME PERFOMING	0.444	0.543	0.283	0.287
THE REPORT	0.490	0.580	0.762	0.879
THE RESULTS	0.459	0.821	0.335	0.363
SAFETY AND PROTECTIVE MEASURES AGAINST RADIATION	0.292	0.741	0.491	0.098
CONTRIBUTION TO THE INSTITUTION	0.231	0.857	0.615	0.339

C.5. Indicators' weights and value (benefit) calculations

Step 1 – Calculate the weight per participant for each indicator

For Patients and Prescribing physicians – ROC method (Barron & Barrett, 1996)

Table 37 – Example of calculation of indicator weights per participant

Benefit indicators – ACCESSIBILITY OF THE SERVICE		Rank by patient 1	From ROC table	Rank by patient 2	From ROC table	...	Rank by patient i (i=no. of patient)	From ROC table
A1	Appointments available for exams	4th	0.0625	1st	0.5208		...	...
A2	Time elapsed from the prescription until the exam is scheduled	3rd	0.1458	3rd	0.1458		...	...
A3	Percentage of tests scheduled and performed at a time and place that is the most convenient for the patient	1st	0.5208	2nd	0.2708	...	...	...
A4	Percentage of examinations and other complementary examinations scheduled for the same day	2nd	0.2708	4th	0.0625		...	...

For Radiographers and Administration – AHP (R. W. Saaty, 1987)

Table 38 – Example of calculation of indicator weights for Radiographer 1

Matrix of preferences using Saaty's scale

	A1	**A2**	**A4**	**A5**
A1	1	¼	½	½
A2	4	1	3	1
A4	2	1/3	1	1/5

A5	2	1	5	1
SUM	*9.00*	*2.58*	*9.58*	*2.70*

	A1	**A2**	**A4**	**A5**	Arithmetic mean
A1	1/9 = 0.11	0.25/2.58 = 0.10	0.05	0.19	**0.11**
A2	4/9 = 0.44	0.39	0.32	0.37	**0.38**
A4	0.22	0.13	0.11	0.07	**0.13**
A5	0.22	0.39	0.53	0.37	**0.38**

Additionally, the consistency index was calculated and it was confirmed that it was lower than 0.1.

Step 2 – Calculate the weight (level of expertise) of each participant within its group – approach of Scala et al. (2016)

Table 39 – Level of expertise of the Radiographers

Indicator	Radiographer 1 (AHP) preferences	Log (Radiographer 1 preferences)	Log (Radiographer 2 preferences)	Log (Radiographer 3 preferences)	Log (Radiographer 4 preferences)	Log (Radiographer 5 preferences)	Log (Radiographer 6 preferences)
A1	0.11*	-0.953	-0.477	-0.699	0.000	0.000	0.000
A2	0.38*	-0.421	-0.778	-0.477	-0.602	-0.699	-0.301
A3	-	-	-	-	-	-	-
A4	0.13*	-0,877	-0.778	-0.845	-0.477	-0.778	0.000
A5	0.38*	-0,424	-0.778	0.000	-0.699	0.000	0.477
...	...	...	...	...	...	...	...
P7	0.10	-1.000	-1.700	-1.300	-1.520	-1.150	-1.400
Radiographer weights by principal components analysis (SPSS)		0.919	1.937	1.127	1.51	0.794	1.613
Standardized weights (Sum =1)		**0.116**	**0.245**	**0.143**	**0.191**	**0.101**	**0.204**

Notes: Use the log of all indicators preference of all participants to run principal components analysis in a statistical software (eg, SPSS) and standardize the participants weights obtained; *Detail of the calculations in Table 38 as an example.

Step 3 – Calculate the weight benefit indicators: indicator weight × participant weight

For Patients and Prescribing physicians – Simple arithmetic mean

Example: Weight of A2 indicator for Patients = $\frac{\sum_{i=1}^{no._of_patientes} weight_of_A2_1}{no._of_patientes}$

Table 40 – Example of calculation of indicator weights

Benefit indicators – ACCESSIBILITY OF THE SERVICE		From ROC table	From ROC table	...	Arithmetic mean across all patients' preferences
A1	Appointments available for exams	0.0625*	0.5208*	...	**0.3163**
A2	Time elapsed from the prescription until the exam is scheduled	0.1458*	0.1458*		**0.2064**
A3	Percentage of tests scheduled and performed at a time and place that is the most convenient for the patient	0.5208*	0.2708*		**0.2784**
A4	Percentage of examinations and other complementary examinations scheduled for the same day	0.2708*	0.0625*		**0.1989**

Note: *Explanation of how to determine in Table 37.

For Radiographers and Administration – Weighted arithmetic mean

Example: Weight of A2 indicator for:

Radiographers=$\sum_{j=1}^{no._of_radiographers}(weight_of_A2_j \text{ x } level_of_expertise_i)$

= (0.38*×0.116†+0.10×0.245†+0.21×0.143†+0.10×0.191†+0.12×0.101†+0.32×0.204†) = 0.1952

Notes: *Detail of the calculation in Table 38, as an example; †Detail of the calculation in Table 38

Step 4 – Calculate the (benefit) indicators - Example:

Table 41 – Calculations of TOPSIS distance for Patients, Indicator A2

Indicator	**Days**			**[0; 1]**		**Weighted**	
	A^+	A^-	Observed	A^+	A^-	Ideal: A^+	Anti-ideal: A^-
A2: Average time between taking the exam and completing the report (MINIMIZE) Indicator ROC Weight: **0.2064**	0	312	7	$\frac{7-0}{312-0} = 0.0224$	$\frac{312-7}{312-0} = 0.9776$	(0.0224× 0.2064) = **0.0046**	(0.9776× 0.2064) = **0.2018**

Note: ROC. Rank-Order Centroid; TOSPIS - Technique for Order of Preference by Similarity to Ideal Solution

Table 42 – Calculations of TOPSIS for Patients, category A – ACCESSIBILITY TO THE SERVICE

Indicators	**Data**	**Min/max**	**Department**	
			Ideal: A^+	Anti-ideal: A^-
A1	3 806	MAX	0.2836	0.0327
A2	7	MIN	0.0046*	0.2018*
A3	0,679	MAX	0.0894	0.1890
A4	0,766	MAX	0.0465	0.1523
SUM			0.4241	0.5758
Category A Benefit = $\frac{A^-}{A^+ + A^-}$ = **0.5759** (TOPSIS closeness coefficient)				

Notes: *Detail of the calculations in Table 41 as an example; TOPSIS. Technique for Order of Preference by Similarity to Ideal Solution

Table 43 – Radiology value (benefit) assessment

Categories / Indicators		**Patients**		**Physicians**		**Radiologists**		**Administration**	
		Ideal A+	Anti-ideal A-	Ideal A+	Anti-ideal A-	Ideal A+	Anti-ideal A-	Ideal A+	Anti-ideal A-
ACCESSIBILITY TO THE SERVICE	A1	0.2836	0.0327	0.2241	0.0259	0.0902	0.0074	-	-
	A2	0.0046*	0.2018*	0.0103	0.4480	0.0044	0.1909	0.0191	0.8337
	A3	0.0894	0.1890	0.0501	0.1061	-	-	-	-
	A4	0.0465	0.1523	0.0317	0.1037	0.1027	0.2173	0.0472	0.0999
	A5	-	-	-	-	0.0906	0.2965	-	-
benefit [0; 1]		***0.5759***		***0.6837***		***0.7121***		***0.9336***	
ADEQUACY OF REQUESTS FOR EXAMS	B1	0.0806	0.2281	0.0951	0.2694	0.0540	0.1528	0.0965	0.2733
	B2	0.0506	0.1066	0.0503	0.1059	0.0732	0.1541	0.0633	0.1333
	B3	0.1362	0.0362	0.0658	0.0175	0.1414	0.0584	-	-
	B4	0.1302	0.2315	0.1425	0.2533	0.1318	0.2342	0.1561	0.2775
benefit [0; 1]		***0.6024***		***0.6462***		***0.5996***		***0.6841***	
THE PROCESS EXAME PERFOMING	C1	0.0124	0.1730	0.0107	0.1498	-	-	-	-
	C2	0.0623	0.0176	0.0574	0.0162	-	-	-	-
	C3	0.0309	0.1546	0.0349	0.1746	0.2689	0.0538	0.1469	0.0294
	C4	0.0001	0.0462	0.0001	0.0674	-	-	0.1968	0.0052
	C5	0.0306	0.1493	0.0206	0.1004	-	-	0.1993	0.0009
	C6	0.0026	0.0755	0.0046	0.1358	0.0321	0.1569	0.0421	0.2056
	C7	0.0290	0.1302	0.0261	0.1173	0.0039	0.1146	0.0057	0.1681
	C8	0.0402	0.0457	0.0393	0.0446	-	-	-	-
	C9	-	-	-	-	0.0673	0.3025	-	-
	C10	-	-	-	-	-	-	-	-
benefit [0; 1]		***0.7921***		***0.8063***		***0.6278***		***0.4092***	
THE REPORT	D1	0.0702	0.0683	0.0394	0.0383	-	-	-	-
	D2	0.0380	0.1964	0.0193	0.0997	-	-	-	-
	D3	0.0005	0.0452	0.0005	0.0404	0.0223	0.1151	0.0269	0.1392
	D4	0.0244	0.0988	0.0129	0.0521	-	-	-	-
	D5	0.0164	0.0589	0.0155	0.0555	-	-	-	-
	D6	0.0683	0.0387	0.0586	0.0332	-	-	-	-
	D7	0.0509	0.0150	0.1522	0.0450	-	-	0.0950	0.1942

Categories / Indicators		Patients		Physicians		Radiologists		Administration	
		Ideal A+	Anti-ideal A-	Ideal A+	Anti-ideal A-	Ideal A+	Anti-ideal A-	Ideal A+	Anti-ideal A-
	D8	0.0506	0.0506	0.0861	0.0861	0.0961	0.0284	0.0730	0.0216
	D9	0.0414	0.0673	0.0630	0.1023	-	-	-	-
	D10	-	-	-	-	0.0554	0.3101	0.0382	0.2139
	D11	-	-	-	-	-	-	-	-
	D12	-	-	-	-	-	-	-	-
	D13	-	-	-	-	0.0215	0.3513	0.0114	0.1866
benefit [0; 1]		***0.6393***		***0.5526***		***0.8048***		***0.3829***	
THE RESULTS	E1	0.0530	0.2720	0.0462	0.2372	-	-	0.0670	0.3443
	E2	0.1031	0.1436	0.1533	0.2134	0.2183	0.3039	-	-
	E3	0.0374	0.1638	0.0269	0.1176	-	-	-	-
	E4	0.0146	0.1159	0.0110	0.0870	0.2146	0.0794	0.4297	0.1589
	E5	0.0080	0.0478	0.0102	0.0613	0.0212	0.0926	-	-
	E6	0.0407	0.0000	0.0361	0.0000	0.0120	0.0582	-	-
benefit [0; 1]		***0.7432***		***0.7164***		***0.5340***		***0.5032***	
SAFETY AND PROTECTIVE MEASURES AGAINST RADIATION	F1	0.0165	0.1249	0.0154	0.1165	-	-	0.0272	0.2050
	F2	0.0505	0.0642	0.0749	0.0953	-	-	0.0523	0.0052
	F3	0.0042	0.0451	0.0071	0.0753	-	-	-	-
	F4	0.0113	0.1454	0.0090	0.1161	0.0118	0.1524	0.0265	0.3417
	F5	0.0358	0.1415	0.0297	0.1173	-	-	-	-
	F6	0.0691	0.0259	0.0626	0.0235	-	-	-	-
	F7	0.0042	0.2189	0.0044	0.2275	0.0479	0.2212	-	-
	F8	0.0037	0.0386	0.0022	0.0231	0.2102	0.0028	-	-
	F9	-	-	-	-	0.0067	0.3469	0.0065	0.3357
benefit [0; 1]		***0.8046***		***0.7947***		***0.7234***		***0.8875***	
CONTRIBUTION TO THE INSTITUTION	G1	0.0267	0.0467	0.0472	0.0827	0.1722	0.0004	-	-
	G2	0.0965	0.0241	0.1216	0.0304	0.1996	0.0026	-	-
	G3	0.0505	0.0111	0.1549	0.0340			-	-
	G4	0.0750	0.0073	0.0788	0.0077	0.0478	0.1741	-	-
	G5	0.1775	0.0273	0.0904	0.0139	0.4002	0.0031	-	-
	G6	0.1906	0.0521	0.1404	0.0384	-	-	-	-
	G7	0.1573	0.0572	0.1171	0.0426	-	-	-	-
benefit [0; 1]		***0.2259***		***0.2497***		***0.1802***		***-***	
S+		2.6167		2.5502		2.8182		1.8269	
S-		4.3833		4.4490		4.1818		4.1731	
C-closeness		**0.6262**		**0.6356**		**0.5974**		**0.6955**	

Notes: *Detail of calculations in Table 42, as an example; †detail of calculations in Table 41, as an example.

D. Appendix to Chapter 5

D.1. Scoping Reviews (PRISMA-ScR) Checklist

Table 44 – Full reporting checklist for the PRISMA-ScR

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	-
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	70-72
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	71
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	-
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	72-73
Information sources	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	72-73
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix D
Selection of sources of evidence	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	72-73
Data charting process	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	-
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	72-73
Critical appraisal of individual sources of evidence	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	-
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	72-73
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Appendix D e E
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Appendix D e E

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	-
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	91-94
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	91-94
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	-
Limitations	20	Discuss the limitations of the scoping review process.	101
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	101-102
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	ii

D.2. Search Strategy Details

Table 45 -Keyword combinations used in the search strategy, organised by components and exclusion terms

Component 1	Component 2	Component 3	Component 4 Exclusions
"value-based payment" "value based payment" "value-based reimbursement" "value-based purchasing" "payment model" "payment system"	"theory" "framework" "conceptual model" "theoretical model" "design" "approach" "conceptualization"	"healthcare" "health care" "health system" "health management" "health economics" "public health" "organisational theory"	"empirical" "case study" "randomized controlled trial" "RCT" "financial impact" "evaluation" "cost analysis" "clinical outcomes" "value based pricing" "value-based pricing" "insurance design" "orphan drug*" "health insurance" "drug pricing" "pharmacist*"

Table 46 -Search strategy by database, including search terms, filters, and number of results

Database: PubMed			
Steps	Search terms	Filters	Number of results
#1	(((((“value-based payment”[Title] OR “value based payment”[Title] OR “value-based reimbursement”[Title] OR “value-based purchasing”[Title] OR “payment model”[Title] OR “payment system”[Title])) AND ((“theory”[Title/Abstract] OR “framework”[Title/Abstract] OR “conceptual model”[Title/Abstract] OR “theoretical model”[Title/Abstract] OR “design”[Title/Abstract] OR “approach”[Title/Abstract] OR “conceptualization”[Title/Abstract]))) AND ((“healthcare”[Title/Abstract] OR “health care”[Title/Abstract] OR “health system”[Title/Abstract] OR “health management”[Title/Abstract] OR “health economics”[Title/Abstract] OR “public health”[Title/Abstract] OR “organisational theory”[Title/Abstract]))) NOT ((“empirical”[Title/Abstract] OR “case study”[Title/Abstract] OR “randomized controlled trial”[Title/Abstract] OR “RCT”[Title/Abstract]))) NOT ((“financial impact”[Title/Abstract] OR “evaluation”[Title/Abstract] OR “cost analysis”[Title/Abstract] OR “clinical outcomes”[Title/Abstract] OR “value based pricing”[Title/Abstract] OR “value-based pricing”[Title/Abstract] OR “insurance design”[Title/Abstract] OR “orphan drug*”[Title/Abstract] OR “health insurance”[Title/Abstract] OR “drug pricing”[Title/Abstract] OR “pharmacist*”[Title/Abstract]))	English From 2015 – 2025	**71**
Database: Web of Science			
Steps	Search terms	Filters	Number of results
#1	(“value-based payment” OR “value based payment” OR “value-based reimbursement” OR “value-based purchasing” OR “payment model” OR “payment system”) (Topic) AND (“theory” OR “framework” OR “conceptual model” OR “theoretical model” OR “design” OR “approach” OR “conceptualization”) (Topic) AND (“healthcare” OR “health care” OR “health system” OR “health management” OR “health economics” OR “public health” OR “organisational theory”) (Topic) NOT (“empirical” OR “case study” OR “randomized controlled trial” OR “RCT”) (Topic) NOT (“financial impact” OR “evaluation” OR “cost analysis” OR “clinical outcomes” OR “value based pricing” OR “value-based pricing” OR “insurance design” OR “orphan drug*” OR “health insurance” OR “drug pricing” OR “pharmacist*”)	English From 2015 – 2025	**74**
Database: Scopus			
Steps	Search terms	Filters	Number of results
#1	(“value-based payment” OR “value based payment” OR “value-based reimbursement” OR “value-based purchasing” OR “payment model” OR “payment system”) (Title) AND (“theory” OR “framework” OR “conceptual model” OR “theoretical model” OR “design” OR “approach” OR “conceptualization”) (Topic) AND (“healthcare” OR “health care” OR “health system” OR “health management” OR “health economics” OR “public health” OR “organisational theory”) (Topic) NOT (“empirical” OR “case study” OR “randomized controlled trial” OR “RCT”) (Topic) NOT (“financial impact” OR “evaluation” OR “cost analysis” OR “clinical outcomes” OR “value based pricing” OR “value-based pricing” OR “insurance design” OR “orphan drug*” OR “health insurance” OR “drug pricing” OR “pharmacist*”)	English From 2015 – 2025	**139**

D.3. PRISMA flow diagram

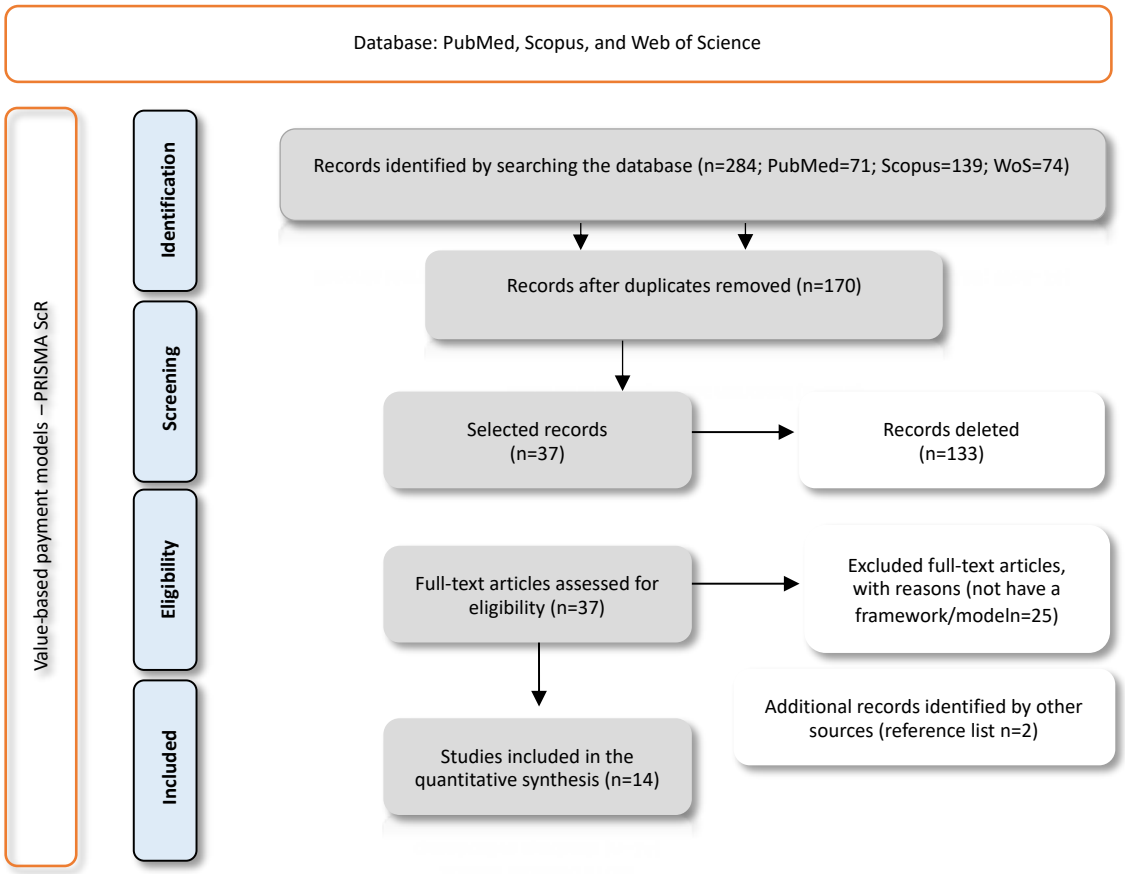


Figure 12 – PRISMA Diagram

D.4. Definitions of the Main Categories for Data Extraction

Table 47 – Definitions of the main categories used for data extraction

Main Categories	***Definition***
Key Components	Key components refer to the foundational elements or building blocks that define the structure and purpose of a VBP model. They capture the conceptual priorities and guiding principle that shape how VBP models are designed to improve outcomes, patient experience, and cost-efficiency.
Core Activities	Core activities represent the essential processes and actions undertaken during the design, development, and implementation of a VBP model.
Core Capabilities	Core capabilities are the organizational and professional competencies required to plan, implement, and sustain a VBP model effectively.
Resources Required	Resources required refer to the infrastructural, technological, human, and financial supports necessary to develop and implement VBP model.

Note: VBP - Value-Based Payment

D.5. Data Extraction Table

Table 48 – Data extracted from the studies included in the scoping review

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
(Conrad et al., 2016)	Implementing Value-Based Payment Reform: A Conceptual Framework and Case Examples	2016	To create and apply a conceptual framework for evaluating multi-stakeholder VBP initiatives, grounded in existing theories, to inform healthcare financing practice and research.	1. Socio-Political Context – Influence of broader social and political environments on the initiation and direction of payment reforms. 2. Reform Learning Cycle – Use of insights and outcomes from prior payment reform experiences to guide future strategies and implementations 3. Iterative Nature of Reform – Recognition of payment reform as a continuous, adaptive process rather than a singular intervention. 4. Patient Value-Dimensions of Value to the Patient – Cost, Quality, Experience and Health outcomes	1. Empathize 2. Define 3. Ideate 4. Prototype 5. Test 6. Implement	1. Assess the internal and external context. 2. Promote the adoption of innovative models. 3. Define the objectives of the payment reform. 4. Design a comprehensive reform strategy. 5. Develop a delivery system reform. 6. Ensure alignment between payment and delivery system reforms. 7. Implement the reform strategy through operational changes. 8. Identify and address barriers and facilitators to reform implementation.	1. Leadership Development – Guiding organizations through transformational change by aligning leadership practices with culture and organizational dynamics. 2. Policy Interpretation – Analysing and translating policy developments into strategic opportunities for reform readiness and system adaptation. 3. Change Management – Embracing reform as a continuous process and aligning internal strategies to facilitate organizational adaptation. 4. Innovation Motivation – Cultivating an environment that encourages experimentation and adoption of APM models. 5. Implementation Capacity Building – Developing internal capabilities and	1. Healthcare Professional Resources – Resources related to the characteristics of healthcare professionals (e.g., qualifications, expertise, experience, attitudes, and readiness for change). 2. Innovation-Related Resources – Resources associated with the features of the intervention or innovation itself (e.g., complexity, usability, adaptability, and perceived benefits).

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
							infrastructure to operationalize new payment models effectively and sustainably.	
(Gratale et al., 2022)	Paediatric alternative payment models: Emerging elements	2022	To explore emerging features of paediatric APMs, uncover strategies to overcome implementation barriers, and present relevant policy recommendations.	1. Strength-Based Approach – Integration of risk stratification methods addressing both medical and social determinants of health. 2. Care Coordination – Systematic organization of patient care activities and information sharing among all participants involved. 3. Integration with Social Services – Facilitation of connections between healthcare systems and social support services to address non-medical needs. 4. Promotion of Resilience and Well-Being – Emphasis on enhancing individual and community capacity for resilience, supporting long-term	1. Empathize 2. Define 3. Test 4. Prototype	1. Establish contextual foundations through social and policy integration. 2. Define the target population. 3. Assess implementation dynamics. 4. Incorporate core components of specific APMs.	1. Evidence-Based Research – Capability to design and conduct research grounded in empirical evidence to inform strategies for adopting APMs.	1. Contracting Infrastructure – Resources related to the contracting entity, which is responsible for engaging with payers and establishing the APM framework to enhance community involvement. 2. Data Resources – Access to and management of data systems necessary for performance measurement, outcome tracking, and informed decision-making within the VBP model. 3. Workforce Resources – A well-prepared and adequately staffed workforce to support the operational and clinical demands of

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
				health and wellness across the life course.				implementing and sustaining value-based care.
(Halder et al., 2020)	Creating a bundled care payment model for treatment of pelvic floor disorders: introducing value into urogynecology	2020	To detail the creation of a bundled care payment model for women with pelvic floor disorders, developed collaboratively with a safety-net insurer and implemented in a subspecialty clinic setting.	NR	1. Empathize 2. Define 3. Prototype 4. Test	1. Conduct a population and context analysis. 2. Perform a baseline financial assessment. 3. Design the care delivery model. 4. Plan and evaluate resource utilization.	1. Clinical Pathway Design – Competence in developing standardized treatment algorithms to ensure consistency, efficiency, and quality in care delivery. 2. Evidence-Based Practice – Proficiency in applying evidence-based guidelines to inform clinical decisions and improve patient outcomes. 3. Condition-Specific Management – Ability to implement and follow protocols tailored to the diagnosis and treatment of specific clinical conditions, supporting targeted and value-driven care.	1. Care Delivery Model Resources – Support for multidisciplinary and team-based care approaches that facilitate coordinated, collaborative service provision across providers. 2. Patient-Centred Care Resources – Infrastructure and capabilities to ensure a broad scope of services and the comprehensive delivery of care for specific medical conditions, tailored to individual patient needs. 3. Organizational Structuring Resources – Development and implementation of an Integrated Practice Unit model, structuring care delivery around

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
								patient conditions to improve efficiency, outcomes, and accountability.
(Harish et al., 2017)	How alternative payment models in emergency medicine can benefit physicians, payers, and patients	2017	To propose a framework for designing APMs in emergency medicine and demonstrate its use through four illustrative examples tailored to this clinical setting.	1. Stakeholder Engagement – Inclusive collaboration with key actors across the health system to ensure alignment of goals, shared accountability, and integrated care delivery. 2. Integration into Coordinated Care Structures – Active participation in models such as Accountable Care Organizations that emphasize quality, efficiency, and population health outcomes. 3. Policy and Governance Representation – Involvement of healthcare professionals in advisory and regulatory bodies to inform policy development and	1. Empathize 2. Define 3. Ideate	1. Conduct a system-level assessment. 2. Define the core design components of the APM. 3. Clarify the role of healthcare providers. 4. Develop and adapt the payment model.	1. Communication and Coordination – Proficiency in facilitating clear, timely communication and collaboration among care teams to ensure integrated service delivery. 2. Patient Education – Ability to engage and empower patients through effective education strategies that support informed decision-making and self-management. 3. Integrated Case Management Services – Competence in delivering coordinated, multidisciplinary case management tailored to individual patient needs across the continuum of care.	NR

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
				advocate for system-level improvements.				
(Howard et al., 2024)	Building alternative payment models in health care	2024	To review and enhance the literature on how industry experts design and implement APMs, focusing on model components and stakeholder involvement in design and contracting.	NR	1. Define 2. Test 3. Prototype 4. Implement	1. Define the population and scope of services. 2. Establish benchmarking standards, performance metrics, and data infrastructure. 3. Design the financial structure and incentives. 4. Define provider roles and foster partnerships. 5. Engage leadership and address regulatory structures to support effective implementation.	1. Strong Leadership Teams – Establishment and support of cohesive leadership structures capable of driving organizational vision, aligning stakeholders, and sustaining transformation efforts in value-based payment implementation.	1. Technological Infrastructure Resources – Existing systems and tools that enable effective data collection, integration, and analysis, supporting performance measurement, outcome evaluation, and continuous improvement within the value-based care framework.
(Kannarkat et al., 2023)	Strengthening the Center for Medicare and Medicaid Innovation's Approach to Constructing Alternative Payment Models	2023	To examine challenges in Center for Medicare and Medicaid Innovation's model development strategy and offer solutions to enhance its effectiveness in promoting	1. Beneficiary Engagement in Incentives – Involve patients in value-based incentives to align behaviours with care goals. 2. Operational Flexibility – Allow regulated flexibility (e.g., waivers) to support adaptive clinical practices.	1. Empathize 2. Define 3. Ideate 4. Prototype 5. Implement	1. Assess the historical context and organizational role. 2. Articulate clear objectives on mitigating the cost of care. 3. Identify key challenges and propose solutions through incentive alignment, bias mitigation, system	NR	NR

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
			sustainable, value-based care through improved payment models.	3. Incentive Alignment Across Models – Ensure consistency between overlapping payment models to avoid conflicting incentives. 4. Mitigation of Selection Bias – Use voluntary short-term and mandatory long-term incentives to encourage broad participation and reduce bias. 5. Population-Based Payment Transition – Shift toward payment models based on population health to control costs and enhance accountability.		reform, and stakeholder engagement. 4. Design a coherent payment model architecture. 5. Plan implementation with care.		
(Shajari Pour Mousavi et al., 2017)	Proposing a Model of "Hospital Value-Based Purchasing" in Selected Teaching Hospitals in Isfahan, Iran: 2015 – 2016	2017	To develop a localized Hospital VBPu model tailored to selected teaching hospitals in Isfahan, Iran, during 2015–2016.	NR	1. Define 2. Test	1. Develop policy formulation to guide the formulation and operationalization of value-based payment models. 2. Define model dimensions and components using structural, quality,	1. Knowledge Integration – Ability to synthesize scientific information, clinical guidelines, educational content, and professional experience to inform evidence-based decision-making and practice.	1. Scientific a Resources – Access to exclusive scientific evidence and innovative technologies that inform and support value-based care strategies. 2. Technological Resources – Availability of

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
						experience, and efficiency metrics. 3. Validate the model's functionality through pilot testing or phased deployment.		advanced equipment and technological tools essential for diagnosis, treatment, monitoring, and evaluation.
(Nowak, 2016)	Hospice Value-Based Purchasing Program: A Model Design	2016	To design a flexible VBPu model for the Medicare Hospice benefit that aligns payment with care quality and efficiency.	NR	1. Test 2. Prototype 3. Implement	1. Select quality measures across process, outcome, and efficiency domains to assess performance. 2. Establish a performance scoring system. 3. Design and implement the payment methodology. 4. Facilitate public reporting of provider performance.	NR	NR
(Riley et al., 2019)	A framework for oral health care value-based payment approaches	2019	To introduce a value-based payment framework tailored to oral health care	1. Coverage Expansion – Addressing service-specific coverage gaps to promote equitable access and comprehensive health benefits. 2. Quality Measurement – Implementing metrics that capture the processes and	1. Empathize	1. Identify and classify the full range of healthcare payment models.	NR	NR

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
				outcomes of care to ensure accountability and continuous improvement. 3. VBP-Aligning financial incentives with patient health outcomes by linking reimbursement to value rather than volume. 4.Care Delivery Reform – Redesigning the delivery model to enhance coordination, efficiency, and patient-centeredness across the continuum of care.				
(Leao et al., 2024)	How to facilitate the introduction of value-based payment models?	2024	To identify essential design elements for pilot Value-Based Payment models, with a focus on the requirements for effective agreements between payers and healthcare organizations	NR	1. Empathize 2. Prototype 3. Test	1. Account for external factors such as regulations, financial misalignments, impact assessments, and patient journey insights. 2. Analyse internal organizational factors. 3. Design contractual elements by aligning model types with strategic goals. 4. Implement rigorous evaluation processes.	1. Multidisciplinary Team Engagement – Valuing diverse perspectives and insights from all team members to enhance comprehensive care delivery. 2. Collaboration and Communication – Ensuring transparency and shared decision-making through standardized communication, regular meetings, and active listening to all	1. Infrastructure and Technology Resources – Investment in healthcare infrastructure and equipment an implementation and maintenance of EHRs to support coordinated data-driven care. 2. Data Management Resources – Systems for patient data collection, storage, and access and

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
						5. Identify and mitigate unintended consequences.	stakeholders, including patients and caregivers. 3. Leadership Competency – Setting strategic goals, fostering a culture of improvement, managing change, and aligning processes with value-based care objectives. 4. Collaborative Learning Capacity – Partnering with internal and external learning teams to develop strategies, improve care outcomes, and control healthcare costs.	mechanisms to incentivize accurate and consistent reporting, ensuring data integrity and accountability. 3. Organisational Process Resources – Development of personalised organisational processes tailored to the specific needs and goals of the care model, promoting alignment with value-based care principles.
(Lighter et al., 2023)	The Framework for Value Based Purchasing in Health Care	2023	To pinpoint key design factors in pilot VBP models, emphasizing the conditions needed for successful payer-provider agreements.	1. Transparency – Public reporting of performance data empowers patient decision-making, reinforces provider accountability, and enhances trust through greater visibility of care quality. 2. Performance Assessment – Comparative analysis across peer	1. Define 2. Ideate 3. Test 4. Implement	1. Define quality measures as metrics assessing provider performance, including process, outcome, experience, and efficiency domains. 2. Employ benchmarking to compare provider performance against established standards or peer groups. 3. Implement payment adjustments that align	NR	NR

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
				organizations to identify performance gaps. 3. Goal Setting: Establishing evidence-based targets to incentivize quality and efficiency improvements. 4. Continuous Improvement – Ongoing evaluation against benchmarks to monitor progress and stimulate adaptive learning. 5. Accountability Mechanisms – Use of benchmarks in public reporting to drive provider responsibility and system responsiveness.		financial incentives with quality performance. 4. Recognize the economic effects of quality measurement on providers. 5. Promote continuous improvement to enhance care quality.		
(Cattel et al., 2020)	Value-based provider payment: towards a theoretically preferred design	2020	To define core value dimensions in VBP models and create a theory-driven framework that integrates implicit base payments with explicit performance	1. High-Quality Care – Emphasis on clinical effectiveness and patient-reported outcomes to ensure both technical excellence and person-centred care. 2. Cost-Conscious Behaviour – Prudent allocation and utilization	1. Empathize 2. Define 3. Prototype 4. Implement	1. Consider contextual and structural determinants. 2. Define the population and scope of care. 3. Incorporate societal and policy preferences. 4. Establish core components of VBP models.	NR	1. Multidisciplinary Provider Group Resources – The ability to collaborate across various healthcare disciplines to deliver integrated and patient-centred care. 2. Implementation Feasibility and System

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
			incentives for optimal design.	of resources to minimize inefficiencies and avoid overuse. 3. Well-Coordinated Care – Integrated, multidisciplinary collaboration across the care continuum to enhance continuity and comprehensiveness of care. 4. Cost-Effective Innovation – Adoption of health interventions and technologies that improve outcomes while reducing or maintaining costs. 5. Cost-Effective Prevention – Investment in preventive strategies that avert disease progression and reduce long-term healthcare expenditure.		5. Implement risk management and adjustment mechanisms. 6. Address operationalisation considerations.		Resources – The integration of robust data systems, overcoming the challenges of siloed providers, and ensuring effective IT infrastructure to support value-based care.
(K. Patel et al., 2016)	Shifting away from fee-for-service: alternative approaches to payment in gastroenterology	2016	To examine APMs in gastroenterology that promote high-value care through targeted delivery reforms and	NR	1. Define 2. Test	1. Categorize types of care within the payment model design. 2. Define the payment structure. 3. Identify actionable quality measures.	NR	1. EHR Infrastructure – The establishment of a reliable and secure Electronic Medical Records system to centralize patient data and

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
			financial incentives for procedural and chronic care management.			4. Conduct comprehensive payment model evaluation.		enhance coordination across care providers. 2. Accurate Data Systems – The implementation of robust data systems to ensure accurate, real-time patient information for decision-making and performance tracking. 3. Risk Adjustment Capability – The integration of risk adjustment tools to account for patient variability and ensure fair evaluation of healthcare outcomes. 4. Multidisciplinary Provider Groups – The formation of multidisciplinary provider groups to promote collaborative care, improving treatment planning and patient outcomes. 5. Extended Patient Support Services – The provision of extended patient support services to

Ref	Title	Year	Study aim	Components	Design Thinking Phases	Activities	Capabilities	Resources
								ensure continuous care and improve patient engagement and satisfaction.
(Hayen et al., 2015)	Incorporating shared savings programs into primary care: from theory to practice	2015	To create and implement a structured method for designing a shared savings program in primary care, piloted within a Dutch network of providers.	NR	1. Define 2. Prototype 3. Implement	1. Define the scope of the pilot program. 2. Calculate provider expenditures. 3. Construct benchmarks by identifying an appropriate benchmark population. 4. Assess savings through rigorous methods to establish savings thresholds. 5. Establish savings sharing rules. 6. Design pilot program structure.	NR	NR

Note: APM- Alternative Payment Model; EHR – Electronic Health Record; NR – Not reported; VBP- Value-Based Payment; VBPu – Value-Based Purchasing

D.6. Core activities, Key Components, and Core Capabilities

Table 49 - Core Activities in Payment Reform (n=28)

Core Activity	#	References
Conducting system and organizational assessment	6	(Cattel et al., 2020; Conrad et al., 2016; Gratale et al., 2022; Halder et al., 2020; Kannarkat et al., 2023; Leao et al., 2024)
Defining and operationalizing quality and performance metrics	4	(Howard et al., 2024; Lighter et al., 2023; Nowak, 2016; K. Patel et al., 2016)
Analysing implementation drivers	3	Conrad et al., 2016; Gratale et al., 2022; Harish et al., 2017
Defining the target population	3	(Cattel et al., 2020; Gratale et al., 2022; Howard et al., 2024)
Defining scope of services and categories of care	3	(Cattel et al., 2020; Howard et al., 2024; K. Patel et al., 2016)
Designing payment model architecture	3	(Cattel et al., 2020; Harish et al., 2017; Kannarkat et al., 2023)
Planning and operationalizing reform execution	3	(Cattel et al., 2020; Kannarkat et al., 2023; Lighter et al., 2023)
Assessing population and social determinants	2	(Cattel et al., 2020; Halder et al., 2020)
Setting strategic reform objectives	2	(Conrad et al., 2016; Kannarkat et al., 2023)
Developing guiding policy and aligning leadership	2	(Howard et al., 2024; Shajari Pour Mousavi et al., 2017)
Designing care delivery model	2	(Conrad et al., 2016; Halder et al., 2020)
Defining providers' roles and partnerships	2	(Harish et al., 2017; Howard et al., 2024)
Aligning payment with delivery reforms and quality	2	(Conrad et al., 2016; Lighter et al., 2023)
Analysing and incorporating existing model elements	2	(Gratale et al., 2022; Riley et al., 2019)
Conducting financial baseline and savings analysis	2	(Halder et al., 2020; Hayen et al., 2015)
Designing payment structure and incentives	2	(Howard et al., 2024; K. Patel et al., 2016)
Identifying reference populations	1	(Hayen et al., 2015)
Aligning contracts with strategic objectives	1	(Leao et al., 2024)
Planning and evaluating resource use	1	(Halder et al., 2020)
Defining savings-sharing rules	1	(Hayen et al., 2015)
Implementing risk adjustment mechanisms	1	(Cattel et al., 2020)
Identifying and mitigating unintended effects	1	(Leao et al., 2024)
Designing pilot program structure	1	(Hayen et al., 2015)
Piloting/phasing model implementation	1	(Shajari Pour Mousavi et al., 2017)
Creating a performance scoring system	1	(Nowak, 2016)
Strengthening quality evaluation	1	(Lighter et al., 2023)
Assessing savings and limitations	1	(Hayen et al., 2015)
Enabling public reporting of performance	1	(Nowak, 2016)

Table 50 - Core Components of VBP Models (n=17)

Core Components	Definition	#	References
Care Coordination	Promotes multidisciplinary collaboration and integrated care models.	3	(Cattel et al., 2020; Gratale et al., 2022; Harish et al., 2017)
Contextual Foundations	Considers social, political, and economic factors shaping payment reforms.	2	(Conrad et al., 2016; Kannarkat et al., 2023)
Equity Strategies	Designs payments to reduce disparities and promote inclusion.	2	(Kannarkat et al., 2023; Riley et al., 2019)
Innovative Care Delivery	Redesigns care pathways for efficiency and integration with social services.	2	(Gratale et al., 2022; Riley et al., 2019)
Payment Model Alignment	Shifts toward population-based payments tied to value, not volume.	2	(Kannarkat et al., 2023; Riley et al., 2019)
Quality Measurement	Uses validated metrics, including PROMs, to assess care quality.	2	(Cattel et al., 2020; Riley et al., 2019)
Reform Dynamics	Emphasizes adaptive, learning-based reform processes.	1	(Conrad et al., 2016)
User-Centred Value	Defines value through user perspectives: cost, quality, experience, and outcomes, with active user engagement.	1	(Conrad et al., 2016; Kannarkat et al., 2023)
Population Risk Management	Uses medical and social risk data to target care effectively.	1	(Gratale et al., 2022)
Stakeholder Engagement	Involves all healthcare actors to ensure shared ownership.	1	(Harish et al., 2017)
Participatory Governance	Includes providers in decision-making and policy structures.	1	(Harish et al., 2017)
Incentive Alignment	Aligns incentives across schemes and supports flexible clinical practices.	1	(Kannarkat et al., 2023)
Performance Benchmarking	Compares performance across peers to drive improvement.	1	(Lighter et al., 2023)
Accountability Mechanisms	Ensures transparency and continuous evaluation.	1	(Lighter et al., 2023)
Cost Efficiency	Invests in prevention and allocates resources strategically.	1	(Cattel et al., 2020)
Cost-Effective Innovation	Prioritizes technologies that improve outcomes at lower costs.	1	(Cattel et al., 2020)
Health Promotion & Resilience	Builds long-term individual and community health capacity.	1	(Gratale et al., 2022)

Table 51 - Core Capabilities Required for VBP Models (n=9)

Capability	#	References
Strategic Leadership and Governance	3	(Conrad et al., 2016; Howard et al., 2024; Leao et al., 2024)
Adaptive Implementation and Organizational Learning	2	(Conrad et al., 2016; Leao et al., 2024)
Design Thinking and Investigative Application	2	(Halder et al., 2020; Shajari Pour Mousavi et al., 2017)

Capability	#	References
Stakeholder-Aligned Strategy and Engagement	2	(Harish et al., 2017; Leao et al., 2024)
Strategic Policy Interpretation	1	(Conrad et al., 2016)
Payment Innovation and Reform Driving	1	(Conrad et al., 2016)
Evidence-Based Clinical Practice and Condition-Based Care Management	1	(Halder et al., 2020)
Patient-Centred Care Coordination	1	(Harish et al., 2017)
Patient Empowerment and Education	1	Harish et al., 2017

D.7. Questionnaire

VALUE-BASED PAYMENT COMPETENCY ASSESSMENT QUESTIONNAIRE

This questionnaire is designed to assess the presence and maturity of competencies related to the design, implementation, and governance of Value-Based Payment models. It is structured in five Focus Areas, *Key Components,* and questions/capabilities.
Please select the scale most appropriate:

- Please indicate from 0 to 100 your level of agreement with each statement:
- Please indicate from 1 (Nonexistent) to 7 (full implemented) your level of agreement with each statement:
- Please indicate from the fuzzy values of competency level = {'NE', 'I', 'D', 'PE', 'E', 'A', 'R'} (# Nonexistent, Initial, Developing, Partially Established, Established, Advanced, Refined) your level of agreement with each statement; and indicate from the fuzzy reliability level = {'NC', 'SC', 'C', 'VC', 'AC'} (# Not confident at all, Slightly confident, Confident, Very confident, Almost certain) your level of confidence with each statement:
- ...

1. Strategic Foundations & Governance

Contextual Foundations

Q1: Competency in interpreting social, political, and economic contexts shaping payment models. *(Conrad et al., 2016; Kannarkat et al., 2023)*

Q2: Competency in strategic policy interpretation to inform reform alignment. *(Conrad et al., 2016)*

Reform Dynamics

Q3: Competency in leading adaptive implementation and promoting organizational learning. *(Conrad et al., 2016; Leao et al., 2024)*

Stakeholder Engagement

Q4: Competency in aligning stakeholder strategy and fostering multisectoral engagement. *(Harish et al., 2017; Leao et al., 2024)*

Participatory and Transparent Governance

Q5: Competency in promoting participatory governance through inclusive decision-making structures. *(Harish et al., 2017)*

Q6: Competency in establishing transparent governance with mechanisms for monitoring and continuous improvement. *(Lighter et al., 2023)*

Value Concept

Q7: Competency in defining value from user perspectives and ensuring active user involvement. *(Conrad et al., 2016; Kannarkat et al., 2023)*

Strategic Leadership and Governance

Q8: Competency in setting vision, aligning goals, and driving strategic transformation in payment reform. *(Conrad et al., 2016; Howard et al., 2024; Leao et al., 2024)*

2. Population & Equity-Centred Design

Population Risk Management

Q9: Competency in assessing medical and social risks to effectively target populations. *(Gratale et al., 2022))*

Equity Strategies

Q10: Competency in designing inclusive payment systems to reduce disparities and promote social equity. *(Kannarkat et al., 2023; Riley et al., 2019)*

User-Centred Value

Q11: Competency in using person-centred definitions of value, including experience, quality, cost, and outcomes. *(Conrad et al., 2016; Kannarkat et al., 2023)*

Patient Empowerment and Education

Q12: Competency in engaging patients through education to support informed decision-making and self-management. *(Harish et al., 2017)*

3. Model & Service Architecture

Payment Model Alignment

Q13: Competency in designing and implementing value-based population payment structures. *(Kannarkat et al., 2023; Riley et al., 2019)*

Q14: Competency in aligning financial mechanisms with care delivery reforms. *(Conrad et al., 2016; Lighter et al., 2023)*

Incentive Alignment

Q15: Competency in structuring payment incentives to support value-based, flexible care delivery. *(Kannarkat et al., 2023)*

Cost Efficiency

Q16: Competency in planning resource allocation and investing in preventive and high-value care. *(Cattel et al., 2020)*

Tecnological Innovation

Q17: Competency in selecting and implementing innovations that improve outcomes at lower cost. *(Cattel et al., 2020)*

Design Thinking and Investigative Application

Q18: Competency in applying design thinking to develop and refine payment models. *(Shajari Pour Mousavi et al., 2017)*

Payment Innovation and Reform Driving

Q19: Competency in conceptualizing and leading payment reform initiatives. *(Conrad et al., 2016)*

4. Integrated Care Delivery

Innovative Care Delivery

Q20: Competency in redesigning care pathways to improve coordination, access, and integration with social services. *(Gratale et al., 2022; Riley et al., 2019)*

Care Coordination

Q21: Competency in implementing multidisciplinary, patient-centred care coordination strategies. *(Cattel et al., 2020; Gratale et al., 2022; Harish et al., 2017)*

Q22: Competency in delivering case management adapted to individual needs. *(Harish et al., 2017)*

Condition-Based Care Management

Q23: Competency in managing care based on specific conditions using standardised clinical pathways. *(Halder et al., 2020)*

Evidence-Based Clinical Practice

Q24: Competency in applying clinical guidelines and evidence to enhance outcomes and quality. *(Halder et al., 2020)*

5. Measurement, Evaluation & Learning

Quality Measurement

Q25: Competency in defining, applying, and monitoring clinical and patient-reported outcome metrics. *(Cattel et al., 2020; Riley et al., 2019)*

Performance Benchmarking

Q26: Competency in using peer-based performance comparisons to guide improvement. *(Lighter et al., 2023)*

Accountability Mechanisms

Q27: Competency in enabling performance monitoring, public reporting, and continuous evaluation. *(Lighter et al., 2023)*

D.8.Artificial data expressed in *LZN*

Table 52 - Artificial data expressed in LZN

Question ID	Exp_1	Exp_2	Exp_3	Exp_4	Exp_5	Exp_6	Exp_7	Exp_8	Exp_9	Exp_10
Q1	(A,C)	(I,C)	(R,VC)	(I,C)	(D,AC)	(E,C)	(I,SC)	(E,C)	(NE,VC)	(D,AC)
Q2	(I,VC)	(R,AC)	(E,VC)	(PE,AC)	(E,VC)	(I,AC)	(D,VC)	(E,C)	(E,VC)	(R,AC)
Q3	(E,SC)	(A,VC)	(PE,C)	(PE,AC)	(D,C)	(R,C)	(PE,VC)	(E,AC)	(E,VC)	(A,C)
Q4	(E,AC)	(NE,NC)	(E,VC)	(I,AC)	(R,SC)	(PE,SC)	(A,VC)	(E,AC)	(A,VC)	(PE,NC)
Q5	(I,SC)	(R,C)	(R,C)	(E,VC)	(R,VC)	(PE,VC)	(R,VC)	(E,SC)	(I,C)	(R,AC)
Q6	(R,AC)	(PE,AC)	(PE,C)	(E,C)	(PE,VC)	(PE,SC)	(A,SC)	(A,C)	(R,AC)	(D,VC)
Q7	(E,C)	(D,AC)	(D,AC)	(E,VC)	(I,AC)	(A,AC)	(D,AC)	(E,C)	(PE,NC)	(R,SC)
Q8	(E,C)	(D,VC)	(A,VC)	(NE,AC)	(R,VC)	(R,AC)	(E,AC)	(E,VC)	(R,AC)	(PE,VC)
Q9	(D,AC)	(PE,C)	(NE,VC)	(A,VC)	(PE,AC)	(R,AC)	(D,SC)	(A,VC)	(NE,C)	(PE,C)
Q10	(D,AC)	(A,VC)	(R,NC)	(PE,C)	(R,C)	(NE,VC)	(E,AC)	(NE,VC)	(D,C)	(R,SC)
Q11	(A,SC)	(E,VC)	(E,VC)	(A,AC)	(D,NC)	(R,C)	(A,VC)	(A,C)	(A,VC)	(A,C)
Q12	(R,AC)	(D,VC)	(R,VC)	(A,C)	(A,C)	(E,SC)	(E,AC)	(R,C)	(A,AC)	(PE,C)
Q13	(D,VC)	(A,NC)	(D,SC)	(A,C)	(E,VC)	(D,SC)	(I,AC)	(E,AC)	(D,AC)	(R,AC)
Q14	(R,C)	(I,VC)	(A,AC)	(R,C)	(E,SC)	(I,C)	(E,C)	(I,AC)	(E,C)	(R,VC)

Question ID	Exp_1	Exp_2	Exp_3	Exp_4	Exp_5	Exp_6	Exp_7	Exp_8	Exp_9	Exp_10
Q15	(PE,VC)	(D,C)	(I,SC)	(A,NC)	(A,VC)	(A,AC)	(I,VC)	(D,AC)	(E,NC)	(A,SC)
Q16	(R,AC)	(A,VC)	(E,AC)	(I,C)	(I,AC)	(R,C)	(A,VC)	(A,SC)	(A,C)	(I,VC)
Q17	(D,VC)	(A,VC)	(E,VC)	(D,AC)	(E,AC)	(A,VC)	(PE,VC)	(E,C)	(A,AC)	(A,C)
Q18	(E,AC)	(I,C)	(A,SC)	(PE,VC)	(A,C)	(A,VC)	(D,AC)	(D,SC)	(PE,C)	(D,AC)
Q19	(PE,AC)	(R,AC)	(PE,C)	(D,AC)	(NE,NC)	(A,C)	(I,SC)	(A,AC)	(D,C)	(A,C)
Q20	(R,VC)	(E,AC)	(E,C)	(E,SC)	(A,C)	(A,C)	(A,VC)	(D,VC)	(D,SC)	(I,AC)
Q21	(R,SC)	(A,VC)	(A,C)	(E,VC)	(I,AC)	(R,SC)	(E,NC)	(I,AC)	(R,SC)	(A,AC)
Q22	(A,AC)	(D,AC)	(A,C)	(NE,SC)	(D,C)	(E,SC)	(E,AC)	(PE,VC)	(R,VC)	(A,AC)
Q23	(A,AC)	(R,SC)	(I,AC)	(A,C)	(I,C)	(E,AC)	(NE,C)	(I,C)	(R,AC)	(PE,VC)
Q24	(A,VC)	(A,C)	(E,AC)	(D,AC)	(E,AC)	(D,NC)	(E,C)	(A,AC)	(E,VC)	(PE,C)
Q25	(I,AC)	(A,SC)	(D,VC)	(D,SC)	(E,SC)	(A,C)	(R,SC)	(A,C)	(NE,AC)	(A,C)
Q26	(PE,VC)	(E,SC)	(E,VC)	(R,VC)	(A,AC)	(E,AC)	(I,SC)	(I,SC)	(D,SC)	(A,SC)
Q27	(I,SC)	(E,C)	(E,VC)	(I,C)	(NE,NC)	(E,VC)	(PE,VC)	(A,AC)	(I,VC)	(A,AC)

D.9.Z-TOPSIS Steps

Considering two finite, discrete linguistic term sets representing different preference data defined as $S = \{s_0, s_1, \dots, s_m\}$ and $T = \{s'_0, s'_1, \dots, s'_n\}$, a linguistic term set in a universe of discourse U is defined as:

$$Z = \{(u, A_{\varphi(u)}.B_{\phi(u)}) | u \epsilon U\} \quad (1)$$

with $s \epsilon S$ being a possible value of the linguistic variable; S it is an ordered set of terms $(s_l < s_k, if\ and\ only\ if\ l < k)$. Arithmetic operations for LZNs were developed by Wang et al. (2017), and their aggregation operators by (Mahmoodi et al., 2020).

Step 1: Evaluate the capabilities

A typical decision matrix, D_{ci}, comprises a set of alternatives (in our case, capabilities) evaluated by a set of criteria *i* (in our case, by only one measure, the LZN).

$$D_{ci} = \begin{array}{c|cccc} & \mathcal{I}_1 & \mathcal{I}_2 & \cdots & \mathcal{I}_q \\ \hline \mathcal{C}_1 & Z_{11} & Z_{12} & \cdots & Z_{1q} \\ \mathcal{C}_2 & Z_{21} & Z_{22} & \cdots & Z_{2q} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \mathcal{C}_p & Z_{p1} & Z_{p2} & \cdots & Z_{pq} \end{array}; \quad D_{ci} = \begin{array}{c|c} & \mathcal{I}_1 \\ \hline \mathcal{C}_1 & Z_{11} \\ \mathcal{C}_2 & Z_{21} \\ \vdots & \vdots \\ \mathcal{C}_p & Z_{p1} \end{array}; \quad D^g_{ci} = \begin{array}{c|c} & \mathcal{I}_1 \\ \hline \mathcal{C}_1 & ((l^g_{11}, m^g_{11}, n^g_{11}), (t^g_{11}, u^g_{11}, v^g_{11})) \\ \mathcal{C}_2 & ((l^g_{21}, m^g_{21}, n^g_{21}), (t^g_{21}, u^g_{21}, v^g_{21})) \\ \vdots & \vdots \\ \mathcal{C}_p & ((l^g_{p1}, m^g_{p1}, n^g_{p1}), (t^g_{p1}, u^g_{p1}, v^g_{p1})) \end{array}$$

Note: Typical Decision matrix; our Decision matrix with one evaluation expressed by a LZN (z_{p1}); described by LZN for expert *g*.

Different weights are assumed among the experts in the LZN situation (g = 0.05 for experts 6 and 7; g = 0.2 for expert 3; and 0.1 for the others), and triangular fuzzy numbers ((*l, m, n*)) are used (Table 3) to represent each linguistic term, with a cardinality of 7 for the fuzzy values of capability level = {'NE', 'I', 'D', 'PE', 'E', 'A', 'R'} (# Nonexistent, Initial, Developing, Partially Established, Established, Advanced, Refined) and 5 for fuzzy reliability, which represents the confidence levels linked to fuzzy assessments, reliability = {'NC', 'SC', 'C', 'VC', 'AC'} (# Not confident at all, Slightly confident, Confident, Very confident, Almost certain). So, the the LZN is translated to a Z-number ((*l, m, n*), (*t, u, v*)).

Table 53 - TFN and expert weights

Expert weights		**Fuzzy value TFN**		**Fuzzy reliable TFN**	
Expert_1	0,1	NE	(0.00, 0.00, 0.17)	NC	(0.00, 0.00, 0.25)
Expert_2	0,1	I	(0.00, 0.17, 0.33)	SC	(0.00, 0.25, 0.50)
Expert_3	0,2	D	(0.17, 0.33, 0.50)	C	(0.25, 0.50, 0.75)
Expert_4	0,1	PE	(0.33, 0.50, 0.67)	VC	(0.50, 0.75, 1.00)
Expert_5	0,1	E	(0.50, 0.67, 0.83)	AC	(0.75, 1.00, 1.00)
Expert_6	0,05	A	(0.67, 0.83, 1.00)		
Expert_7	0,05	R	(0.83, 1.00, 1.00)		
Expert_8	0,1				
Expert_9	0,1				
Expert_10	0,1				

Note: TFN - Triangular Fuzzy Numbers

Step 2: Aggregate the individual evaluations into a group evaluation

Through the following equation, we obtained the aggregated D'_{ci}.

$$\left((l'_{ci}, m'_{ci}, n'_{ci}), (t'_{ci}, u'_{ci}, v'_{ci})\right) = \sum_{g=1}^{\#Experts}((w_g.\, l^g_{ci}, w_g.\, m^g_{ci}, w_g.\, n^g_{ci}), (t'_{ci}, u'_{ci}, v'_{ci})), \quad (2)$$

$c = 1,2, \ldots, p\ competencies; i = 1\ (evaluation\ per\ competency); g = 1,2, \ldots,$ #experts

$$D'_{ci} = \begin{array}{c|cccc} & \mathcal{E}xp_1 & \mathcal{E}xp_2 & \cdots & \mathcal{E}xp_g \\ \hline \mathcal{C}_1 & ((l'_{11}, m'_{11}, n'_{11}), (t'_{11}, u'_{11}, v'_{11})) & ((l'_{12}, m'_{12}, n'_{12}), (t'_{12}, u'_{12}, v'_{12})) & \cdots & \left((l'_{1g}, m'_{1g}, n'_{1g}), (t'_{1g}, u'_{1g}, v'_{1q})\right) \\ \mathcal{C}_2 & ((l'_{21}, m'_{21}, n'_{21}), (t'_{21}, u'_{21}, v'_{21})) & ((l'_{22}, m'_{22}, n'_{22}), (t'_{22}, u'_{22}, v'_{22})) & \cdots & \left((l'_{2g}, m'_{2g}, n'_{2g}), (t'_{2g}, u'_{2g}, v'_{2g})\right) \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \mathcal{C}_p & ((l'_{p1}, m'_{p1}, n'_{p1}), (t'_{p1}, u'_{p1}, v'_{p1})) & \left((l'_{p2}, m'_{p2}, n'_{p2}), (t'_{p2}, u'_{p2}, v'_{p2})\right) & \cdots & \left((l'_{pg}, m'_{pg}, n'_{pg}), (t'_{pg}, u'_{pg}, v'_{pg})\right) \end{array}$$

Step 3: Estimate the Z-number positive and negative ideal solutions

The ideal reference points to which the current values of each capability are compared (i.e., distances are calculated) are:

- the Z-number positive ideal solution *(ZPIS)=((1,1,1),(1,1,1))* and
- the Z-number negative ideal solution *(ZNIS)=((0,0,0),(1,1,1)).*

Step 4: Determine the distance of each capability from ZPIS and ZNIS

$$\delta_c^+ = \sum_{c=1}^{p}(Z_c, ZPIS) \quad (3)$$

$$\delta_c^- = \sum_{c=1}^{p}(Z_c, ZNIS) \quad (4)$$

The distance formula used between two Z-numbers is:

$$Distance(z_1, z_2) = Distance\left[\left((l_1, m_1, n_1), (t_1, u_1, v_1)\right); \left((l_2, m_2, n_2), (t_2, u_2, v_2)\right)\right] = \frac{1}{3}[|l_1 - l_2| + 2|m_1 - m_2|] + |n_1 - n_2| + |t_1 - t_2| + 2|u_1 - u_2| + |v_1 - v_2| \quad (5)$$

Step 5: Determine the relative closeness degree of each capability

$$CD_c = \frac{\delta_c^-}{\delta_c^- + \delta_c^+} \quad (6)$$

D.10. Capability-to-Maturity Level Mapping

Table 54 - Capability-to-Maturity Level Mapping

Dimension	Key Component	Capability	L1	L2	L3	L4	L5
Strategic Foundations and Governance	Contextual Foundations	Interpreting social, political, and economic contexts	x	x	x	x	x
		Strategic policy interpretation for reform alignment			x	x	x
	Reform Dynamics	Leading adaptive implementation and learning			x	x	x
	Stakeholder Engagement	Aligning strategy and fostering engagement			x	x	x
	Participatory and Transparent Governance	Promoting inclusive decision-making structures			x	x	x
		Establishing transparent governance					x
	Value Concept	Defining value from user perspectives		x	x	x	x

Dimension	Key Component	Capability	L1	L2	L3	L4	L5
	Strategic Leadership and Governance	Setting vision, aligning goals, driving transformation					x
Population and Equity-Centred Design	Population Risk Management	Assessing medical and social risks			x	x	x
	Equity Strategies	Designing inclusive systems for equity		x	x	x	x
	User-Centred Value	Using person-centred definitions of value			x	x	x
	Patient Empowerment and Education	Engaging patients through education	x	x	x	x	x
Model and Service Architecture	Payment Model Alignment	Designing value-based payment structures			x	x	x
		Aligning financial mechanisms with care			x	x	x
	Incentive Alignment	Structuring incentives for flexible care				x	x
	Cost Efficiency	Planning for preventive and high-value care			x	x	x
	Technological Innovation	Selecting innovations to improve outcomes			x	x	x
	Design Thinking and Investigative Application	Applying design thinking in model development			x	x	x
	Payment Innovation and Reform Driving	Leading payment reform initiatives				x	x
Integrated Care Delivery	Innovative Care Delivery	Redesigning care pathways and integration				x	x
	Care Coordination	Multidisciplinary, patient-centred coordination			x	x	x
		Case management adapted to needs			x	x	x
	Condition-Based Care Management	Managing care with standardized pathways			x	x	x
	Evidence-Based Clinical Practice	Applying evidence and guidelines			x	x	x
Measurement, Evaluation and Learning	Quality Measurement	Applying and monitoring PROMs and outcomes		x	x	x	x
	Performance Benchmarking	Using performance comparisons				x	x
	Accountability Mechanisms	Monitoring, reporting, and evaluation in system-wide learning					x

D.11. Z-TOPSIS calculations

Table 55 - Calculations using the TOPSIS with Z-numbers

Normalize aggregated *Z*-Number	S+	S-	Closeness degree	aggregated %
(0.342,0.434,0.582),(0.375,0.625,0.825)	1,253	0,815	0,394	51,43
(0.4575,0.585,0.715),(0.575,0.825,0.975)	0,819	0,999	0,549	64,29
(0.458,0.65,0.8),(0.4,0.65,0.85)	0,964	1,112	0,536	70,00
(0.433,0.584,0.733),(0.375,0.575,0.75)	1,130	1,073	0,487	64,29
(0.573,0.718,0.799),(0.35,0.6,0.825)	0,939	1,159	0,552	75,71
(0.482,0.666,0.801),(0.4,0.65,0.825)	0,953	1,138	0,544	71,43
(0.359,0.55,0.699),(0.475,0.7,0.825)	1,047	1,009	0,491	61,43

Normalize aggregated *Z*-Number	**S+**	**S-**	**Closeness degree**	**aggregated %**
(0.5165,0.667,0.783),(0.575,0.825,0.975)	0,722	1,104	0,604	71,43
(0.3,0.482,0.635),(0.45,0.7,0.875)	1,125	0,876	0,438	55,71
(0.491,0.566,0.684),(0.375,0.6,0.8)	1,106	1,001	0,475	62,86
(0.577,0.765,0.916),(0.35,0.575,0.8)	0,892	1,293	0,592	80,00
(0.633,0.766,0.883),(0.425,0.675,0.85)	0,776	1,269	0,621	80,00
(0.3935,0.549,0.699),(0.425,0.65,0.8)	1,095	1,009	0,480	61,43
(0.508,0.635,0.748),(0.375,0.625,0.825)	1,008	1,074	0,516	68,57
(0.3515,0.549,0.716),(0.325,0.525,0.725)	1,245	1,029	0,452	61,43
(0.459,0.65,0.782),(0.45,0.7,0.875)	0,911	1,101	0,547	70,00
(0.485,0.649,0.816),(0.525,0.775,0.95)	0,792	1,113	0,584	70,00
(0.393,0.532,0.7),(0.4,0.65,0.825)	1,106	0,975	0,469	60,00
(0.3835,0.532,0.684),(0.4,0.625,0.775)	1,148	0,992	0,464	60,00
(0.451,0.633,0.782),(0.375,0.625,0.825)	1,017	1,093	0,518	68,57
(0.5505,0.717,0.832),(0.35,0.575,0.75)	0,978	1,226	0,556	75,71
(0.468,0.599,0.75),(0.45,0.7,0.85)	0,961	1,063	0,525	65,71
(0.358,0.534,0.666),(0.45,0.7,0.85)	1,069	0,949	0,470	60,00
(0.4845,0.633,0.799),(0.475,0.7,0.85)	0,909	1,133	0,555	68,57
(0.377,0.582,0.733),(0.275,0.525,0.725)	1,225	1,041	0,459	64,29
(0.442,0.584,0.732),(0.3,0.55,0.75)	1,169	1,043	0,471	64,29
(0.3255,0.468,0.632),(0.4,0.625,0.825)	1,211	0,882	0,422	54,29
		Total	**0,510**	**65,98**

E. Appendix to Chapter 6

E.1. Survey Instrument

1. Informed Consent

Title of the Study: Designing Value-Based Payment in Healthcare: Expert Contributions to Framework Development

You are invited to participate in a research study conducted by [Name] at [University]. The objective of this study is to establish a framework for the development, construction, and implementation of value-based payment models, based on expert opinion in the field.

Participation involves completing a questionnaire, which takes approximately 20 minutes. Data will be collected once and stored securely. Participation is voluntary, and you may withdraw at any time without providing a reason or facing any consequences.

All responses will be kept confidential and anonymous. The information collected will be used exclusively for academic research purposes and will comply with GDPR and university ethics guidelines.

For questions regarding data protection, you may contact the University Data Protection Officer at [email].

This research is funded by [Institution] and supervised by [Supervisor Name].

For further information, please contact:

[Name]

[Email]

☐ I have read and understood the information provided above and voluntarily agree to participate in this study.

2. Survey Structure



The survey was organised into five sections:

1. Identifying key components of VBP
2. Mapping the phases of development
3. Linking each phase to its core activities
4. Associating activities with the necessary core capabilities
5. Identifying the resources required to support those capabilities

Section 1 – Identifying key components of Value-Based Payment models

Question1: Which of the following do you consider essential components of a Value-Based Payment model? (Select all that apply)

- Contextual Foundations
- Reform Dynamics
- User-Centred Value
- Population Risk Management
- Equity Strategies
- Innovative Care Delivery
- Care Coordination
- Stakeholder Engagement
- Participatory Governance
- Incentive Alignment
- Payment Model Alignment
- Quality Measurement
- Performance Benchmarking
- Accountability Mechanisms
- Cost Efficiency
- Cost-Effective Innovation
- Health Promotion & Resilience
- Other (please specify)

Question 2. Confidence Level: Respondents were asked to indicate their confidence level in their selections on a scale from 0% (Not confident at all) to 100% (Extremely confident).

Section 2 – Mapping the phases of development

Question 3. Ranking Exercise**:** Respondents were asked to rank the following phases in order of occurrence in the development and implementation of a Value-Based Payment model:

- Stakeholder Insight and Context Analysis
- Problem Definition and Value Proposition Clarification
- Strategic Co-Design and Conceptual Modelling
- Model Structuring and Operational Design
- Pilot Implementation and Performance Assessment
- Full-Scale Deployment and System Integration

- Other (please specify)

Participants could also select “Not Applicable”.

Question 4. Confidence Level: Measured using a 0–100% confidence scale.

Section 3 –Linking phases to core activities

Question 5. Respondents were asked to indicate to which phase(s) each of the following activities belongs (multiple selections allowed):

- Conduct system and organisational assessment
- Assess population and social determinants
- Analyse implementation drivers
- Define the target population
- Identify reference populations
- Set strategic reform objectives
- Develop guiding policy and align leadership
- Align contracts with strategic objectives
- Design care delivery model
- Define scope of services and categories of care
- Define providers’ roles and partnerships
- Plan and evaluate resource use
- Align payment with delivery reforms and quality
- Design payment model architecture
- Analyse and incorporate existing model elements
- Conduct financial baseline and savings analysis
- Define savings-sharing rules
- Implement risk adjustment mechanisms
- Identify and mitigate unintended effects
- Design payment structure and incentives
- Design pilot programme structure
- Pilot or phase implementation
- Plan and operationalise reform execution
- Define and operationalise quality metrics
- Create performance scoring system
- Strengthen quality evaluation

- Assess savings and limitations
- Enable public reporting of performance
- Other (please specify)

Question 6. Confidence Level: Confidence was measured using a 0–100% scale.

Section 4 – Associating activities with required core capabilities

Question 7. Respondents were asked to identify which core capabilities are critical for each activity (multiple selections allowed):

- Core Capabilities included:
- Strategic leadership and governance
- Strategic policy interpretation
- Stakeholder-aligned strategy and engagement
- Adaptive implementation and organisational learning
- Payment innovation and reform driving
- Design thinking and investigative application
- Evidence-based clinical practice
- Condition-based care management
- Healthcare team coordination and integration
- Patient-centred care coordination
- Patient empowerment and education

Question 8. Open-ended question: "Are there additional capabilities you consider important?"

Question 9. Confidence measured using 0–100% scale.

Section 5 – Identifying resources supporting those capabilities

Question 10. Respondents were asked to identify which resources are essential for each capability (multiple selections allowed). Resources included:

- Leadership resources
- Contracting and payer engagement mechanisms
- Clinical decision support technologies
- Health data systems and infrastructure
- Integrated team-based care structures
- Value-oriented infrastructure and facilities
- Patient support service programmes
- Evidence and innovation platforms

- Risk adjustment tools and methodologies

Question 11. Open-ended question: "Are there other resources that should be considered?"

Question 12. Confidence measured using 0–100% scale.

Section 6 – Respondent Profile

Question 13. Professional Role (multiple selections allowed)

- Professor
- Researcher
- Healthcare Manager
- Medical Doctor
- Policy Advisor
- Consultant
- Other (please specify)

Question 14. Primary Areas of Interest in Value-Based Healthcare

- Patient outcomes measurement
- Value-Based Payment models
- Clinical pathway redesign
- Health information systems
- Health policy implementation
- Cost-effectiveness evaluation
- Patient engagement
- Quality improvement
- Education and training
- Other (please specify)

Question 15. Years of Experience in Value-Based Payment

- Less than 3 years
- 3–5 years
- 6–8 years
- 9–11 years
- More than 11 years

Question 16. Participation in Design/Implementation

- Yes, directly involved
- Yes, indirectly involved

- No, but studied/researched the topic

E.2. Ethics Committee Approval



Universidade do Minho

Conselho de Ética

Comissão de Ética para a Investigação em Ciências Sociais e Humanas (CEICSH)

Identificação do documento: CEICSH 140/2025

Título do projeto: *Hospital Value Based Reimbursement*

Equipa de Investigação: Ana Sofia Rodrigues Moreira (IR), Doutoranda em Gestão, Escola de Economia, Gestão e Ciência Política da Universidade do Minho; Professor Doutor José Crispim (Orientador), Escola de Economia, Gestão e Ciência Política, Universidade do Minho.

PARECER

A Comissão de Ética para a Investigação em Ciências Sociais e Humanas (CEICSH) analisou o processo relativo ao projeto de investigação acima identificado, intitulado *Hospital Value Based Reimbursement*.

Os documentos apresentados revelam que o projeto obedece aos requisitos exigidos para as boas práticas na investigação com humanos, em conformidade com as normas nacionais e internacionais que regulam a investigação em Ciências Sociais e Humanas.

Face ao exposto, a Comissão de Ética para a Investigação em Ciências Sociais e Humanas (CEICSH) nada tem a opor à realização do projeto nos termos apresentados no Formulário de Identificação e Caracterização do Projeto, que se anexa, emitindo o seu parecer favorável, que foi aprovado por unanimidade pelos seus membros.

Braga, 1 de outubro de 2025.

O Presidente da CEICSH

Assinado por: **Emanuel Pedro Viana Barbas de Albuquerque**
Num. de Identificação: 07089799
Data: 2025.10.01 12:27:39 +0100

(Emanuel Pedro Viana Barbas Albuquerque)

Anexo: Formulário de identificação e caracterização do projeto

E.3. Supplementary Results (Figures and Tables)

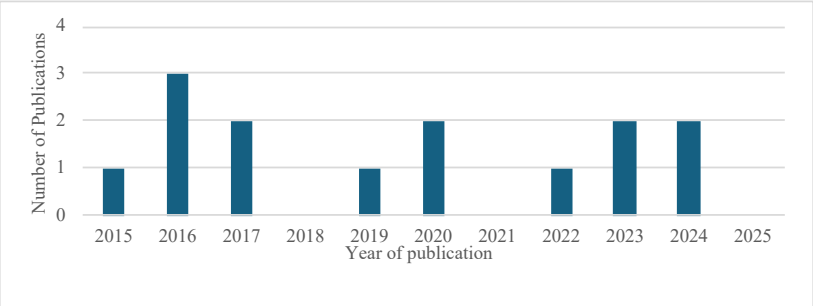


Figure 13 - Distribution of Included Studies by Year of Publication

Table 56 - Resources Required for Developing and Implementing VBP Models.

	Resources Required	#	References
1	Leadership resources	2	(Conrad et al., 2016; Gratale et al., 2022)
2	Contracting and payer engagement mechanisms	1	(Gratale et al., 2022)
3	Clinical decision support technologies	3	(Gratale et al., 2022; Leao et al., 2024; Shajari Pour Mousavi et al., 2017)
4	Health data systems and infrastructure	4	(Cattel et al., 2020; Howard et al., 2024; Leao et al., 2024; K. Patel et al., 2016)
5	Integrated team-based care structures	3	(Cattel et al., 2020; Halder et al., 2020; K. Patel et al., 2016)
6	Value-oriented infrastructure and facilities	2	(Halder et al., 2020; Leao et al., 2024)
7	Patient support service programs	1	(K. Patel et al., 2016)
8	Evidence and innovation platforms	1	(Shajari Pour Mousavi et al., 2017)
9	Risk adjustment tools and methodologies	1	(K. Patel et al., 2016)

Table 57 - Frequency Distribution of Core Components of VBP Models

	Value-Based Payment Key Components	***Frequency***
1	Contextual Foundations	5
2	Reform Dynamics	5
3	**User-Centred Value**	**10**
4	Population Risk Management	6
5	Equity Strategies	4
6	Innovative Care Delivery	5
7	Care Coordination	6
8	Stakeholder Engagement	7
9	Participatory Governance	5
10	**Incentive Alignment**	**9**
11	**Payment Model Alignment**	**9**

Value-Based Payment Key Components		*Frequency*
12	**Quality Measurement**	**10**
13	Performance Benchmarking	6
14	Accountability Mechanisms	7
15	Cost Efficiency	4
16	Cost-Effective Innovation	6
17	Health Promotion & Resilience	4
	Others	4

Table 58 - Expert Rankings of VBP Model Development Phases

Development and Implementation of a Value-Based Payment Model	Phase	Mode	Median
Problem Definition and Value Proposition Clarification	1	7	1,7
Stakeholder Insight and Context Analysis	2	6	1,5
Strategic Co-Design and Conceptual Modelling	3	8	2,7
Model Structuring and Operational Design	4	8	3,7
Pilot Implementation and Performance Assessment	5	8	4,7
Full-Scale Deployment and System Integration	6	8	5,8

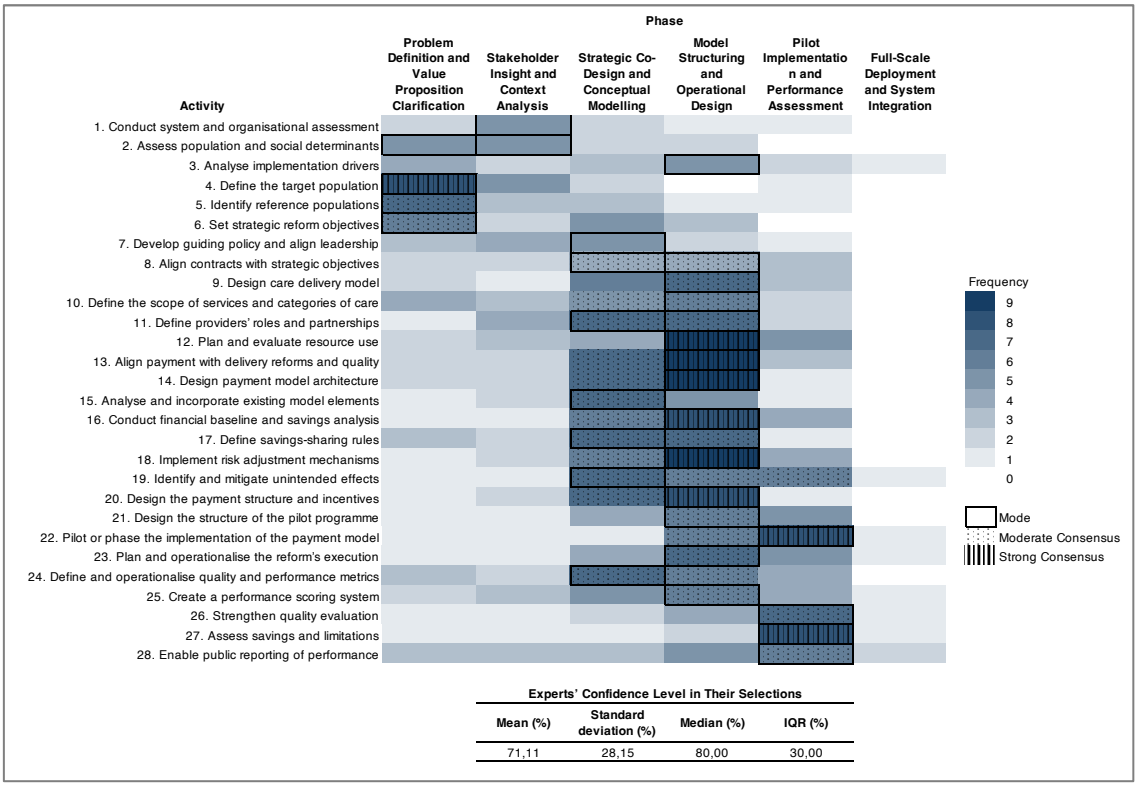


Figure 14 - Mapping of Activities Across Phases of VBP Model Development

Shading reflects response frequencies, and outlined cells indicate the most frequent phase-activity combinations. Consensus levels (moderate or strong) are shown through the figure's patterning. Summary statistics for experts' confidence levels appear below the matrix.

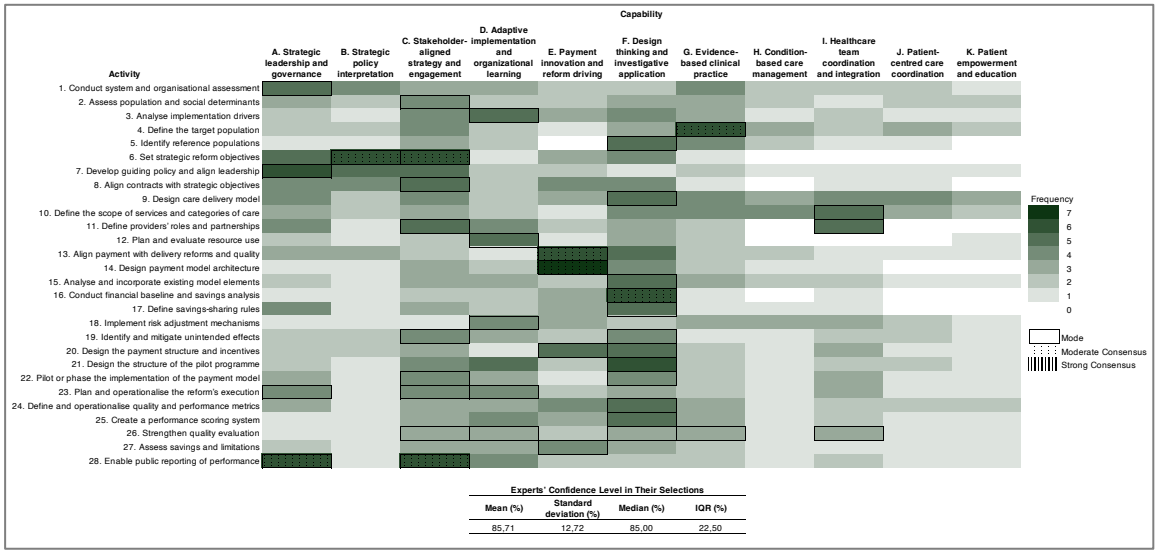


Figure 15 - Mapping of Activities to Core Capabilities in VBP Model Development
Shading reflects response frequencies, and outlined cells indicate the most frequent activity-capability combinations. Consensus levels (moderate or strong) are shown through the figure's patterning. Summary statistics for experts' confidence levels appear below the matrix.

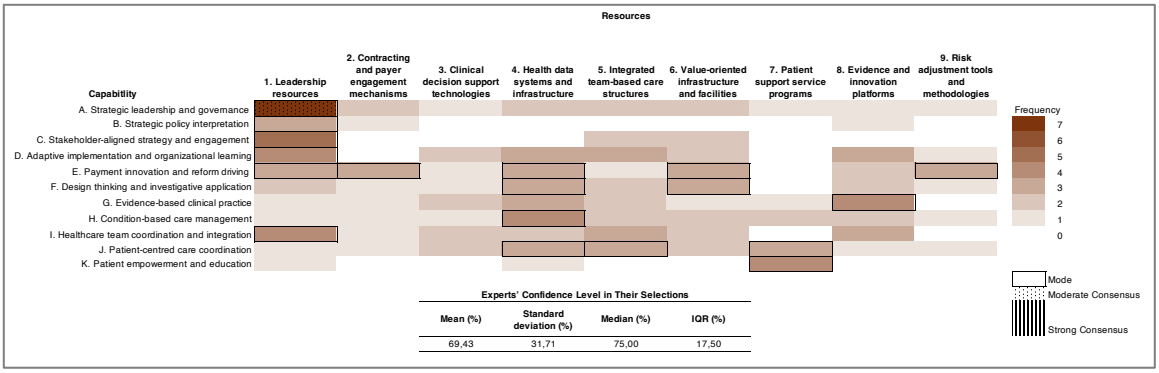


Figure 16 - Associations Between Capabilities and Resource Categories in VBP Model Development
Shading reflects response frequencies, and outlined cells indicate the most frequent capability-resource combinations. Consensus levels (moderate or strong) are shown through the figure's patterning. Summary statistics for experts' confidence levels appear below the matrix.

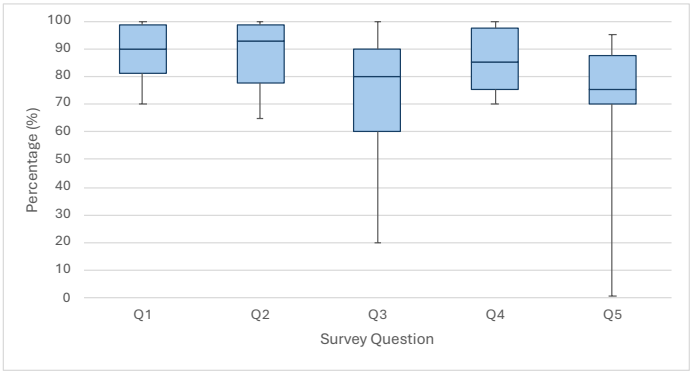


Figure 17 - Boxplot of Experts' Confidence Levels Across Survey Question Groups

Table 59 - Exploratory Associations Between Expert Profiles and Framework Evaluations

Expert Profile	Typical Conceptual Focus	Relational or Operational Emphasis	Interpretive Tendencies / Insights
Researchers	User-Centred Value, Quality Measurement, Accountability Mechanisms	Emphasis on data-driven assessment and performance metrics	Analytical approach; strong confidence in conceptual coherence; focus on evidence generation
Professors / Academics	Population Risk Management, Equity Strategies, Reform Dynamics	Broad, system-level understanding; attention to theoretical integration	Conceptual depth and long-term sustainability orientation
Consultants / Healthcare Managers	Stakeholder Engagement, Care Coordination, Incentive Alignment	Implementation and inter-organisational collaboration	Pragmatic focus: value placed on feasibility and governance
Policy Advisors	Contextual Foundations, Reform Dynamics, Accountability Mechanisms	Early-phase strategic alignment; regulatory and policy coherence	Governance-oriented; cautious about implementation scalability
Experts with >9 Years VBHC Experience	Participatory Governance, Cost-Effective Innovation, Integrated Care	Multi-capability integration (A-K); use of diverse resources	Systemic understanding; holistic, cross-level alignment
Experts with <5 Years VBHC Experience	User-Centred Value, Incentive Alignment	Limited range of associated phases or capabilities	Focused conceptual lens; higher variability in relational assessments
Directly Involved in Implementation	Care Coordination, Incentive Alignment, Governance Design	Later development phases (Pilot Implementation, System Integration)	Operational orientation; emphasis on applied learning and feedback
Indirect or Analytical Role	Quality Measurement, User-Centred Value	Early and conceptual phases (Problem Definition, Stakeholder Insight)	Reflective, analytical stance; theoretical emphasis

Note: VBHC – Value-Based Healthcare.