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Research article

The measurement of intangible assets in the healthcare and public sectors: a scoping review of current knowledge

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Supplementary information

A: search strategies

Initial search terms:

1) "intangible assets" OR "intangible capital" OR "public intangibles" OR" intellectual capital" OR "intellectual property products" OR "knowledge capital" OR "knowledge asset*" OR "computer* information" OR "economic competencies" OR "innovative property" OR "data assets" OR "digital assets" OR "organisational capital" OR "brand*" OR "Design" OR "software" OR "artistic originals" OR "mineral exploration"

Terms relating to intangible assets

AND

2) "healthcare" OR "human health activities" OR "health sector" OR "public sector" OR "public service" OR "non-market"

Terms relating to the health sector and the public sector at large

AND

3) “measure*” OR “value” OR “valuation” OR “assess*” OR “national account*” OR “productivity”

Terms relating to measurement

Final search terms

1) “intangible asset*” OR “intangible capital” OR “public intangible*” OR” intellectual capital” OR “intellectual property product*” OR “knowledge capital” OR “knowledge asset*” OR “computer* information” OR “economic competencies” OR “innovative property” OR “data asset*” OR “digital asset*” OR “organisational capital”

AND

2) “healthcare” OR “human health activit*” OR “health sector” OR “public sector” OR “public service*” OR “non-market”

AND

3) “measure*” OR “value” OR “valuation” OR “assess*” OR “national account*” OR “method*” OR “productivity”

Database: Scopus
Search date: [19/07/2025]
Filters: English [lang]; [2005–2025]

Concept 1 – Intangible Assets / Capital

1. TITLE-ABS-KEY(“intangible asset*”) (4386 hits)
2. TITLE-ABS-KEY(“intangible capital”) (514 hits)
3. TITLE-ABS-KEY(“public intangible*”) (6 hits)
4. TITLE-ABS-KEY(“intellectual capital”) (7671 hits)
5. TITLE-ABS-KEY(“intellectual property product*”) (35 hits)
6. TITLE-ABS-KEY(“knowledge capital”) (736 hits)
7. TITLE-ABS-KEY(“knowledge asset*”) (1366 hits)
8. TITLE-ABS-KEY(“computer* information”) (1985 hits)
9. TITLE-ABS-KEY(“economic competencies”) (66 hits)
10. TITLE-ABS-KEY(“innovative property”) (216 hits)
11. TITLE-ABS-KEY(“data asset*”) (1281 hits)
12. TITLE-ABS-KEY(“digital asset*”) (3744 hits)
13. TITLE-ABS-KEY(“organisational capital”) (534 hits)
14. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 → Set A (20953 hits)

Concept 2 – Health / Public Sector

15. TITLE-ABS-KEY(healthcare) (723,242 hits)

16. TITLE-ABS-KEY(“human health activit*”) (32 hits)
17. TITLE-ABS-KEY(“health sector”) (17006 hits)
18. TITLE-ABS-KEY(“public sector”) (57058 hits)
19. TITLE-ABS-KEY(“public service*”) (36854 hits)
20. TITLE-ABS-KEY(“non-market”) (3879 hits)
21. 14 OR 15 OR 16 OR 17 OR 18 OR 19 → Set B (823830 hits)

Concept 3 Measurement

22. TITLE-ABS-KEY(measure*) (819369 hits)
23. TITLE-ABS-KEY(value) (6208690 hits)
24. TITLE-ABS-KEY(valuation) (71703 hits)
25. TITLE-ABS-KEY(assess*) (7779321 hits)
26. TITLE-ABS-KEY(“national account*”) (2314 hits)
27. TITLE-ABS-KEY(“productivity”) (456324 hits)
28. 21 OR 22 OR 23 OR 24 OR 25 → Set C (28849258 hits)

Final combination

29. Set A AND Set B AND Set C → (450 hits)

English language filter and dates 2005-2025 applied throughout

(TITLE-ABS-KEY (“intangible asset*” OR “intangible capital” OR “public intangible*” OR “ intellectual capital” OR “intellectual property product*” OR “knowledge capital” OR “knowledge asset*” OR “computer* information” OR “economic competencies” OR “innovative property” OR “data asset*” OR “digital asset*” OR “organisational capital”) AND TITLE-ABS-KEY (“healthcare” OR “human health activit*” OR “health sector” OR “public sector” OR “public service*” OR “non-market”) AND TITLE-ABS-KEY (“measure*” OR “value” OR “valuation” OR “assess*” OR “national account*” OR “method*” OR “productivity”)) AND PUBYEAR > 2004 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE , “English”))

Database: Web of Science
Search date: [19/07/2025]
Filters: English [lang]; [2005–2025]

Concept 1 – Intangible Assets / Capital

1. Topic=(“intangible asset*”) (3200 hits)
2. Topic=(“intangible capital”) (382 hits)
3. Topic=(“public intangible*”) (4 hits)
4. Topic=(“intellectual capital”) (5486 hits)
5. Topic=(“intellectual property product*”) (32 hits)
6. Topic=(“knowledge capital”) (624 hits)
7. Topic=(“knowledge asset*”) (147 hits)

8. Topic=(“computer* information”) (895 hits)
9. Topic=(“economic competencies”) (31 hits)
10. Topic=(“innovative property”) (24 hits)
11. Topic=(“data asset*”) (211 hits)
12. Topic=(“digital asset*”) (525 hits)
13. Topic=(“organisational capital”) (66 hits)
14. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 → Set A (12946 hits)

Concept 2 – Health / Public Sector

14. Topic=(healthcare) (494206 hits)
15. Topic=(“human health activit*”) (25 hits)
16. Topic=(“health sector”) (10264 hits)
17. Topic=(“public sector”) (32442 hits)
18. Topic=(“public service*”) (11700 hits)
19. Topic=(“non-market”) (2748 hits)
20. 14 OR 15 OR 16 OR 17 OR 18 OR 19 → Set B (555887 hits)

Concept 3 – Measurement

21. Topic=(measure*) (6564503 hits)
22. Topic=(value) (4939989 hits)
23. Topic=(valuation) (61183 hits)
24. Topic=(assess*) (5494946 hits)

25. Topic=(“national account*”) (1653hits)
26. Topic=(method*) (14387965 hits)
27. Topic=(productivity*) (366736 hits)
28. 21 OR 22 OR 23 OR 24 OR 25 OR 26 OR 27 → Set C (21581239 hits)

Final Combination

28. Set A AND Set B AND Set C → Final result: 304 records

“intangible asset*” OR “intangible capital” OR “public intangible*” OR” intellectual capital” OR “intellectual property product*” OR “knowledge capital” OR “knowledge asset*” OR “computer* information” OR “economic competencies” OR “innovative property” OR “data asset*” OR “digital asset*” OR “organisational capital” (Topic) and “healthcare” OR “human health activit*” OR “health sector” OR “public sector” OR “public service*” OR “non-market” (Topic) and “measure*” OR “value” OR “valuation” OR “assess*” OR “national account*” OR “method*” OR “productivity” (Topic) and English (Languages)

Filters: 2005-2025, English language

Database: PubMed
Search date: [19/07/2025]
Filters: English [lang]; [2005–2025]

Concept 1 – Intangible Assets / Capital

1. "intangible asset*"[Title/Abstract] (77 hits)
2. "intangible capital"[Title/Abstract] (5 hits)
3. "public intangible*"[Title/Abstract] (0 hits)
4. "intellectual capital"[Title/Abstract] (180 hits)
5. "intellectual property product*"[Title/Abstract] (0 hits)
6. "knowledge capital"[Title/Abstract] (21 hits)
7. "Knowledge asset*"[Title/Abstract] (25 hits)
8. "computer* information"[Title/Abstract] (167 hits)
9. "economic competencies"[Title/Abstract] (2 hits)
10. "innovative property"[Title/Abstract] (0 hits)
11. "data asset*"[Title/Abstract] (128 hits)
12. "digital asset*"[Title/Abstract] (94 hits)
13. "organisational capital"[Title/Abstract] (0 hits)
14. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13→ **Set A** (1121 hits)

Concept 2 – Health / Public Sector

14. "healthcare"[Title/Abstract] (454163 hits)
15. "human health activit*"[Title/Abstract] (8 hits)
16. "health sector"[Title/Abstract] (7975 hits)
17. "public sector"[Title/Abstract] (7813 hits)
18. "public service*"[Title/Abstract] (1937 hits)
19. "non-market"[Title/Abstract] (272 hits)
20. 14 OR 15 OR 16 OR 17 OR 18 OR 19 → **Set B** (470383 hits)

Concept 3 – Measurement

21. "measure*"[Title/Abstract] (3114545 hits)
22. "value"[Title/Abstract] (1019246 hits)
23. "valuation"[Title/Abstract] (7026 hits)
24. "assess*"[Title/Abstract] (3404763 hits)
25. "national account*"[Title/Abstract] (87 hits)
26. "method*"[Title/Abstract] (7625658 hits)
27. "productivity"[Title/Abstract] (85272)
28. 21 OR 22 OR 23 OR 24 OR 25 OR 26 → Set C (12008638 hits)

Final Combination

29. Set A AND Set B AND Set C (151 hits)

Search: ((“intangible asset*”[Title/Abstract] OR “intangible capital”[Title/Abstract] OR “public intangible*” OR” intellectual capital”[Title/Abstract] OR “intellectual property product*”[Title/Abstract] OR “knowledge capital”[Title/Abstract] OR “knowledge asset”[Title/Abstract] OR “computer* information”[Title/Abstract] OR “economic competencies”[Title/Abstract] OR “innovative property”[Title/Abstract] OR “data asset*”[Title/Abstract] OR “digital asset*”[Title/Abstract] OR “organisational capital”[Title/Abstract]) AND (“healthcare”[Title/Abstract] OR “human health activit*”[Title/Abstract] OR “health sector”[Title/Abstract] OR “public sector”[Title/Abstract] OR “public service*”[Title/Abstract] OR “non-market”[Title/Abstract])) AND (“measure*”[Title/Abstract] OR “value”[Title/Abstract] OR “valuation”[Title/Abstract] OR “assess*”[Title/Abstract] OR “national account*”[Title/Abstract] OR “method*”[Title/Abstract] OR “productivity”[Title/Abstract]) Filters: English, from 2005 - 2025

B: **Review protocol**

Box B1: Review protocol

Abstract

Intangible assets play an increasing role in developed economies and have become a focus of reform in the UK health sector over recent years. Despite the advances in measurement in the private sector, the healthcare sector (and wider public sector) remains under researched. This protocol describes the methodology used to review publications discussing methods of measuring intangible assets in the healthcare and wider public sectors.

Methods and analysis

This review protocol incorporates insights from Arksey and O'Malley's review methodology framework (2005), although it is not a scoping review itself. Online and electronic databases from 2005 to 2025, and grey literature sources will be searched, and a manual study of the citations of the literature will be carried out to identify and identify eligible studies. Due to time constraints, one reviewer will undertake the search process to identify relevant literature and studies, and two reviewers will independently determine whether studies meet the inclusion criteria. All eligible articles will be charted using a standard form (appendix 5).

Ethics/dissemination

This review uses publicly available materials and entails no primary research, so research ethics approval is not required. This review will identify gaps in the measurement of intangible assets in the public sector to inform the improvement of current and development of future measurement methodologies.

B*ox B2: Strengths and weaknesses of review*

Strengths and Weaknesses

This will be the first review to identify methods of measuring intangible assets in the healthcare and public sectors

The search strategy is limited to a few databases and sources in English. Further, due to time and resource constraints, it is not a scoping review

There is greater focus on the CHS framework than on the IC framework, leading to a shallower understanding of it

Due to the non-empirical nature and mixture of styles of the literature, there is no evidence synthesis or formal quality assessment

Background

Modern economies have become increasingly dominated by the use and production of non-physical assets, known as intangible assets, such as software, branding and organisational knowledge. In the UK private sector, investment in intangibles has outpaced that in tangibles, reaching nearly £200 billion in 2022 (ONS 2024). Over the past two decades, investment in intangibles has been broadly equal to tangibles (Martin 2019). This trend is equally visible in healthcare, where there is an increasing focus on digitalisation, data-driven systems and online service provision. In particular, under recent government initiatives, the NHS is moving from "analogue to digital".

Intangible assets, or knowledge capital, are, essentially, non-physical assets (Corrado 2005, 2009). The System of National Accounts defines an asset as a store of value that provides identifiable benefits beyond one year (SNA 2025 11.10). Frameworks such as Corrado et al (2005, 2009) (CHS) define categories including computerised information, innovative property, and economic competencies. These cover items like R&D, software, and organisational processes (Nakamura 2001). National Accounts (NA) already capitalise certain intangibles such as databases (expanded in SNA 2025 to include data itself), software, and R&D, while additional assets are estimated in supplementary "satellite accounts".

Intangible assets are highly scalable, non-rivalrous, and capable of generating spillovers and synergies (Martin 2024; Martin et al 2024; Corrado et al 2022; Corrado et al 2017). These features make intangibles crucial to productivity growth. With UK public sector budgets constrained since the financial crisis, and healthcare productivity still below pre-Covid levels (ONS 2024a), understanding the role of intangible assets is vital. This is particularly important considering evidence suggests hospitals with stronger intangible capital achieve higher efficiency and competitive advantage (Scafarto et al 2023; Evans 2015; Gastaldi 2013; Rahman and Liu 2023; Subramaniam and Youndt 2005).

Despite advances in the private sector (Bontadini et al 2023; Corrado et al 2009), public sector measurement remains limited. Methodologies such as INTANinvest and INNOdrive have been developed for the private sector, and agencies like the ONS produce estimates for both national accounts and non-national accounts assets (Martin et al 2024; Van Criekingen et al 2022; Pastor et al 2017; Osinski 2017). However, attempts to measure intangibles in the public sector are sparse and fragmented (Dumay et al 2015). EUKLEMS public sector estimates often do not disaggregate healthcare from other services and Bachhini's 2016 estimates were a one off cross section.

Measurement is inherently difficult because intangibles are frequently 'own-account', lack observable market prices, and are unique so cannot be compared to other marketised assets (Corrado et al 2005; Martin et al 2024). They are also frequently expensed rather than capitalised (Barker et al 2022) and their benefits are hard to separate from complementary assets. Estimating deflators and depreciation rates is also challenging. These issues are exacerbated in the public sector, where outputs are not sold at market prices, and productivity measures don't disaggregate between labour and capital as sources of growth.

The rise of intangible assets has profound implications for healthcare and the wider public sector. They underpin digital transformation, efficiency gains, and long-term productivity. Yet, limited measurement frameworks in healthcare limit understanding and policy. Better tools to capture and value intangibles would clarify their contribution to healthcare productivity and inform policymakers. To know where we must go, we must first know where we are. This review aims to establish where we stand.

Methods and analysis

The purpose of this review is to gain an understanding of the available measurement frameworks for intangible assets. The findings from this review will inform the future progress of scholarship in this area by establishing what has been done and what needs to be done in future to improve these measurements.

A scoping review was chosen as the format for this study because although it is rigorous and methodological in its approach, unlike the systematic review, it does not narrow the parameters of the review or require quality assessment.

Whilst it was not possible, due to time and resource constraints, to conduct a scoping review, this review's design was inspired by the scoping review framework proposed by Arksey and O'Malley (2005) to ensure it was somewhat rigorous and systematic. For this reason, we include below the five stages used in this review in accordance with the Arksey and O'Malley (2005) protocol.

Table B1. Review process.

Table B1 Stages of the review		
1. Identifying the research question	1.1 Overarching goal	To identify, summarise and understand the existing methods of measuring intangible assets in the public sector and consider how we may use them.
	1.2 Research questions	RQ 1: What methods are used to measure intangible assets in the healthcare and public sectors? RQ 2: What are the specific challenges posed to measurement of intangible assets by the healthcare or public sector setting? RQ 3: What would be the effect of including intangible assets in a measure of NHS productivity?
	1.3 Purposes of this scoping review	1.3.1 To review what methods exist to measure intangible assets in a healthcare or public sector setting.
		1.3.2 To determine what challenges to these measurements are posed by the public sector setting.
		1.3.3 To begin to consider the future challenges and uses of such measures.
2. Identifying relevant literature and studies	2.1 Three-step search process (to be updated as needed, when review is undertaken)	2.1.1 Using free text and controlled vocabulary, an initial broad search was undertaken using terms identified from an extensive reading of the wider intangible assets literature.
		2.1.2 A consequent database search using a refined search was undertaken, using the identified key terms, in SCOPUS, Web of Science and Pubmed.
		2.1.3 Finally, we completed a citation search by manually scanning the references from relevant studies.
	2.2 Eligibility criteria to guide search	2.2.1 Published in the English Language.
		2.2.2 Published in the range 2005-2025
		2.2.3 Subject headings, keywords and related terms for intangible assets, healthcare and the public sector and measurement
		2.2.4 Tailor advanced search strategy to each database and reduce irrelevant results.
		2.2.5 To be relevant for full-text review, the title must include at least one intangible asset and a healthcare or public sector context. They should also imply some measurement or valuation
3. Selecting the studies	3.1 To be included, eligible articles will undergo a full text review according to an inclusion criteria that requires them to be assessed using three (3) questions.	3.1.1 Does the article measure intangible assets?
		3.1.2 Does the article do this measurement in a healthcare or public sector context?
4. Charting the data	4.1 Articles will be categorised along two dimensions	4.1.1 Type of capital measured
		4.1.2 Method of measurement
	4.2 Data will not be extracted as this review concerns methodologies not empirical results	
	4.3 Subcategories will be created according to the article category.	
5.Collating, summarising, and reporting results	Results from the comprehensive search and screening process will be presented according to the PRISMA reporting guidelines for systematic reviews.	

Ethics Guidelines

This protocol is about a search for publicly available studies and does not involve any human or animal subjects' research.

Conclusions

This Appendix presented a protocol for conducting a review of published and unpublished articles and studies to summarise methodologies related to the measurement of intangible assets in the healthcare and public sectors. It concerns the period since the seminal Corrado et al (2005) framework. Currently, no reviews have been conducted concerning the measurement of intangible assets in healthcare or the public sector. As this is the first review of this topic, it will provide unique insights into how public intangible assets are measured and the challenges associated with this, as well as highlight gaps in the existing methods and literature. It will also consider the use of these measures in a measure of NHS productivity.

References to Appendix 2

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C: Tables of reviewed literature and quality assessment

Table C1. Key for and summary of the reviewed literature. Papers with a blue reference number are from the SPINTAN project and those with a red reference number are from Globalinto.

Ref #	Author(s)	Title	Journal/Project	Year	REVIEW (Y/N)	TYPE OF REVIEW	AIM	Method of measuring intangibles
1	Bacchini	Estimates of intangible investment in the public sector: EU, US, China and Brazil	SPINTAN Project: Smart Public intangibles	2016	No	N/A	Implement the SPINTAN framework to estimate intangible investment in the public sector: EU, US, China and Brazil	Market price and sum of costs (national accounts methods)
2	Basal et al	Brand equity in digital marketing: what does it mean in the health sector and how does it affect consumer decisions?	E3S Web of Conf. Volume 402 International Scientific Siberian Transport Forum	2023	No	N/A	Measure the brand equity of hospitals and see how it affects consumers choice of health services	Survey
3	Berger	IPSAS Explained: A Summary of International Public Sector Accounting Standards	Wiley (published book)	2015	No	N/A	Summarise accounting standards for the public sector	Market price and sum of costs (national accounts methods)
4	Chulski	The Influence of Relational Intellectual Capital and Information Technology on Hospital Efficiency	Proceedings of the European Conference on Knowledge Management, ECKM	2023	No	N/A	Investigate how intellectual capital and IT affects hospital efficiency	Survey (Likert scale
5	Corrado et al	Public Intangibles: The Public Sector and Economic Growth in the SNA	Review of Income and Wealth	2017	No	N/A	Summarise the SPINTAN methodology in a GDP context	Market price and sum of costs (national accounts methods)
6	Corrado et al	SPINTAN Manual:	SPINTAN Project:	2016	No	N/A	Create a comprehensive method to	Market price and

		Measuring Intangible Capital in the Public Sector	Smart Public intangibles				measure the full suite of CHS intangibles in the public sector	sum of costs (national accounts methods)
7	daSilva et al	Effects of Structural Intellectual Capital on The Innovation Capacity of Public Administration	Journal of Technology Management and Innovation	2021	No	N/A	Measuring the structural intellectual capital of local government and investigate its effect on innovation	Survey (Likert scale)
8	Dekkers et al	Measuring European public sector information resources	Final Report of Study on Exploitation of public sector information benchmarking of EU framework conditions	2006	No	N/A	To measure public information resources in Europe	Survey
9	Dragomir	The Impact of Intangible Capital on Firm Profitability in the Technology and Healthcare Sectors	International Journal of Financial Studies	2024	No	N/A	Investigate how intangible capital affects hospital and technology sector profits	Indicators derived from accounting data
10	Dumay et al	IC and public sector: A structured literature review	Journal of Intellectual Capital	2015	Yes	Literature review	Perform a structured literature review of the public sector intellectual capital literature	Survey and indicators
11	Erickson and Rothberg	Healthcare and hospitality: intangible dynamics for evaluating industry sectors	Service Industries Journal	2017	No	N/A	Review intangible theory and use metrics to identify intangible practices across the healthcare industry be identified in all the industry sectors across healthcare	Indicators
12	Evans	Intellectual capital in the healthcare sector: A systematic review and critique of the literature	BMC Health Services Research 2015	2015	Yes	Systematic review	To synthesise what is currently known about the conceptualisation, management and measurement of IC in healthcare	Mostly surveys (59% of papers used), but also semi-structured managerial interview and indicators

13	Fazlagić and Szczepankie-wicz	Intellectual capital statement model for counties in Poland	Amfiteatru Economic	2018	No	N/A	To create an original IC measurement model for local government	Survey (Likert scale) and indicators
14	Fleckenstein et al	Data Valuation: Use Cases, Desiderata, and Approaches	Proceedings of the Second ACM Data Economy Workshop	2023	No	N/A	To develop a Data Valuation Framework with reference to past approaches	Survey
15	Garlatti et al	Intellectual capital evaluation in a healthcare organisation. A case study	XIX IRSPM Conference–E102	2015	No	N/A	To investigate the subject of IC measurement within a public health care context, with reference to a case study organization	Survey and indicators
16	Heiling	Digital transformation and the accounting for intangible assets in the public sector	Journal of Public Budgeting, Accounting & Financial Management	2025	No	N/A	To present analyse financial reporting practices for intangible assets in the public sector and the challenges posed by the digital transformation to IPSAS intangible assets, focusing on selected public sector entities	Market price and sum of costs (national accounts methods)
17	Khomenko	Review of Methods and Tools for Intellectual Property Analysis of Public Sector Entities	Journal of Corporate Finance Research	2020	Yes	No specified type	To review of the methods and tools of analysis used by Russian and foreign scientists for intellectual property	Survey and indicators
18	Le Mouel et al	Investment in organisational capital: methodology and panel estimates	SPINTAN Project: Smart Public intangibles	2016	No	N/A	To create a method of measuring organisational capital in the public sector and provide estimates of it extent of intangible investment in schools t	Market price and sum of costs (national accounts methods)
19	Lytras and de Pablos	Managing, measuring and reporting knowledge-based resources in hospitals	International Journal of Technology Management	2009	No	N/A	To analyse the importance and strategic significance of knowledge-based assets resources for hospitals. Secondly, to identify specific indicators to measure knowledge based resources	Indicators
20	O'Mahony et al	Organisational capital and hospital	SPINTAN Project: Smart Public	2016	No	N/A	To measure investment in organisational capital for NHS	Market price and sum of costs

		performance in England	intangibles				Acute Trusts and determine if there is a relationship between this and Trust performance	(national accounts methods)
21	Peng et al	Intellectual capital and performance indicators: Taiwanese healthcare sector	Journal of Intellectual Capital	2007	No	N/A	Investigate how hospitals view the importance and performance of intellectual capital in the healthcare sector	Survey
22	Piekkola	Intangible assets in the public sector: an extended definition and methodological guide	School of Economics and Business	2020	No	N/A	To summarises the predominant definition of intangibles in the public sector and to propose a methodology for the Globalinto project to measure intangibles in the public sector based on the Innodrive methodology	Market price and sum of costs (national accounts methods)
23	Pirozzi et al	Intellectual capital and performance measurement in healthcare organizations: An integrated new model	Journal of Intellectual Capital	2016	No	N/A	To create a new model, to measure and manage organisational performance and intellectual capital in a healthcare organization	Indicators
24	Ramírez	Intellectual capital models in Spanish public sector	Journal of Intellectual Capital	2010	No	N/A	Aid in public sector entities development of intellectual capital measurement	Indicators
25	Ramírez et al	Formulating and elaborating a model for the measurement of intellectual capital in Spanish public universities	International Review of Administrative Sciences	2017	No	N/A	To create a model for the measurement of intellectual capital in Spanish public universities intellectual capital in higher education institutions.	Indicators
26	Redek et al	Deliverable 7.6 Report on the empirical analysis on the role of intangible assets in the public sector	Globalinto project	2021	No	N/A	To investigate whether the quality of an institutional framework is related to intangible capital in the public sector and the differences between the various components of intangible capital between the public. Also implements Globalinto	Market price and sum of costs (national accounts methods)

							methodology for Slovenia private sectors	
27	Saam et al	Public ICT Investment in Reaction to the Economic Crisis--A Case Study on measuring IT-related Intangibles in the Public Sector	SPINTAN Project: Smart Public intangibles	2016	No	N/A	To analyse the intangible and tangible asset creation of the German public IT-spending programme 2009-11 and apply the finding to the general German federal spend on IT adopted after the crisis in terms of its tangible vs. intangible asset creation	Market price and sum of costs (national accounts methods)
28	Schulz and Beckmann	Hospital performance and intangible investments: the impact of 'own-account' organisational capital	SPINTAN Project: Smart Public intangibles	2016	No	N/A	To measure the amount of investments in 'own-account' organizational capital and its impact on hospital performance in Germany	Market price and sum of costs (national accounts methods)
29	Steherer	Industry Level Growth and Productivity Data with Special Focus on Intangible Assets	EUKLEMS	2019	No	N/A	To give an outline of the methods and data of EU KLEMS 2019 growth and productivity release with a particular focus on the intangible assets involved	Market price and sum of costs (national accounts methods)
30	Stokes et al	The role of intangibles in school performance: a case study for England	SPINTAN Project: Smart Public intangibles	2016	No	N/A	To better understand the role and extent of organisational capital in English schools	Market price and sum of costs (national accounts methods)
31	Wall	The measurement and management of intellectual capital in the public sector: Taking the lead or waiting for direction?	Public Management Review	2005	No	N/A	To compare and contrast the development of measuring intellectual capital in the public and private sector of development reached by the public and private sectors	Survey

Ref #	Are intangibles valued in monetary terms?	Types of intangibles measured	Framework followed	Could this method be repeated over multiple years with existing data	Country/international	Sector
1	Yes	All CHS intangibles	CHS/National accounts	Yes	International	Whole public sector
2	No	Branding (CHS)	CHS/National accounts	No	Turkey	Healthcare
3	Yes	National accounts intangibles (CHS)	CHS/National accounts	Yes	International	Whole public sector
4	No	Relational intellectual capital and ICT	Intellectual capital	No	Poland	Healthcare
5	Yes	All CHS intangibles	CHS/National accounts	Yes	International	Whole public sector
6	Yes	All CHS intangibles	CHS/National accounts	Yes	International	Whole public sector
7	No	Structural intellectual capital	Intellectual capital	No	Brazil	Local government
8	No	Information	Own framework	No	EU and Norway	Whole public sector
9	No	National accounts intangibles	CHS/National accounts	Yes	International (EU plus Norway, Switzerland, UK)	Private sector hospitals and technology
10	No	Intellectual capital	Intellectual capital	No	International	Public sector
11	No	Data/information, explicit knowledge, tacit knowledge, intelligence	Own framework	Yes	International	Healthcare and hospitality
12	No	Intellectual capital	Intellectual capital	No	International	Healthcare
13	No	Intellectual capital	Intellectual capital	No	Poland	Local government

14	No	Data (CHS)	CHS/National accounts	No	International	Public and private sector
15	No	Intellectual capital	Intellectual capital	No	Italy	Healthcare
16	Yes	Software (especially cloud, AI and agile software) (CHS)	CHS/National accounts	Yes	International	Public sector
17	No	Intellectual property products	Own framework	Yes	Russia	Public sector (mostly universities and public R&D centres)
18	Yes	Organisational capital	CHS/National accounts	Yes	International	Public sector
19	No	Range of own defined intangible assets (including human capital, organisational capital and IT)	Own framework	Yes	International	Healthcare
20	Yes	Organisational capital (own-account only)	CHS/National accounts	Yes	England	Healthcare
21	No	Intellectual capital	Intellectual capital	No	Taiwan	Healthcare
22	Yes	Limited CHS (ICT, R&D and organisational capital)	CHS/National accounts	Yes	International	Public sector
23	No	Intellectual capital	Intellectual capital	Yes	Italy	Healthcare
24		Intellectual capital	Intellectual capital	No	Spain	Public sector
25	No	Intellectual capital	Intellectual capital	Yes	Spain	Universities
26	Yes	Limited CHS (ICT, R&D and organisational capital)	CHS/National accounts	Yes	International	Public sector
27		CHS defined software, organisational capital, databases with added categories of IT training and concepts	CHS/National accounts	Yes	Germany	Public sector
28	Yes	Organisational capital (own-account only)	CHS/National accounts	Yes	Germany	Healthcare
29	Yes	All CHS intangibles	CHS/National	Yes	International	Whole economy (including public

			accounts			sector)
30	Yes	Organisational capital (CHS)	CHS/National accounts	Yes	England	Education
31	No	Intellectual capital	Intellectual capital	No	Northern Ireland	Public sector

Ref #	Main result	Keywords	Notes
1	The US has higher investment into intangibles than the EU, and within the EU north west is higher than the south east. China has lower levels, but much higher growth than both. US higher in R&D and IT, EU in economic competencies and China in R&D. Brazil weak overall		Identical method to the SPINTAN manual
2	Higher brand equity is associated with consumer confidence and increases the likelihood of consumers choosing that provider		Explains well how the unfamiliar concept of branding translates to the healthcare setting. It doesn't consider whether branding actually meet criteria for being capital (e.g. durability).
3	Public sector entities should include intangible assets on their balance sheets if they meet the asset criteria (they are identifiable, controlled, and expected to provide future service potential or economic benefits, provided they can be measured reliably)		A handbook to accounting standards
4	Both relational intellectual capital and ICT have a positive effect on hospital efficiency	Healthcare management, Information and communication technology, Knowledge management in healthcare, Relational intellectual capital, SEM-PLS modelling	Paper doesn't distinguish between tangible and intangible ICT limiting it's usefulness. It also doesn't consider whether Intellectual and ICT elements actually meet criteria for being capital (e.g. durability).
5	Successfully creates a framework for measuring intangible assets in the public sector in a way that is consistent and compatible with existing national accounts and tangible assets		By far the most rigorous and comprehensive method found. Creates a framework that can be implemented in national accounts and productivity, provided some future research is done
6	Successfully creates a framework for measuring intangible		By far the most rigorous and comprehensive method

	assets in the public sector in a way that is consistent and compatible with existing national accounts and tangible assets		found. Creates a framework that can be implemented in national accounts and productivity, provided some future research is done
7	Strengthening intellectual capital increases local government innovation capacity	Knowledge management; intellectual capital; structural capital; innovation in the public sector; innovation capacity	
8	Significant variation across Member States and domains. Countries with fragmented systems (e.g., Greece, Italy) showed weaker results. By 2005, Europe lagged behind the U.S. in unlocking the economic potential of PS		Measures info through a mix of indicators created by surveys and other data
9	Firms with a larger stock of intangibles tend to have lower profitability, no effect of intangible utilisation rate on profitability	intangible assets; structural capital; intellectual capital; research and development; technology sector; healthcare sector; European companies	Study focuses on private sector but methods could be applied to the wider, non-market healthcare sector
10	Measurement of IC in the public sector is possible but methods are very context dependent and aren't standardised	Public sector, IC research, Intellectual capital, Structured literature review	Highlights the large differences and issues with comparability in measuring IC in the public sector
11	Best practices in process management and customer relationship management from hospitality can improve healthcare outcomes and patient satisfaction. Big data and analytics are critical intangibles in both industries	Big data; analytics; knowledge; healthcare; hospitality	For knowledge, uses a version of Tobin's Q which isn't applicable in the public sector
12	IC is important for healthcare but under researched. Future work should clarify definitions and unify measurement approaches	Intellectual capital, Organizational knowledge, Intangible assets, Knowledge management, Health system performance	Notes, like Dumay, the lack of consensus on how to measure IC in healthcare. Also notes how healthcare IC literature focuses little on financial valuation compared to the broader IC literature. Found zero studies that applied national accounts methods to healthcare
13	It is possible to create an IC model for local government	intellectual capital, human capital, organizational capital, relational capital, social capital, intellectual capital model, intellectual capital statement, intellectual city capital, intellectual capital at the level of counties in Poland, intellectual capital at the level of local	

		government in Poland.	
14	Data is increasingly important for organizations, and they create their own data valuation model. Higher priced data sets tended to be better quality and more voluminous	Data Valuation, Data Monetization, Data Valuation Framework, Economic Data Model, Market-based Data Model, Dimensional Data Models	Study creates a generic survey data valuation method for the public or private sector, but claims "there is no standard to measure the value of data" when there is a standardised national accounts approach value of data"
15	Traditional financial reporting and control tools are insufficient for evaluating performance in healthcare organizations. IC evaluation was used as a connecting tool to balance economic and non-financial dimensions during the transition to activity based funding	Intellectual capital, healthcare management, management control	The study uses indicators but notes their data quality is very poor. It is not explicit about what or how
16	IPSAS 31 does not properly capture the digital transformation in the public sector and so financial statements underrepresent intangible digital investments	s Digitalization, Financial reporting, Intangible assets, International organizations, IPSAS 31, Local governments, National governments	Study does not account for SNA 2025 which better captures data, cloud software and AI
17	IP in the public sector is still measured in a disparate way, with an over-reliance on patent analytics that can't account for the full range of IP	intellectual property, intangible assets, public sector, patent analytics, information disclosure	
18	Greece has the lowest OC, the UK has the highest. organisational capital intensity is higher in services than in manufacturing. Estimates are correlated with INTANinvest results		Identical method to the SPINTAN manual
19	Hospitals should adopt intellectual capital models to manage and disclose their knowledge-based resources, to improve their management, accountability, and the delivery of healthcare	healthcare industry; hospital; intellectual capital disclosure; knowledge-based resources; knowledge management; measurement	Again, like many papers doesn't distinguish capital from day-to-day spending
20	Investment in organisational capital in NHS Trusts rose, driven mainly by clinical managers rather than general managers. Evidence for a relationship with trust performance is mixed, with a positive relationship with inpatient activity but no relationship with an overall cost weighted activity measure		Cost weighted activity measures mirror ONS PSP measures, making this a useful comparison.
21	Intellectual capital is considered by managers to be fundamental for good hospital performance.	Intellectual capital, Performance measurement (quality), Health services, Taiwan	

22	Provides the framework to extend Innodrive to the public sector		Doesn't cover the full suite of CHS intangibles and requires further research (on time shares and depreciation) to be reliable
23	Identifies specific indicators for intellectual capital and link them to better performance	Leadership, Intellectual capital, Performance measurement system, Healthcare organizations	Many of the indicators are survey based, e.g. patient satisfaction
24	IC is useful for improving efficiency, effectiveness, and accountability in the public sector. Managers already deal with IC regularly but need a formal framework to move forward	Intellectual capital, Public sector organizations, Spain	Many of the indicators are survey based, e.g. employee satisfaction and motivation, image and reputation of the public entity
25	Successfully create a stakeholder-validated model with 31 key indicators	intellectual capital, model, Spain, universities	
26	Finds public sector intangibles are lower than private sector averages, organisational capital is relatively more important in the public sector and intangibles are important to institutional performance and long-term economic growth		Exactly the same methodology as Piekkola (2020). Implements the method for Slovenia
27	About half of the IT programme spending was on intangibles. Also note that data was of poor quality. Note that CHS categories should be expanded, e.g. to include concepts		Deviates from CHS framework, limiting comparability. Also extends the project-based estimates to the wider federal spending despite federal level data being accurately included in national accounts
28	Hospitals invest around €1 million annually in 'own-account' organisational capital and there is a strong positive relationship between organisational capital and hospital performance, driven by quantity	own-account organizational capital, hospital performance, Germany	Implements SPINTAN methodology in a practical example
29	Shows how intangibles are incorporated into EUKLEMS data and the effect they have	growth accounting, total factor productivity, ICT, intangibles	
30	Positive and significant relationship between organisational capital and school performance. Leadership organisational capital the most important, but broader organisational capital also mattered. Schools increased their organisational capital in response to poor OFSTED inspections.		Identical method to the SPINTAN manual
31	Public sector bodies in the UK are more familiar with measuring non-financials like intangibles. Scorecards (a type of survey) is the most common way of measuring, but management of IC is still weak.	Government initiatives, intellectual capital, intellectual capital management, performance management, performance measurement	

Table C2. Table of the quality assessment of the reviewed literature.

Ref #	Author(s)	Year	REVIEW (Y/N)	Method of measuring intangibles	Was the setting/organisation clearly described?	Were assets boundaries clearly defined?	Are the methods clearly explained?	Does the method capture quality of asset?
1	Bacchini	2016	No	CHS	Yes	Yes	Yes	Yes
2	Basal et al	2023	No	Survey	Yes	No	No	Yes
3	Berger	2015	No	CHS	Yes	Yes	Yes	Yes
4	Chulski	2023	No	Survey	Yes	Yes	No	Yes
5	Corrado et al	2017	No	CHS	Yes	Yes	Yes	Yes
6	Corrado et al	2016	No	CHS	Yes	Yes	Yes	Yes
7	daSilva et al	2021	No	Survey	Yes	Yes	Yes	Yes
8	Dekkers et al	2006	No	Survey	Yes	Yes	Yes	Yes
9	Dragomir	2024	No	Indicators	Yes	Yes	Yes	Yes
10	Dumay et al	2015	Yes	Survey and indicators	Yes	Yes	Yes	Yes
11	Erickson and Rothberg	2017	No	Indicators	Yes	Yes	Yes	No
12	Evans	2015	Yes	Survey and indicators	Yes	No	No	No
13	Fazlagić and Szczepankiewicz	2018	No	Survey and indicators	Yes	Yes	Yes	Yes
14	Fleckenstein et al	2023	No	Survey	Yes	Yes	Yes	Yes
15	Garlatti et al	2015	No	Survey and indicators	Yes	No	No	No
16	Heiling	2025	No	CHS	Yes	Yes	Yes	Yes
17	Khomenko	2020	Yes	Survey and indicators	Yes	Yes	No	Yes
18	Le Mouel et al	2016	No	CHS	Yes	Yes	Yes	Yes
19	Lytras and de Pablos	2009	No	Indicators	Yes	Yes	Yes	No
20	O'Mahony et al	2016	No	CHS	Yes	Yes	Yes	Yes
21	Peng et al	2007	No	Survey	Yes	Yes	No	Yes
22	Piekkola	2020	No	CHS	Yes	Yes	Yes	Yes

23	Pirozzi et al	2016	No	Indicators	Yes	Yes	Yes	Yes
24	Ramírez	2010	No	Indicators	Yes	Yes	Yes	Yes
25	Ramírez et al	2017	No	Indicators	Yes	Yes	Yes	Yes
26	Redek et al	2021	No	CHS	Yes	Yes	Yes	Yes
27	Saam et al	2016	No	CHS	Yes	Yes	Yes	Yes
28	Schulz and Beckmann	2016	No	CHS	Yes	Yes	Yes	Yes
29	Steherer	2019	No	CHS	Yes	Yes	Yes	Yes
30	Stokes et al	2016	No	CHS	Yes	Yes	Yes	Yes
31	Wall	2005	No	Survey	Yes	Yes	No	Yes

Ref #	Were objective, standard units of measurement used for measurement of assets?	Can results be comapred with other studies?	Can results be comapred between asset types?	Does the study account for time with deflation and depreciation?	Does the method require collection oif data that isn't pre-existing, making it harder to reproduce?
1	Yes	Yes	Yes	Yes	No
2	No	No	No	No	No
3	Yes	Yes	Yes	Yes	No
4	No	No	No	No	Yes
5	Yes	Yes	Yes	Yes	No
6	Yes	Yes	Yes	Yes	No
7	No	No	No	No	Yes
8	No	No	No	No	Yes
9	Yes	Yes	No	No	No
10	No	No	No	No	Yes
11	Yes	No	No	No	Yes
12	No	No	No	No	Yes
13	Mixed	No	No	No	Yes
14	No	No	No	No	Yes
15	Mixed	No	No	No	Yes

16	Yes	Yes	Yes	Yes	No
17	Mixed	No	No	Mixed	Yes
18	Yes	Yes	Yes	Yes	No
19	No	Yes	No	No	Yes
20	Yes	Yes	Yes	Yes	No
21	No	No	No	No	Yes
22	Yes	Yes	Yes	Yes	No
23	No	No	No	No	Yes
24	No	Yes	No	No	Yes
25	No	Yes	No	No	Yes
26	Yes	Yes	Yes	Yes	No
27	Yes	Yes	Yes	Yes	No
28	Yes	Yes	Yes	Yes	No
29	Yes	Yes	Yes	Yes	No
30	Yes	Yes	Yes	Yes	No
31	No	No	No	No	Yes

Table C3. Outline of the CHS framework of intangible assets, definitions from Corrado et al (2005) and the System of National Accounts (SNA 2025).

Category	Definition of Category	Asset	Definition of Asset
Computerised information	"Knowledge embedded in computer programs, computerised databases"	Software	"Computer programs, program descriptions and supporting materials for both systems and applications software, that are expected to be used in production for more than one year. It also includes AI systems."
		Databases	"Electronic files of data, including the information content (i.e., the data themselves), organised in such a way as to permit resource-effective access to and use of the data, either for own use in production for more than one year, or for sale as an item or for sale by means of a licence to access the information contained"
Innovative property	"Knowledge acquired through scientific R&D and non-scientific inventive and creative activities"	R&D	"Creative work undertaken on a systematic basis to increase the stock of knowledge, including knowledge of humans, culture or society, and use of pre-edit version of this stock of knowledge for the purpose of discovering and developing new products, including improved versions or qualities of existing products, or discovering or developing new or more efficient processes of production." (includes all new product development costs)
		Entertainment and artistic originals	"Original films, series and other visual recordings, sound recordings, games, manuscripts, tapes, models, etc., on which entertainment, literary and artistic output, etc., are recorded or embodied."
		Design	The capitalised value of developing the form, style, and functional features of products
		Mineral exploration	"The capitalised value of expenditures on exploration for mineral and energy deposits and the subsequent evaluation of the discoveries" (SNA 2025)
Economic competencies	"Knowledge embedded in firm specific human and structural resources, including brand names"	Brands	"Assets that generate economic benefit through customer loyalty and reputation"
		Organisational capital	Firm-specific structural resources, management practices, business processes and organisational knowledge
		Firm-specific human capital	Skills and knowledge created through employer-provided worker training that are specific to the firm and not easily transferable to other employers (only firm- specific is considered because this is the portion (economically) owned by the firm). Non-firm-specific human capital is captured by labour quality