Hospital Construction Costs: Analytical Note

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Analytical Note: Peter O'Connor

Overview

Ireland is proposing, planning, or building eight new public hospitals. This note highlights the complexities of hospital construction and details the factors affecting costs and risks. To mitigate financial risk, cost forecasts should be validated and benchmarked against similar projects. However, this is currently limited by the lack of comparable international data on hospital construction costs. Factors affecting accurate cost comparisons include:

- the relevance of cost per 'bed' as an appropriate measure of cost.
- cost per square metre not reflecting the model or level of acuity in each facility and therefore not necessarily providing an equivalence.
- whether construction costs include Value Added Tax (VAT) or sales tax.
- whether reported costs cover only construction or the entire program, including equipment and furnishings.
- difficulty in accounting for inflation in incomplete projects.
- adjusting for price differences across countries.

Comparing health expenditure is crucial for states to benchmark their performance. While initiatives like the OECD System of Health Accounts have improved the comparability of current health expenditure, a similar initiative for capital expenditure would be highly beneficial. To compare and analyse hospital construction costs and floor areas across countries, it is important to have a comparable dataset with consistent definitions. Clear guidelines on reporting hospital construction costs (e.g., including or excluding VAT/sales tax, land costs, and medical equipment) and new hospital floor areas (e.g., gross floor area, internal area, or usable area) would be valuable.

Despite the challenges in comparing hospital construction costs, this paper adds to the discussion by creating a dataset of 356 hospitals, detailing construction costs, number of beds, and area in square meters. Additionally, it compares cost data by hospital type, including children's, elective, maternity, psychiatric, and rehabilitation hospitals.

Key Findings

1. **Cost Benchmarking**:
   - **New Children's Hospital (NCH)**: The cost of Ireland's new NCH is above average when compared with other hospitals in the dataset.
   - **Elective Hospitals**: The indicative up-front costs of the proposed new elective hospitals in Cork and Galway appear to be high on a per square metre basis when compared with other similar hospitals in the dataset.
2. **Whole Lifecycle Cost of Hospital Buildings:** The whole lifecycle cost of hospital buildings (i.e., capital expenditure plus operating expenditure over 30 to 100 or more years) is primarily driven by operational costs (particularly labour costs). Capital expenditure for a new hospital building is equivalent to circa 5% to 10% of its lifetime operational expenditure.

3. **Design Maturity:** Developing a high-quality, peer-reviewed, and mature design before commencing a major construction project reduces the risk of a cost overrun.
4. **Project Management:** Effective project management for large-scale capital projects requires expert personnel. It also requires planning, internal controls, change management systems, a formal gateway process, and an assurance framework.
5. **Flexibility:** Hospitals should be designed to allow for future alterations and expansions.
6. **Medical Equipment Planning:** Integrating medical equipment planning, alongside new facility design reduces late design changes, delays, and cost overruns, while also allowing flexibility for accommodating new technologies.
7. **Urban Sites vs Greenfield Sites:** Urban or brownfield sites pose challenges such as site clearance, decanting, and remediation works. There can also be limitations on access for materials delivery. Building works in urban areas may contribute to congestion and the need to temporarily relocate services to create the necessary space to build. Greenfield sites offer fewer constraints and greater flexibility for phased construction but may lack the synergies, clinical benefits and workforce access found in co-located or urban sites.

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Disclaimer

1. Objective and Structure of the Paper

This note aims to identify the factors contributing to the complexity of hospital construction projects and provide detailed information on associated costs and risks. This is particularly relevant as eight new public hospitals are proposed, planned, or under construction in Ireland. Benchmarking these costs is challenging due to the lack of comparable international data on hospital construction prices. This paper attempts to advance research in this area.

In terms of structure, Section 2 of this note introduces the topic and outlines the structure of the Irish hospital system. Section 3 delves into the cost drivers of hospital space. Section 4 benchmarks hospital construction costs in Ireland against comparable international examples. Section 5 focuses on children's hospitals. Section 6 focuses on elective hospitals. Section 7 focuses on maternity hospitals. Section 8 focuses on psychiatric hospitals. Section 9 focuses on rehabilitation hospitals. Section 10 outlines the site, design, and environmental risks that can affect hospital construction projects. Section 11 outlines potential communication and coordination risks. Section 12 outlines financial risks. Section 13 outlines technological risks. Section 14 outlines operational risks that can affect hospital buildings. References and appendices start from page 47.

2. Introduction

A hospital is a major capital and labour asset, used to produce healthcare services. Hospitals concentrate scarce resources within planned referral networks to respond efficiently to population health needs (Love & Ika, 2022). The primary function of hospitals is the delivery of medical care (i.e., diagnosis and treatment) to inpatients or outpatients.[1] This can take the form of elective or emergency care.[2] Hospitals also serve secondary functions such as teaching and research (Rechel et al, 2009a).

Major capital investment or procurement is difficult in any sector (McKee, Edwards, & Atun, 2006). Hospitals are among the most critical and complex types of buildings to plan, design, construct, and operate (Bilec, et al., 2009). Large hospital construction projects may be planned for many years in advance of the commencement of construction. Their costs are influenced by a range of factors such as:

- the type of hospital facility being built,
- site-specific statutory obligations,
- national building standards (e.g., fire safety requirements),
- infection prevention requirements,
- planning constraints,
- special infrastructure requirements (e.g., for radiology or operating theatre space), and
- the scope for ancillary upgrades.[3]

Internationally, health and hospital construction projects have average cost overruns of 29% (Flyvbjerg & Gardner, 2023).

[1] An 'inpatient' is a patient who goes into hospital to receive medical care and stays there one or more nights while they are being treated, and may need expert monitoring post procedure. Patients who have an appointment in a hospital but do not need to stay overnight are either outpatients or day-case patients. An outpatient comes into the hospital for a short appointment (e.g., a consultation with a specialist, a test, or a scan etc). Day-case patients comes in for more involved procedures than an outpatient.
[2] Emergency care involves life-threatening illnesses or accidents which require immediate treatment. Elective care involves non-acute (i.e., non-emergency) consultations or procedures.
[3] DPENDR - Political Party Costings - Pre Budget 2024 - The Labour Party Costings - Budget 2024. 'Hospital beds' section, p35 to 39.

Hospitals are typically designed to have a lifespan of more than 30 years. During this time, the demands placed on the facility are likely to change significantly due to changes in demographics, technology, and models of care (Olsson & Hansen, 2010). Until the 1950s, hospitals primarily provided bed rest and convalescence, with limited medical interventions (Rechel et al, 2009a). Over subsequent decades there were major developments in hospital care and design such as:

- reductions in the average length of hospital stays (ALOS),[4]
- the closer integration of surgery and imaging departments (Symons, 2021),
- the increase in size of inpatient rooms, exam rooms and operating rooms (Kendall, 2018),
- the movement of long-stay psychiatric patients to community settings,
- the provision of more nursing care for the elderly outside hospitals,
- the restructuring of acute care with more ambulatory treatment and rehabilitation,[5] and
- the increased use of primary care and home care (Rechel et al, 2009a).

2.1 The organisation and models of hospitals in Ireland

Ireland's stock of health infrastructure per person is around half the level of other high-income European countries (Conroy & Timoney, 2024). Much of the Health Service Executive's (HSE) estate is old, with the average year of construction of healthcare buildings currently in use being 1953 (DoH, 2024b). The older a building is, the more likely negative outcomes are for energy efficiency, patient safety, functional suitability, compliance with health standards, maintenance costs and refurbishment costs (Shine & Hennessy, 2022).

Irish hospitals are defined as being Model 1 to 4 based on the type of activity they provide.[6,7] The purpose of these models is to clearly define hospital services:

i. **Model 1 hospitals:** These are community or district hospitals, with sub-acute in-patient beds. These hospitals do not have surgery, emergency care, acute medicine, or critical care.

ii. **Model 2 hospitals:** These hospitals can provide most hospital activities including extended day surgery, selected acute medicine, local injuries, a large range of diagnostic services (including endoscopy, laboratory medicine, point-of-care testing, and radiology), specialist rehabilitation medicine and palliative care. This hospital will not have an Intensive Care Unit (ICU).

iii. **Model 3 hospitals:** These provide 24/7 acute surgery, acute medicine, and critical care.

iv. **Model 4 hospitals:** These are similar to Model 3 hospitals but provide tertiary care and, in certain locations, supra-regional care (HSE, 2013); (HSE-NDTP, 2023).[8,9]

In addition, there are other forms of healthcare facility which are not categorised under the hospital model system such as:

[4] Day-case procedures have risen, often supplementing rather than replacing inpatient care, and with shorter, more intense hospital stays for more seriously ill inpatients, requiring more intensive care. ALOS in Irish hospitals fell from 9.7 to 6.6 days from 1980 to 1993 (DoH, 2002). See also OECD (2017) 'Average length of stay in hospitals'.
[5] Ambulatory care refers to outpatient medical services, without admission to a hospital.
[6] See HSE-NDTP (2023) 'NDTP Model 3 Hospitals Report'. Note the acronyms Hospital Group (HG) and University Hospital (UH).
[7] See Shine & Hennessy (2023) 'Hospital Performance' p6 for a map of unscheduled care facilities in Ireland.
[8] Primary Care relates to a patient's first point of contact with healthcare professionals, or first aid assistance. Secondary care refers to the intervention of specialists, generally after GP referral and typically takes place in hospitals or clinics. Tertiary care is the most specialised level of care and occurs in specialist centres (HSE, 2016).
[9] Supra-regional care refers to specialised medical services provided to a broader region beyond the immediate catchment area.

v. **Specialised hospitals**: These are characterised by the specialist medical care they provide (Wagenaar et al, 2019).

vi. **Private hospitals**: There are 19 private hospitals whose funding is largely obtained from private sources e.g., private health insurance.[10] They do not have emergency room facilities comparable to those found in public hospitals and tend to specialise in elective procedures e.g., orthopaedics (Mercille, Turner, & Lucey, 2021). Over 47% of Ireland's population is covered by private health insurance, a significant benefit of which is access to private hospitals (HIA, 2023). It should also be noted that the National Treatment Purchase Fund sources capacity in the private healthcare system for specific groups of patients on waiting lists (NTPF, 2023).

vii. **Primary care centres:** These are modern, purpose-designed buildings which provide a single location for a primary care team to work from. They often consist of general practitioners, public health nurses, pharmacists, physiotherapists, and psychotherapists. These teams support populations of around 7,000 to 10,000 people.[11] They offer an alternative to hospitals for the management of many aspects of care for long-term conditions like diabetes, asthma, or chronic obstructive pulmonary disease (COPD). Primary care centres and other community facilities can also be developed to support access to diagnostics and to provide minor surgery.[12] There are 174 operational Primary Care Centres (Watt, 2024).[13]

New hospital construction costs vary depending on the type of hospital being constructed. For instance, a Model 3 hospital, or a Model 4 hospital extension project, is very different to a completely new, standalone, Model 4 hospital. A Model 4 hospital with only some of the full range of clinical specialities (e.g., any of the Model 4 adult hospitals in Dublin) is very different in complexity and acuity to a National Level 4 hospital with all the clinical specialties (e.g., the new NCH).

The new maternity hospitals (in Dublin and Limerick) and the new elective hospitals (in Dublin, Cork and Galway) are specialist hospitals which do not align with the Model System as set out in the report of the National Acute Medicine Programme 2010 (HSE, 2010).

As shown in Table 1, there are currently eight new public hospitals proposed or under construction in Ireland.

[10] See Mercille, Turner, & Lucey (2021) 'Ireland's takeover of private hospitals during the COVID-19 pandemic'.
[11] See Project Ireland 2040 document on Primary Care Centres and Age Friendly Ireland (2021) 'Towards Age Friendly PCCs'.
[12] See Department of Health – Policy information – Primary Care 25/07/2019.
[13] See Robert Watt - Department of Health - William Petty Lecture – Dublin Economics Workshop 2024.

Table 1: New public hospitals (proposed or under construction) in Ireland.

No.	Hospital	Beds	Square Metres[14]	Cost	Year of completion
1.	**National Children's Hospital (NCH)**	473[15]	170,285[16]	€1.794 bn[17]	2025
2.	**National Maternity Hospital (NMH)**[18]	244	50,000	€0.500 to €1.000 bn	2029
3.	**Elective Hospital Cork (St. Stephens)**	TBD	27,022	€0.828 bn	2027
4.	**Elective Hospital Galway (Merlin Park)**	TBD	22,360	€0.695 bn	2027
5.	**Elective Hospital Dublin (Blanchardstown)**	TBD	TBD	TBD	2027
6.	**Elective Hospital Dublin (Crumlin)**	TBD	TBD	TBD	2027
7.	**New Limerick Maternity Hospital**	TBD	TBD	TBD	TBD
8.	**National Rehabilitation Hospital (NRH), Dublin**	235	TBD	TBD	TBD

Sources: Author's analysis based on data from various sources. NCH bed and year of completion figures from DPER (2024), while its cost and m^2 figures are based on information received from the DoH and National Paediatric Hospital Development Board (NPHDB). NMH data from DPER (2024). NRH data from their 2023 annual report. Cork Elective Hospital sq/m and cost data from ECC Cork PBC (2022) p4 & p14; Galway Elective Hospital m^2 and cost data from ECC Galway PBC (2022) p4 & p14 – capital budget with optimism bias with costs stated "at 2022 levels". Year of completion figures for all four elective hospitals from DPER (2024).

See an overview of Irish hospitals by hospital group (Table 2), estimated size in square metres (Figure 1), and by annual budget (Figure 2).

[14] The NMH's square metres figure related to 'Gross Floor Area'. The Elective hospital figures are 'Gross Internal Area' (GIA). The NCH's figure relates to Gross Floor Area plus the basement car park. The issue of inconsistent hospital floor area definitions is discussed in Section 3 (d).
[15] See DPER 'Prospects 2024/2025: Ireland's Major Infrastructure Project Pipeline'.
[16] The National Children's Hospital (NCH) has a Gross Floor Area (GFA) of 134,570m^2. This is exclusive of the basement car park that adds another 35,715m^2. Total is circa 170,285m^2. The €1.88bn budget includes all project costs such as Value-Added Tax (VAT), decant costs, Aspergillus (mold) prevention, host campus investments, medical and non-medical equipment, design costs, project management, legal costs, risk contingency as well as the satellite centres in Tallaght, Connolly Hospital and Cork (which have a GFA of circa 10,000m^2).
[17] The €1.88bn for the NCH is the costs to plan, design, build and equip the NCH and the two satellite centres in Blanchardstown and Tallaght, including overall programme costs. The €2.24 billion budget includes the costs of merging three hospitals into one at a corporate level. For NCH beds info, see a Dáil debate from 26 June 2024. Expenditure on the construction of the satellite centres at Tallaght and Connolly is noted as €86 million (see the Committee of Public Accounts debate 19/10/2023). Therefore, the cost of the new NCH is assumed to be €1.794 billion for the purposes of this analysis.
[18] This project is currently out to tender. See DPER 'Prospects 2024/2025: Ireland's Major Infrastructure Project Pipeline', the Department of Health – press release 26/04/2024, the Joint Committee on Health from 09/10/2024, and a Dáil debate from 31/05/2022.

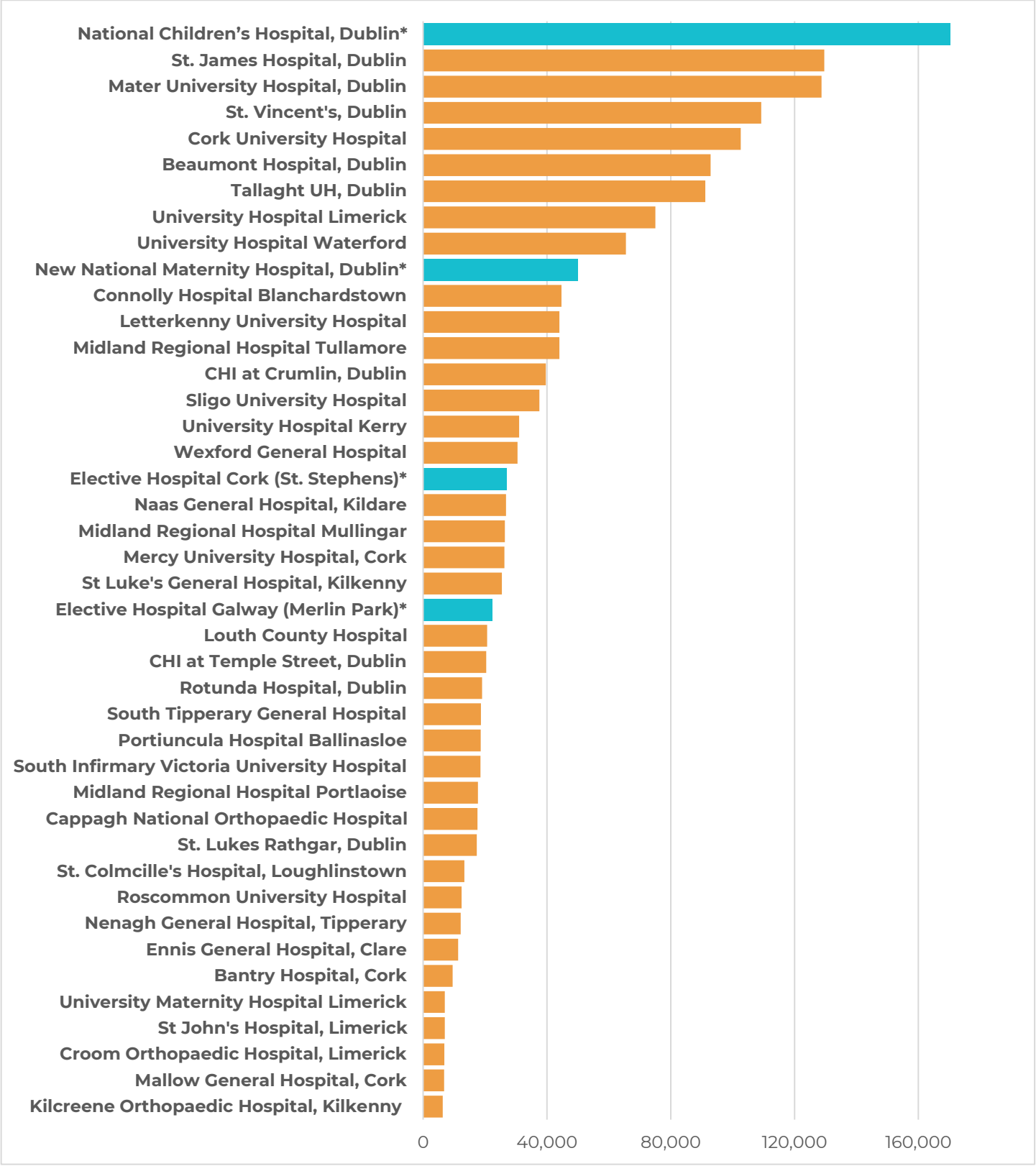
Table 2: Irish public hospitals by health region

Health Region	Model 4 Hospital	Model 3 Hospital	Model 2 Hospital	Other/Specialist Hospital
HSE Dublin & North East	• Beaumont Hosp., Dublin • Mater Misericordiae UH	• Cavan General & Monaghan Hospitals • Connolly Hospital, Dublin • Our Lady of Lourdes Hospital, Drogheda • Our Lady's Hospital Navan	• Louth County Hospital, Dundalk	• Rotunda Maternity H. Dublin • Cappagh Nat. Orthopaedic H. • CHI at Connolly
HSE Dublin & South East	• St Vincent's UH • UH Waterford	• St Luke's General Hospital, Kilkenny • Wexford General Hospital • Tipperary University Hospital, Clonmel	• St Columcille's Hospital, Loughlinstown • St Michael's H., Dun Laoghaire	• National Rehabilitation H., Dun Laoghaire • National Maternity H., Dublin • Royal Victoria Eye & Ear Hosp. • Kilcreene Ortho. H., Kilkenny
HSE Dublin & Midlands	• St James's H., Dublin • Tallaght UH	• Midlands Regional Hospital, Portlaoise • Midlands Regional Hospital, Tullamore • Naas General Hospital • Midlands Regional Hospital, Mullingar	• N/A	• Coombe Women & Infants UH • St Luke's, Rathgar (Radiation Oncology) • CHI at Crumlin • CHI at Tallaght • CHI at Temple Street
HSE South West	• Cork UH	• University Hospital Kerry, Tralee • Mercy University Hospital, Cork	• Bantry General Hospital • Mallow General Hospital • South Infirmary Victoria UH, Cork	• Cork Univ. Maternity Hospital
HSE Mid West	• UH Limerick	• N/A	• Ennis Hospital • Nenagh Hospital • St John's Hospital, Limerick	• Uni. Maternity Hosp. Limerick • Croom Orthopaedic Hospital
HSE West & North West	• UH Galway	• Letterkenny University Hospital • Mayo University Hospital, Castlebar • Portiuncula University Hospital, • Ballinasloe Sligo University Hospital	• Roscommon University Hosp. • Merlin Park UH, Galway	• N/A

Sources: Author's analysis based on HSE-NDTP (2023) 'Model 3 Hospitals Report' p44/61, HSE Dublin & North East webpage, HSE Dublin & South East webpage, HSE Dublin & Midlands webpage, HSE South West webpage, HSE Mid West webpage, and the HSE West & North West webpage.

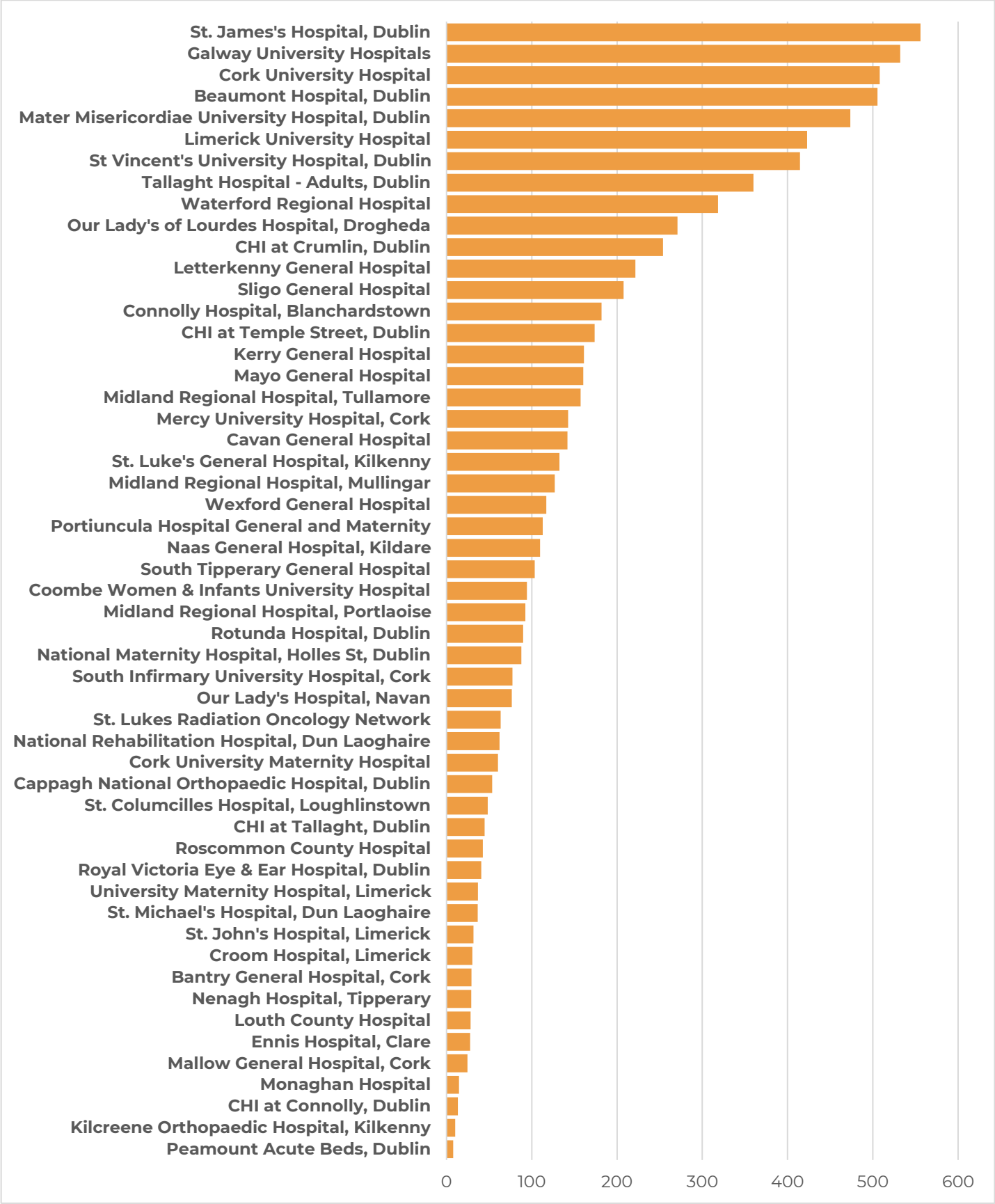
Note the acronyms Children's Health Ireland (CHI), Hospital (H), and University Hospital (UH).

Figure 1: Size of Irish hospitals in square metres



Data sources: Shine & Hennessy (2022) p19, Beaumont Hospital (2015) p13, DPER (2024) p41. Hospitals that are proposed or under construction are highlighted in turquoise and marked with an asterisk (*). See Table 1 for new hospital data. Note that there is a smaller set of hospitals in Figure 1 compared with Figure 2. Also note that new NCH area is GFA (134,570 m^2) + basement carpark (35,715 m^2). The new NMH area is GFA. The areas of hospitals highlighted in orange, as well as the new elective hospitals, are GIA. Beaumont hospital's area-type is not defined.

Figure 2: Annual budgets of hospitals in million € in 2023

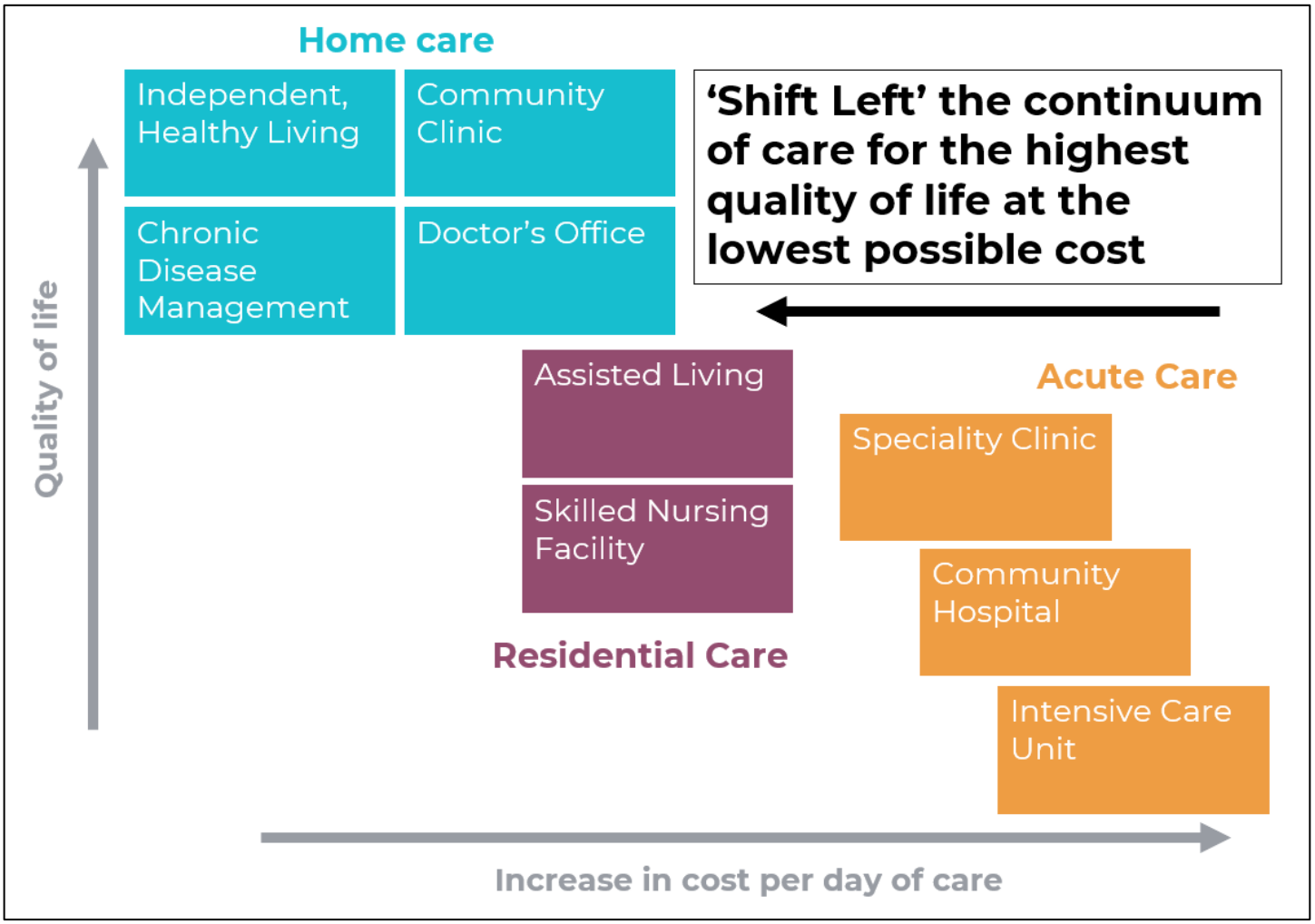


Source: HSE '[Management Data Report December 2023](#)' p150 and Author's analysis. Also note Shine & Hennessy ([2024](#)) p41-42 for a breakdown of acute hospital expenditure.

2.2 Delivering more care in the community

While there are a number of new hospital projects in Ireland, expanding primary and community care is at the heart of Sláintecare and is part of the 2025 Programme for Government.[19,20] The underlying principle is called 'shifting to the left' (i.e., delivering care as close to the patient's home as possible).[21] An overview of the 'stay left, shift left' strategy is set out in Figure 3 below.

Figure 3: Diagram of the Stay Left, Shift Left Strategy



Source: HSE presentation 'Stay Left, Shift Left: Digital Disruption and Transformation' p19..

- **Stay Left**: This is about keeping people well and managing chronic or long-term condition closer to home.
- **Shift Left**: This is about moving patients as quickly as possible from an acute setting to a community or home-based setting (DoH, 2024a).

In addition to the intensity of care provided, patient costs may be higher in hospitals compared with other settings due to the level of specialist staff employed, diagnostics provided and medicines used for procedures and treatments (Beales & Smith, 2012); (Dale et al, 1996); (Huskins,

[19] Note the 'Sláintecare Report' (Committee on the Future of Healthcare, 2017) and the 'Sláintecare Implementation Strategy & Action Plan 2023' (Government of Ireland, 2021).
[20] See the 2025 Programme for Government.
[21] This is an international principle embedded within the Irish health sector via Sláintecare..

Richter, & van Staden, 2001). As shown in Table 3, running or operational costs per patient per year vary considerably across different care and accommodation settings.

Table 3: Annual operational costs to the State per patient by tenure

Tenure	Annual cost
Private housing	€0
Independent Living	€2,000
Assisted Living	€5,200
Specialised Living	€33,020
Nursing home	€45,883
Hospital	€365,000

Source: Mulholland & Molloy (2020) p20.

The HSE's Acute Hospitals division accounts for 38% of HSE expenditure, compared with 23% and 3% in the Primary Care and Health & Wellbeing divisions respectively,[22] indicating that a significant portion of the budget is allocated to hospitals.

Finally, the Department of Health's (DoH) Strategic Healthcare Investment Framework (SHIF) is designed to guide healthcare infrastructure investment in Ireland (DoH, 2024b).[23]

[22] See the 'HSE Annual Report and Financial Statements 2022' p126 and Duff (2017) 'Acute Hospital Expenditure Review'.
[23] See DoH (2024) 'Strategic Healthcare Investment Framework'

3. Cost Drivers of Hospital Space

Capital spending refers to building or acquiring assets such as hospitals, medical equipment, and ICT equipment. Current spending refers to day-to-day operational costs, such as salaries, administrative overheads, and medicine (PBO, 2023). Within hospitals, the capital expenditure requirements associated with different departmental areas have different cost profiles. As shown in Table 4, hospital space may be analysed according to function.

Table 4: Modelling hospital space (layers approach) according to different functions

No.	Segment	Description	Typical % of floor space
1.	**Hot Floor**	This is the only segment of the hospital that is truly 'medical'. It includes the emergency department, operating rooms, diagnostic imaging, and intensive care facilities. Other segments of the hospital are utilities which service it. The costs per square metre of the Hot Floor area are twice that of the Office area. In addition, the life cycle of the Hot Floor area is much shorter than that of the Office area.	24-46%
2.	**Hotel**	These are low care nursing departments of bedrooms and wards where, in addition to care, the residential function plays a primary role. This asset is similar to a hotel.	21-27%
3.	**Factory**	This relates to production line functions that are not part of the primary process, such as laboratories, laundries, kitchens, clinical decontamination units, pharmacies, facilities management, and clinical engineering.	9-13%
4.	**Office**	All office facilities, administration, staff departments, consulting rooms and outpatient units.	24-36%
5.	**Other**	Some wards are very specialised and costly e.g., haematology, cardiac, transplant, and urology. While they may not easily be classified as 'Hot Floor', it is also difficult to classify them within a low care, generic 'Office' or residential 'Hotel' function.	Varies

Sources: Rechel et al (2009a), Wright et al (2012) and Author's analysis.

In general, more complex, high acuity areas are more expensive to construct. As shown in Figure 4, the capital costs associated with critical care beds are particularly high.[24]

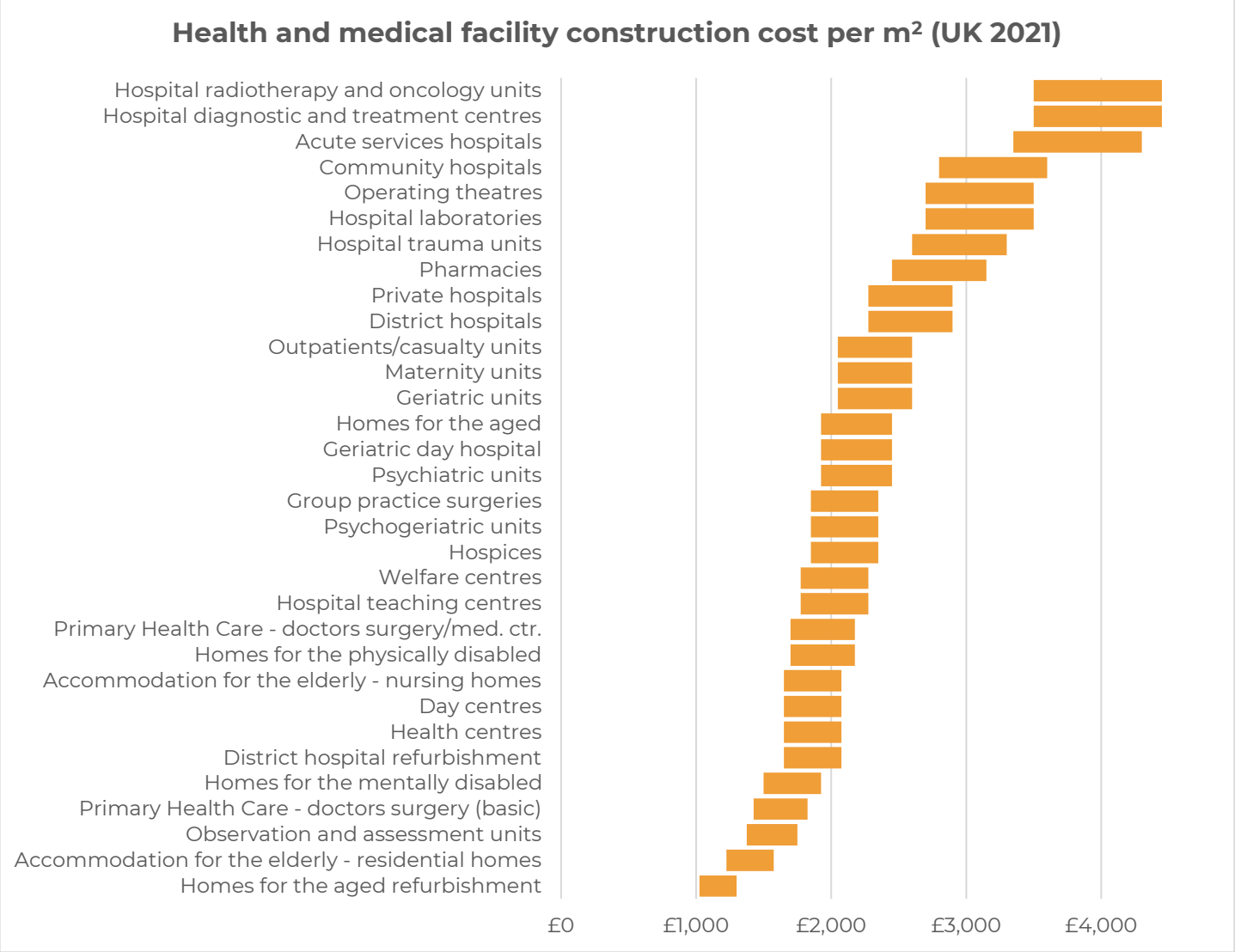
Figure 4: Bed Type Estimated Capital Cost Range Per Unit

Source: DPENDR - Political Party Costings - Pre Budget 2024 - The Labour Party Costings - Budget 2024

As shown in Figure 5, different types of medical and health facilities typically have different levels of construction cost per square metre.

[24] The indicative cost range for an additional acute inpatient bed is estimated to be between €0.75 million to €1.1 million, based on recent construction projects (Government of Ireland, 2024).

Figure 5: Cost range per square metre of health, medical and welfare facilities



Source: AECOM (2021) 'Spon's Architects' and Builders' Price Book 2022' p84-85 and PBO analysis.

3.1 Lifecycle costs of hospitals

It is important to consider the expected Whole Life Cost (i.e., Capital Expenditure plus Operating Expenditure over 30 to 100 or more years) or the planned useful life of the building, because the operating costs will far outweigh the construction costs over the lifetime of the building. Capital expenditure for a hospital may be circa 5% to 10% of lifetime operating expenditure.

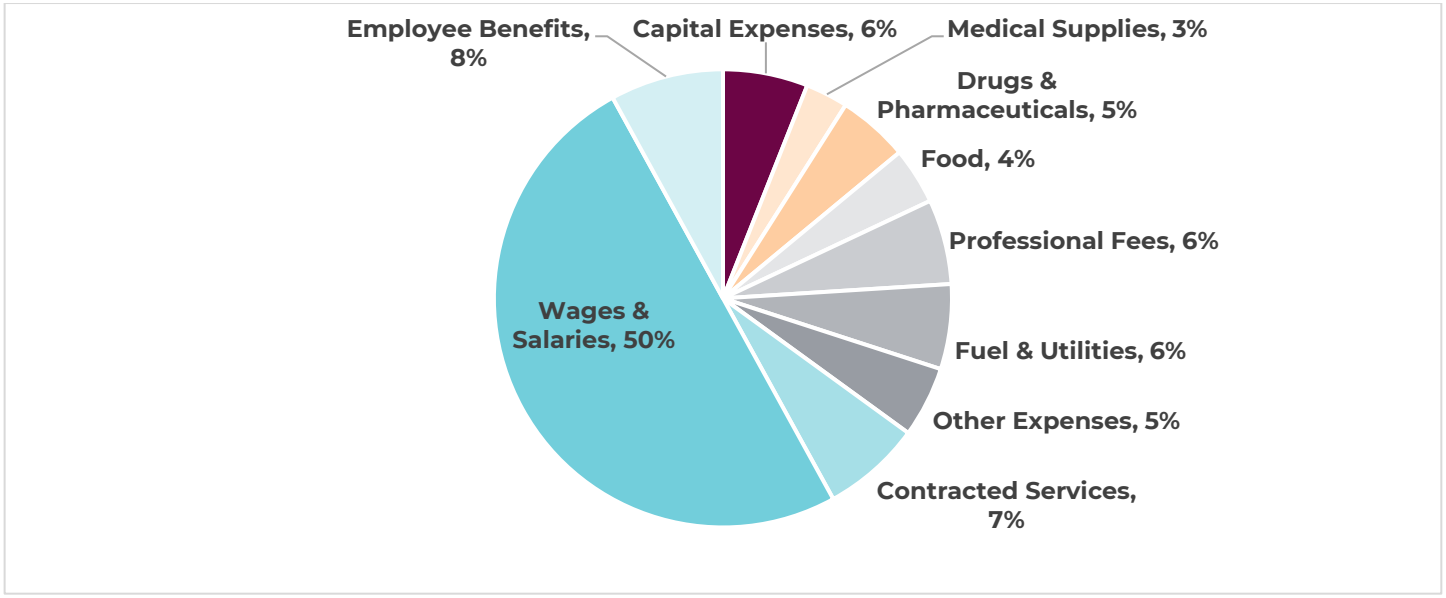
The healthcare sector is not particularly capital intensive (Acemoglu & Guerrieri, 2008); (Elmasr, 2007).[25,26,27] Between 1994 and 2020, capital expenditure accounted for only 3% to 5% of the total health budget in Ireland (Hennessy, Shine, & Walker, 2021). About two-thirds of national healthcare budgets are typically spent on personnel costs (Wagenaar et al, 2019).[28] Therefore, even

[25] 'Capital Intensity' is the amount of plant, property, equipment, inventory and other tangible or physical assets required to generate a unit of revenue (Elmasr, 2007).
[26] From 2017 and 2021, average capital expenditure in the health sector in OECD countries was below 0.6% of GDP, compared to an average of around 9% of GDP on current health spending over the same period (OECD, 2023).
[27] While health systems continue to be highly labour-intensive, capital has become an increasingly significant factor of production of health services in recent decades (OECD, Eurostat and World Health Organization, 2017).
[28] See PBO (2023) 'Health Spending in Ireland 2015 – 2023'.

considerable cost overruns in new hospital construction projects may only be equivalent to a matter of months of its operational expenditure and therefore less significant when seen in the context of a building lifetime perspective (Rechel, Wright, Edwards, Dowdeswell, & McKee, 2009a).[29,30]

As shown in Figure 6, 65% of a hospital's typical life cycle costs, over its many decades of use, are primarily attributable to personnel expenses, including salaries and contracted services.

Figure 6: Typical hospital lifecycle costs



Source: Kiss (2011)

[29] 'Life-cycle costing' takes account of the initial cost to build, together with the costs arising over the whole life of the building, including energy, equipment maintenance or replacement, staff training and finally the disposal cost at the end of the life of the building (Rechel, Wright, Edwards, Dowdeswell, & McKee, 2009a).
[30] Life-Cycle Cost (LCC) is the total discounted cost of owning, operating, maintaining, and disposing of a building over a period of time i.e., the aggregate cost to the building owner for the full range of ownership expenditure, from initial planning and inception through to termination of that building or system's expected service life (US DoD, 2016).

4. Benchmarking International Hospital Construction Costs

Each hospital represents a unique combination of design decisions which are determined by its specific context, including the population it serves, demographic trends, the healthcare system, and economic conditions (Wagenaar et al, 2019). It is difficult to make hospital construction cost comparisons for a number of other reasons including:

a) **Functional complexity:** Hospitals differ greatly in terms of function, size, and complexity e.g., the number of operating theatres, physiotherapy pools, research facilities and other specialist items etc.

b) **Relevance of bed numbers:** The traditional measure of hospital capacity - bed numbers - has become less relevant over time. Traditionally, inpatient care was the largest component of acute hospitals. Much of this care is increasingly provided in other settings (Rechel et al, 2009a).

c) **Total Beds definition:** The number of beds is not calculated in a uniform fashion e.g., in some countries ICU beds are not counted (Dowdeswell, Simpson, & Erskine, 2005). The bed set-up choice (e.g., single bedrooms or multi-bed ward rooms) can also greatly impact the total floor area required.[31]

d) **Total Floor Area definition:** The measurement of floor area (e.g., the definition of gross, net area, and usable floor area) varies greatly from country to country. In England and Ireland, for example, the footprint of the external walls is not counted inside the gross area.[32] Technical areas and interstitial floors are not counted in Norway and Ireland (Dowdeswell et al, 2005). France employs several different definitions: the Surface Hors Oeuvre Brute (SHOB) includes terraces, balconies, and parking spaces, while the Surface Hors Oeuvre Nette (SHON) is closer to gross area, although it excludes shafts and stairways (Dowdeswell et al, 2005). The US has several definitions such as Gross Floor Area which relates to the total floor area within the building to include all rooms, mechanical rooms, hallways, stairs, closets, walls, columns, or other features and Net Floor Area which relates to the actual occupied area in a functional space, not including thickness of walls, chases, columns, or general circulation.[33]

e) **Building Standards:** Hospitals in the UK and Ireland use similar building standards e.g., Health Building Notes and Health Technical Memoranda. Other countries do not work to these technical standards.[34,35]

f) **Length of delays:** When comparing costs of similar projects, it is useful to also note where significant delays have occurred, such as the Royal Liverpool University Hospital, and the Metropolitan Midland Hospital outside Birmingham, where the main contractor Carillion went into liquidation (KPMG, 2019).[36]

[31] While Single Bedrooms have benefits such as improved privacy, dignity, and infection prevention & control, they also have negative consequences such as increased maintenance costs e.g., increased numbers of (i) internal corners which need thorough cleaning and (ii) water outlets requiring cleaning, manual monitoring and periodic activation (QEUH Ind. Review, 2020).
[32] British medical planners use Gross Building Area (GBA) as the main measurement of area which is the combined total of (i) Gross Departmental Area (GDA), (ii) Gross Communications Area (GCA), (iii) Gross Plant Area (GPA) and (iv) Gross Facility Management Area (GFMA) (Burke, 2014).
[33] See US DoD (2016) 'Unified Facilities Criteria - Design: Military Medical Facilities' p284.
[34] See the NHS England website for further information on the Health Building Notes and Health Technical Memoranda.
[35] Military medical facilities may be built to particularly high or 'world-class' design standards (US DoD, 2016).
[36] Military medical facilities may subject long approval processes (Eller, 1996).

g) **Extent of site clearance:** Varying levels of enabling or decant works may be required.

h) **Level of inbuilt redundancy:** The quality of backup systems installed, in case primary electricity, water or medical equipment systems fail, varies across different hospitals.

i) **Level of resilience:** This refers to the level of structural integrity and emergency preparedness to prevent critical failures.

j) **Labour costs and productivity levels:** The cost of labour and level of construction productivity varies across jurisdictions.

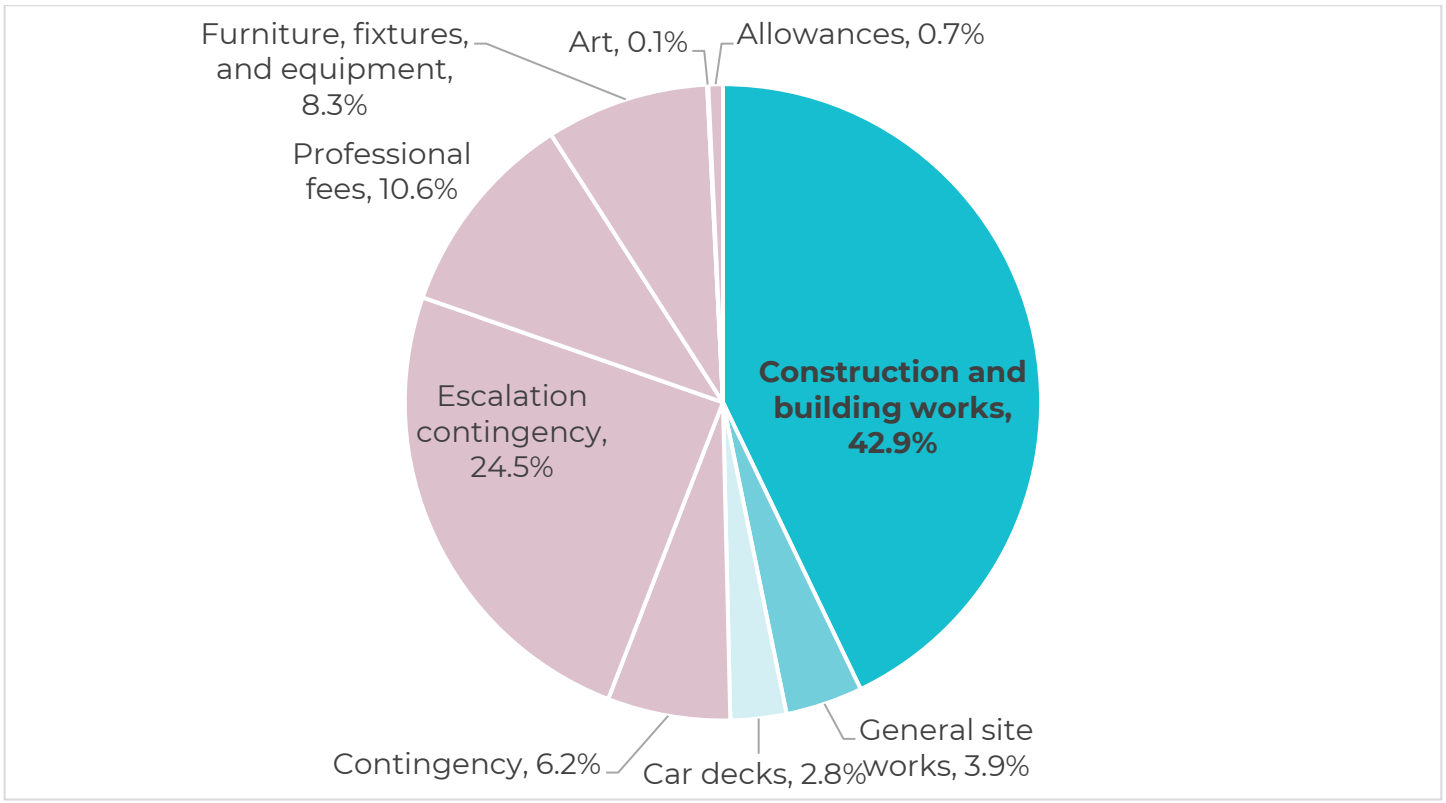
k) **Maintenance agreements**: In some cases, the price agreed for the construction of a new hospital includes a provision for the building contractor to continue to maintain the facility for several years post completion.

l) **Medical equipment**: The inclusion or exclusion of medical equipment purchasing and installation within the construction cost varies across projects.

m) **Location:** Urban versus rural settings and the associated land costs.

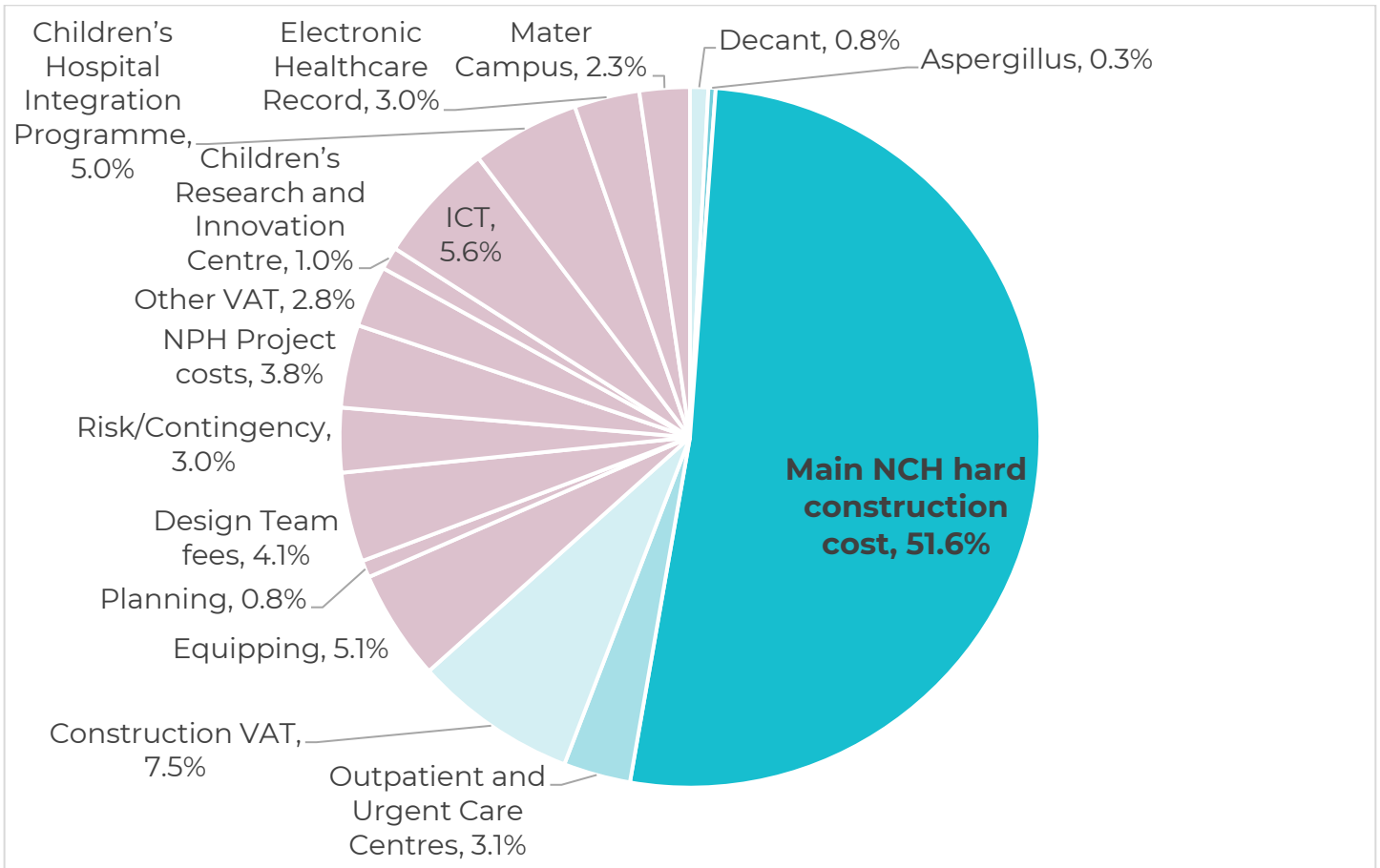
n) **Cost transparency:** There is a lack of international uniformity in relation to what is reported as hospital construction 'cost' i.e., it can be unclear if cost figures refer to a tender price, or the tender price plus programme management costs, or include design, planning, fit-out, ICT, equipment, and VAT (or equivalent) costs etc. In addition, for hospitals where detailed cost information is available, there is a lack of uniformity in relation to the disaggregation of construction costs into sub-components. See Figures 7 and 8 for construction cost breakdowns for the Fiona Stanley Hospital in Western Australia and Ireland's new NCH.

Figure 7: Breakdown of costs for Fiona Stanley Hospital in Western Australia



Source: Love & Ika (2022)

Figure 8: Breakdown of NCH project costs in 2018



Source: Author's analysis based on Dáil Éireann Debate 05/02/2019, National Children's Hospital Expenditure

3.1 Methods

A dataset of 356 hospitals was compiled for this analytical note. Each datapoint is characterised by four key variables: (i) year of completion or the year a cost estimate was developed, (ii) cost of construction, (iii) number of beds or maximum bed capacity, and (iv) area in square meters.

International examples of hospital construction costs are shown in Figures 9 to 18.

Health warning/caveats: It should be noted that the data was not uniformly generated under a single framework by any individual national or international organisation. The data on hospital construction costs in a range of countries is drawn from publicly available sources including academic papers, reports produced by government departments, media articles, architecture books, construction firm websites, and reports produced by national or regional audit agencies. The examples used relate to hospitals which are (i) located in high income jurisdictions,[37] and (ii) completed post-2005.

The dataset does not include all hospitals built in high-income jurisdictions since 2005. Certain countries may be over-represented e.g., Australia, Canada, Ireland, New Zealand, the UK, and the US collectively account for 27% of the world's high income jurisdiction population,[38] but 62% of hospitals in the dataset are from these countries.

For inflation 'up-rating' adjustments, World Bank producer price index (PPI) inflation data is used.[39] For several countries, 2024 PPI data was not available on the World Bank website as of 08/01/2025. For these data points, data from relevant national authorities was used. PPI data is a relevant metric for assessing construction input cost inflation, as it tracks price changes specific to producers, including raw materials and intermediate goods. Other indices, such as the Consumer Price Index, the Food Price Index, the Energy Price Index, and the GDP Deflator, are less relevant to capture cost variations in construction.

After inflation uprating to 2024-levels, non-Dollar denominated hospital construction projects prices are converted to US Dollar purchasing power parity (PPP) using International Monetary Fund PPPs.[40]

It is difficult to make like-for-like comparisons between different projects. There is ongoing debate on the relevance of 'beds' as a measure of modern hospitals given reductions in lengths of stay and the complexity of hospital activity. Similarly, the cost per square metre does not address the model or level of acuity in each facility and so does not necessarily provide an equivalence. For many hospitals there is a lack of clarity as to whether the construction costs include VAT or sales tax, whether it's purely construction costs or if it includes the costs of the wider construction programme, and the level of completion (e.g., if it includes equipment and furnishings). There is limited information, outlining, or distinguishing between, private and public hospitals. Additionally, for incomplete projects, it is difficult to determine whether an inflation factor for potential cost overruns has been included.

In certain instances, the sample size is small when comparing specific types of hospitals, so these comparisons are only indicative and should be interpreted with caution.

See a list of the sources of data in the appendix.

[37] See the World Bank 'The World by Income and Region' webpage.
[38] See the data section of the World Bank website.
[39] See the World Bank's Global Database of Inflation.
[40] See the International Monetary Fund's implied PPP conversion rate data.

Where the reported price is an indicative budget or tender price rather than actual outturn cost, an asterisk (*) is used. Where an indicative cost range is provided for a hospital project, the mid-point is used.

3.2 Discussion

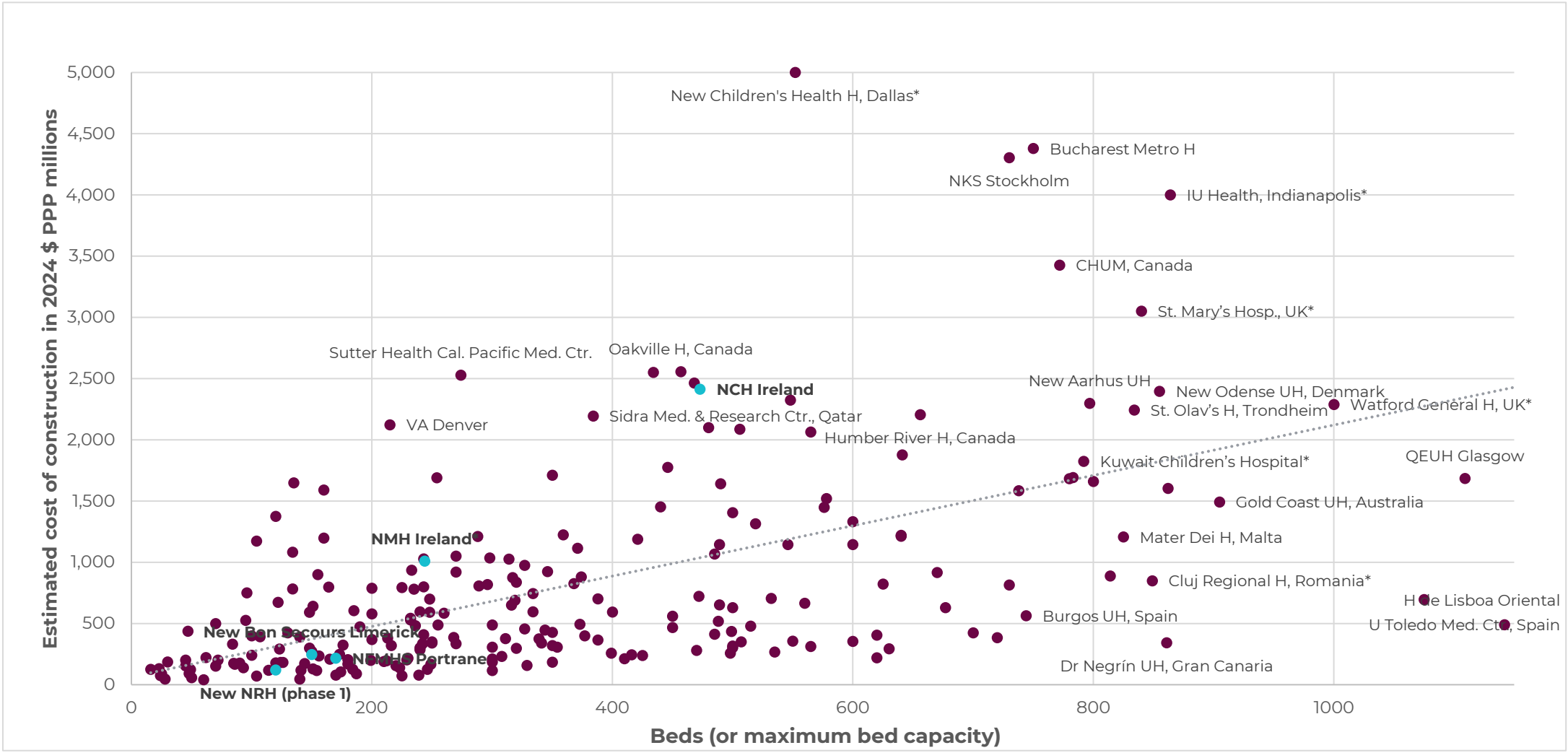
Although comparing international hospital construction projects involves several caveats and challenges, this analysis aims to contribute to the literature by gathering a substantial number of observations (see Figures 9 and 10). This effort seeks to provide a more comprehensive assessment of costs within an international context. The key findings from the analysis are as follows:

- **NCH**: The cost of Ireland's new NCH is above average when compared with other hospitals in the dataset (see Figures 11 and 12). Note that in each of these two charts, the dotted linear trendline represents the best-fit straight line through the data points.
- **Elective Hospitals**: The indicative up-front costs of the proposed new elective hospitals in Cork and Galway appear to be high on a per square metre basis when compared with other similar hospitals in the dataset (see Figure 13).[41]
- **NMH**: While the indicative up-front cost of the proposed new NMH in Dublin appears to be comparatively high (see Figure 14),[42] it should be noted that there is a limited number of maternity hospitals in the dataset. Therefore, this analysis should be interpreted as contextual information, as it does not allow for definitive conclusions to be drawn.
- **NFMHS Portrane**: The cost of the National Forensic Mental Health Service Portrane Hospital appears to be slightly above average when comparing against other psychiatric hospitals in the dataset, both on a per bed basis and a per square meter basis (see Figures 15 and 16). However, it should be noted that there is a limited number of psychiatric hospitals in the dataset. Therefore, the figures should be viewed as contextual information.
- **NRH**: While the cost of phase one of the new National Rehabilitation Hospital in Dún Laoghaire is below average (see Figures 17 and 18), it should be noted that there is a limited number of rehabilitation hospitals in the dataset. Therefore, this analysis should be interpreted as contextual information.

[41] See ECC Cork PBC (2022) p4, and ECC Galway PBC (2022) p4, for estimated initial (capital) budgetary requirements.

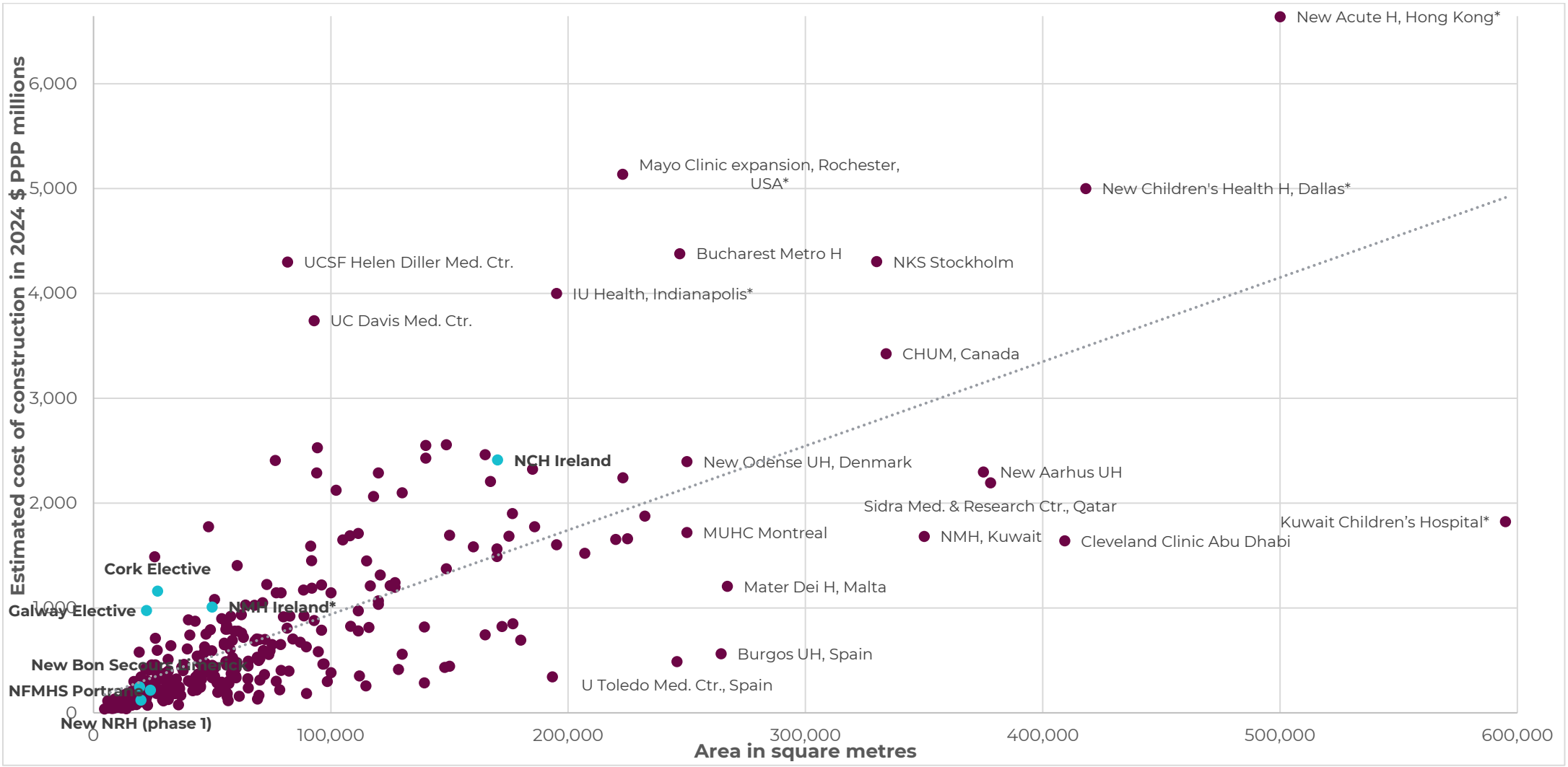
[42] DPER (2024) p41 suggest an indicative cost range of €500m to €1bn for the new NMH. This analysis uses the mid-point (€750m).

Figure 9: New Hospital Construction by number of beds and estimated or indicative cost (in 2024 $ PPP millions)[43]



[43] Note: Author's calculations based on the sources listed in the appendix. For inflation 'uprating' adjustments, PPI is used. After inflation uprating to 2024-levels, prices are converted to US Dollar PPP using IMF data.

Figure 10: New Hospital Construction by area and estimated or indicative cost (in 2024 $ PPP millions)[44]



[44] Note: Author's calculations based on sources listed in the appendix. For inflation 'uprating' adjustments, PPI is used. After inflation uprating to 2024-levels, prices are converted to US Dollar PPP using IMF data.

5. Children's Hospitals

Children are a special patient category, and can be disaggregated into five separate age groups, each with their own distinctive characteristics and needs:

- neonates (0–28 days old),
- infants (28 days to 1 year old),
- toddlers (1–3 years old),
- early-school children and pre-adolescents (3–12 years old), and
- adolescents and young adults (12–18 years old).

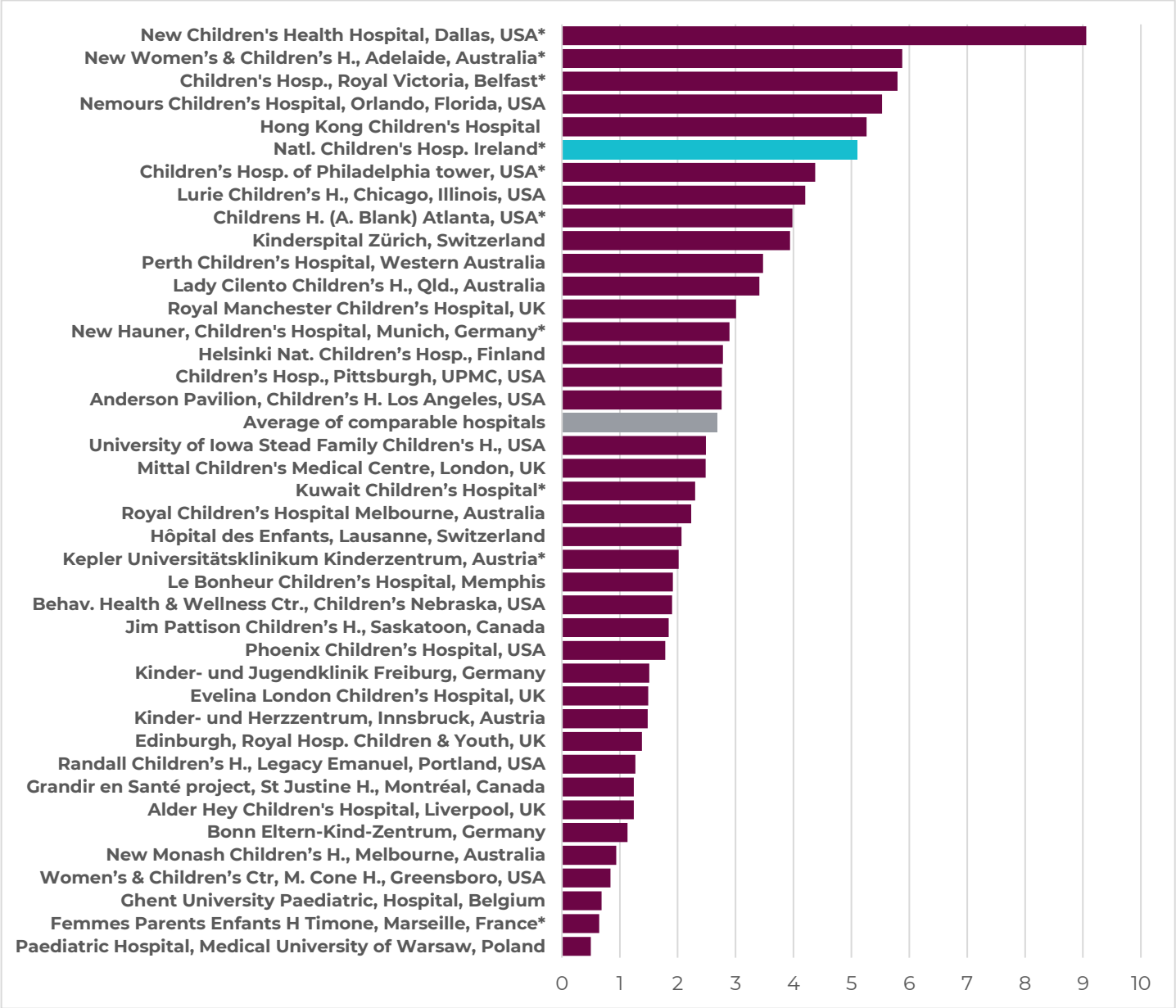
Specialised children's hospitals have emerged over time as a standalone hospital-type. Technological advances and the trend towards increased sub-specialisation allow doctors to do more for sick children and to do it in centres that have substantial capabilities (McKinsey, 2006).

Children's hospitals are focused on ameliorating the pain, fear and distress caused by disease and medical interventions. They may also provide opportunities for play and schooling. As medical equipment can increase children's fear and distress, the design of these facilities focuses on creating normal, child-friendly spaces. As children can be more sensitive to the qualities of the environment than adults, the healing environment concept is particularly important e.g., colour, natural light, sound reduction and greenery. It also important to ensure close contact with parents, who may need to stay overnight. Over the years, patient rooms in these facilities have grown larger, more private, and increasingly family centred (Wagenaar et al, 2019).

5.1 Benchmarking international children's hospital construction project costs

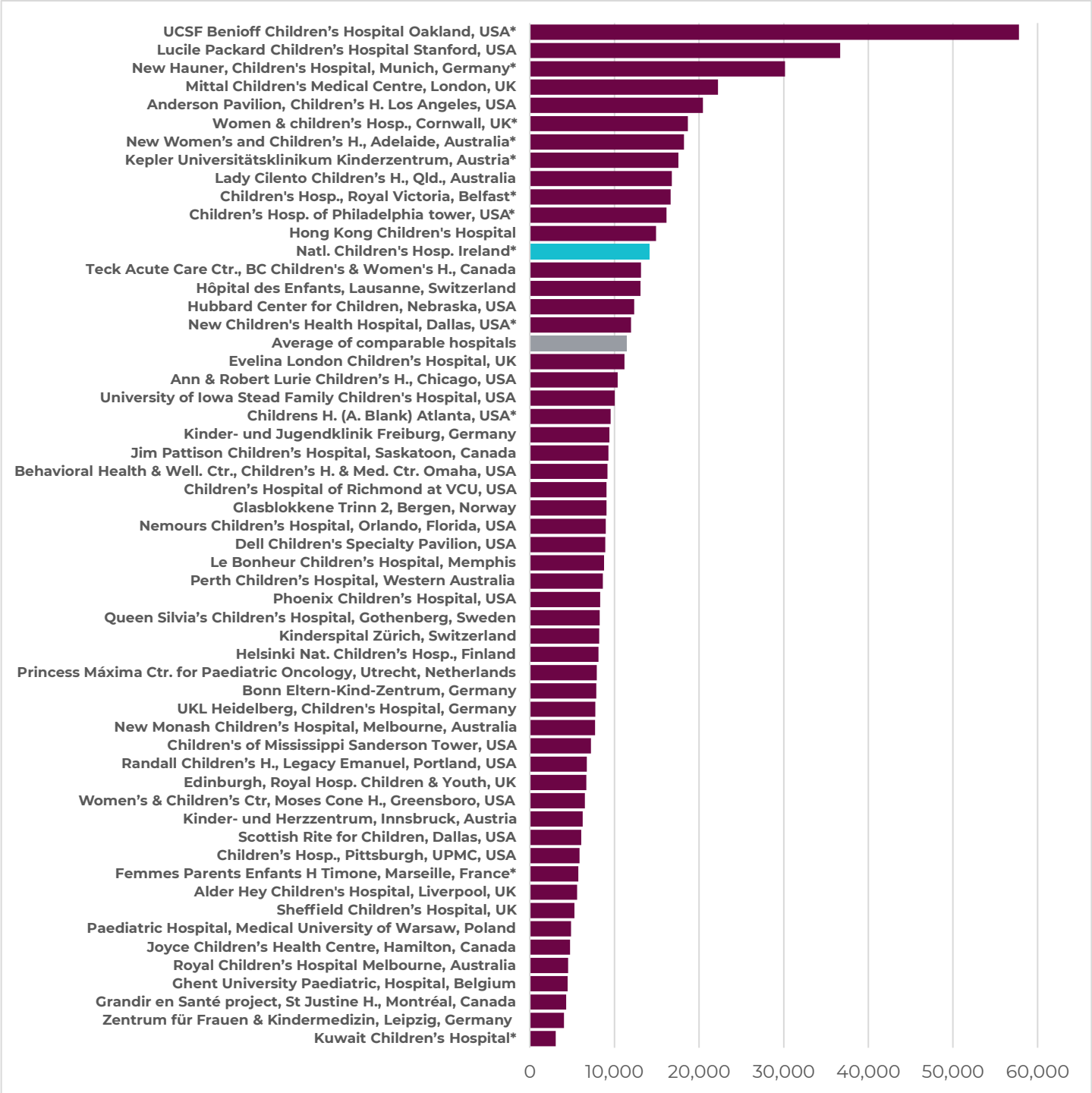
Figures 11 and 12 show cost comparisons of new children's hospital projects.

Figure 11: Comparison of children's hospitals by estimated cost per bed (in 2024 million $ PPP)



Sources: Author's analysis based on the sources listed in the appendix. Notes: An asterisk (*) is used when the reported price is an indicative budget or tender price rather than actual outturn cost.

Figure 12: Comparison of children's hospitals by estimated cost per m² (in 2024 $ PPP)



Sources: Author's analysis based on the sources listed in the appendix. Notes: An asterisk (*) is used when the reported price is an indicative budget or tender price rather than actual outturn cost.

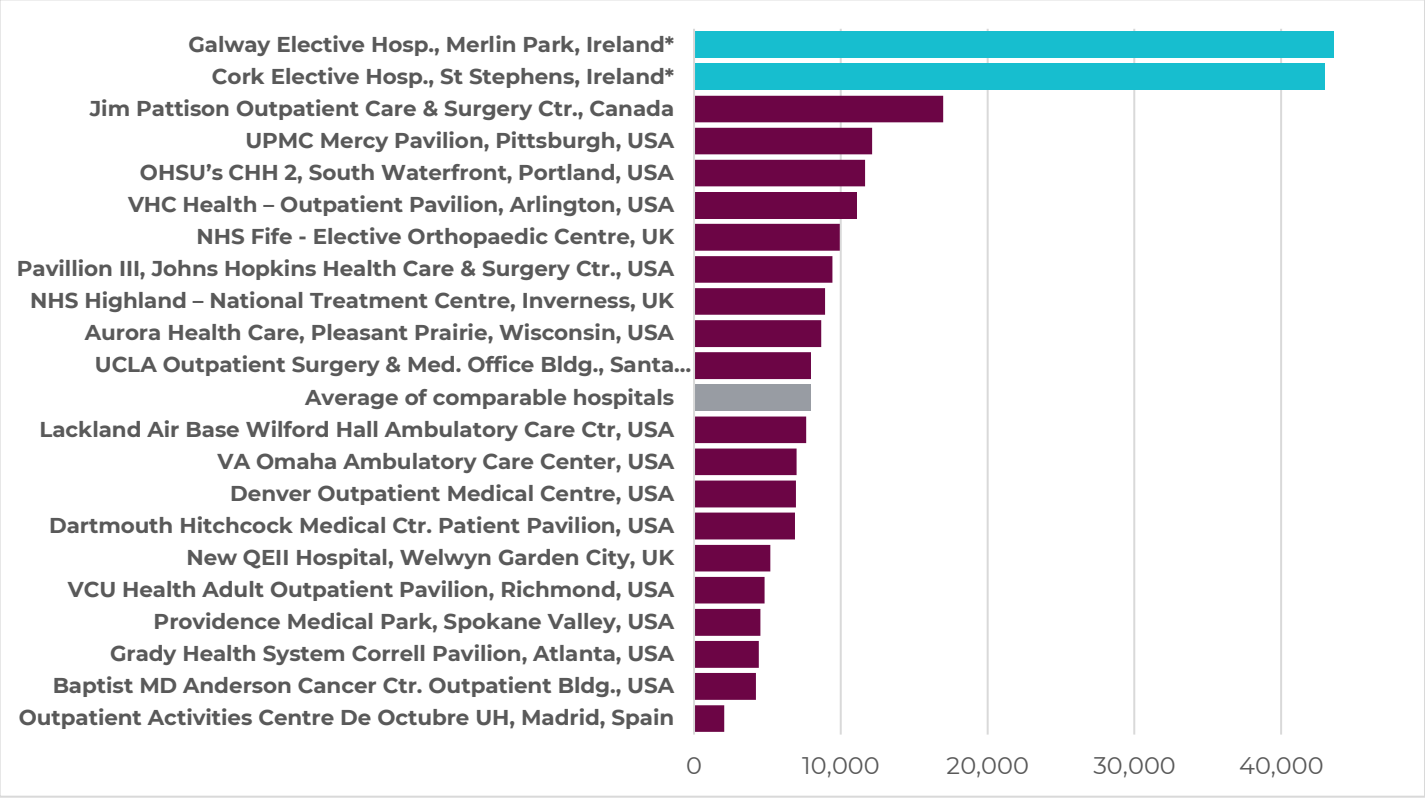
6. Elective, Ambulatory, and Outpatient Care Hospitals

Elective care (as opposed to emergency care) is planned care, for those whose clinical condition requires a procedure or treatment that can be managed by placement on a waiting list. Elective care ranges from clinic visits and diagnostics to invasive procedures (Thompson & McKay, 2020).[45] The growing prevalence of elective care settings is being driven by several factors such as:

- **Advances in clinical approaches and technology**: Developments in anaesthesia, pain control, and minimally invasive surgical procedures, have enabled numerous procedures (e.g., knee replacements, tonsillectomies) to migrate into ambulatory (i.e., day case) settings (McKinsey, 2020).
- **Benefits of separating elective and emergency surgical patient flows**: During periods of peak demand for operating rooms, emergency cases can displace elective cases (Rutherford, Anderson, Kotagal, Luther, & Provost, 2020). The Sláintecare Report suggests designating certain hospitals within each Hospital Group[46] as elective-only to prevent emergency and urgent care from delaying elective procedures. This approach aims to ensure protected capacity for elective care without reducing Emergency Department services (Committee on the Future of Healthcare, 2017).

See a comparison of estimated/indicative construction costs for new elective, ambulatory, and outpatient care hospitals in Figure 13.

Figure 13: Comparison of elective care hospitals by estimated cost per m² (in 2024 $ PPP)



Sources: Author's analysis based on the sources listed in the appendix. Notes: An asterisk (*) is used when the reported price is an indicative budget or tender price rather than actual outturn cost.

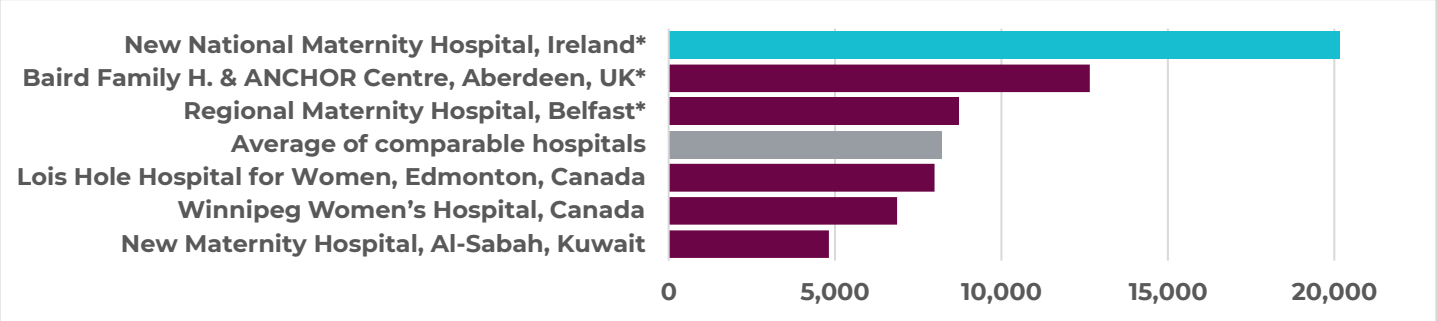
[45] Ambulatory (i.e., day case) surgical procedures account for 75 to 80% of all elective surgical procedures (NI DoH, 2017a). Ambulatory surgery is not appropriate for all patients including those with complex comorbidities or those with significant blood loss (McKinsey, 2020); (Fritts, Mannava, & Hislop, 2023).
[46] The Hospital Group structure was replaced by the new HSE health regions in 2024.

7. Maternity Hospitals

The characteristics of maternity services vary considerably across different jurisdictions. Settings of care range from hospital-based systems with consultant-led care - which is common in Ireland, to birth at home led by a midwife – which is common in the Netherlands (Hanafin & O'Reilly, 2016). Dublin's model of stand-alone maternity hospitals is not the norm internationally (KPMG, 2008).

See a comparison of indicative construction costs for new maternity hospitals in Figure 14.

Figure 14: Comparison of maternity hospitals by estimated cost per m² (in 2024 $ PPP)



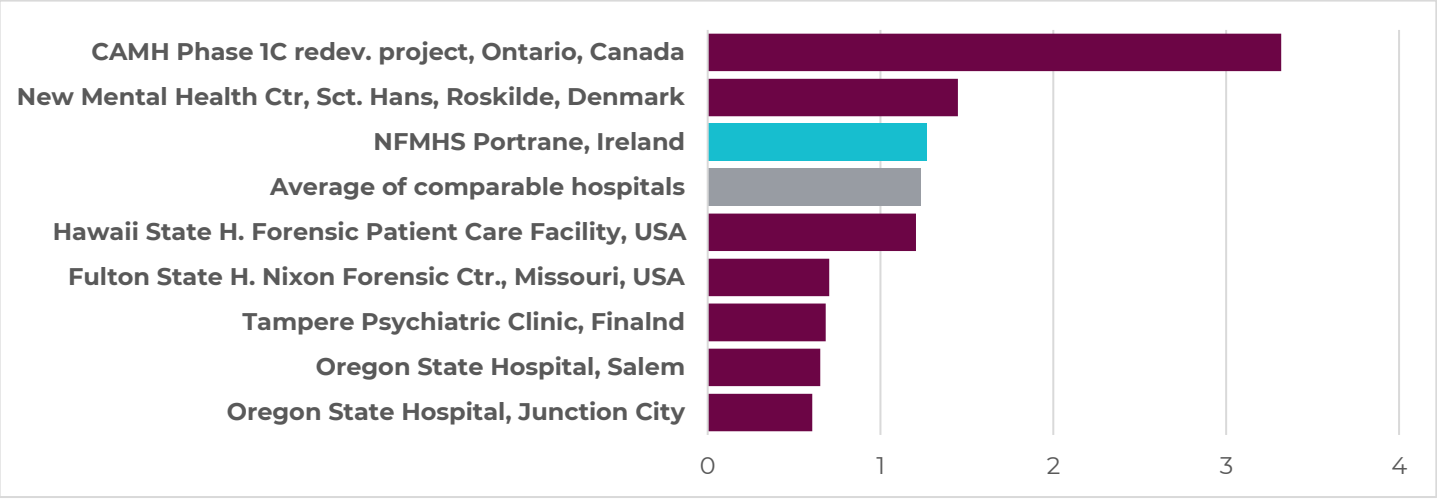
Sources: Author's analysis based on the sources listed in the appendix. Note that the Baird Family Hospital will provide some non-maternity related services (see its website for further information). Note that the cost of the new NMH is assumed to be the midpoint (€0.75bn) of its €0.5bn to €1.0bn cost range – see DPER (2024) p41. An asterisk (*) is used when the reported price is an indicative budget or tender price rather than actual outturn cost.

8. Psychiatric Hospitals

Psychiatric hospitals are facilities that primarily provide 24-hour inpatient care to people with mental illnesses (SAMHSA, 2021).

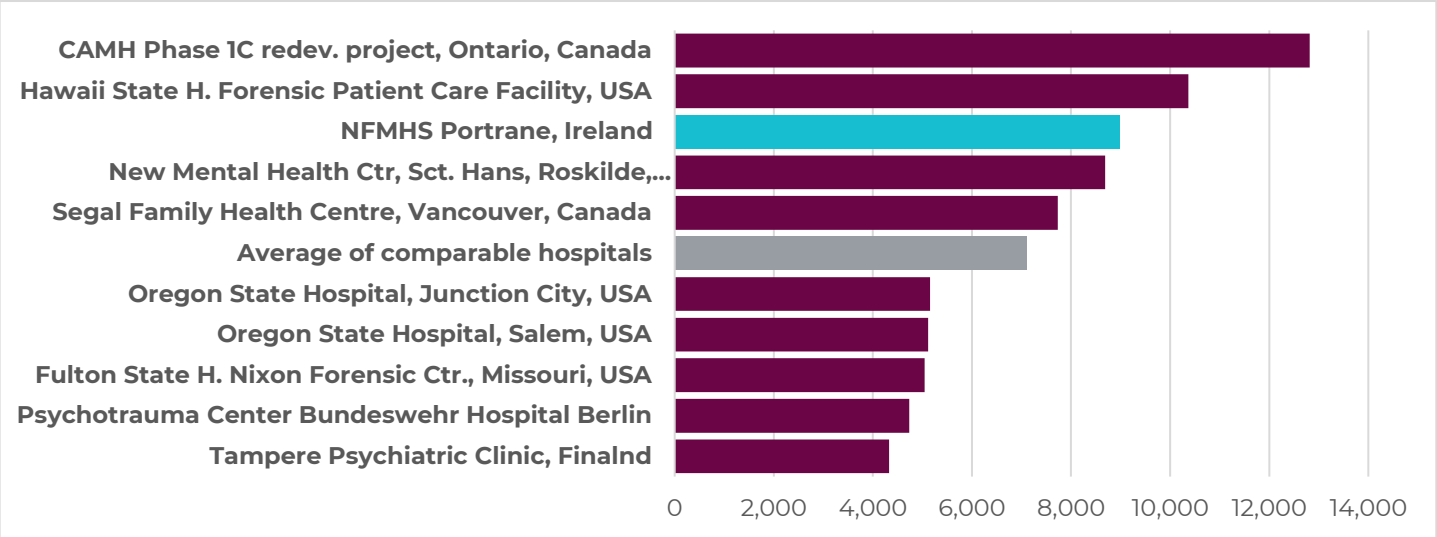
See a comparison of construction costs for new psychiatric hospitals in Figures 15 and 16.

Figure 15: Comparison of psychiatric hospitals by estimated cost per bed (in 2024 $ PPP)



Sources: Author's analysis based on the sources listed in the appendix.

Figure 16: Comparison of psychiatric hospitals by estimated cost per m² (in 2024 $ PPP)



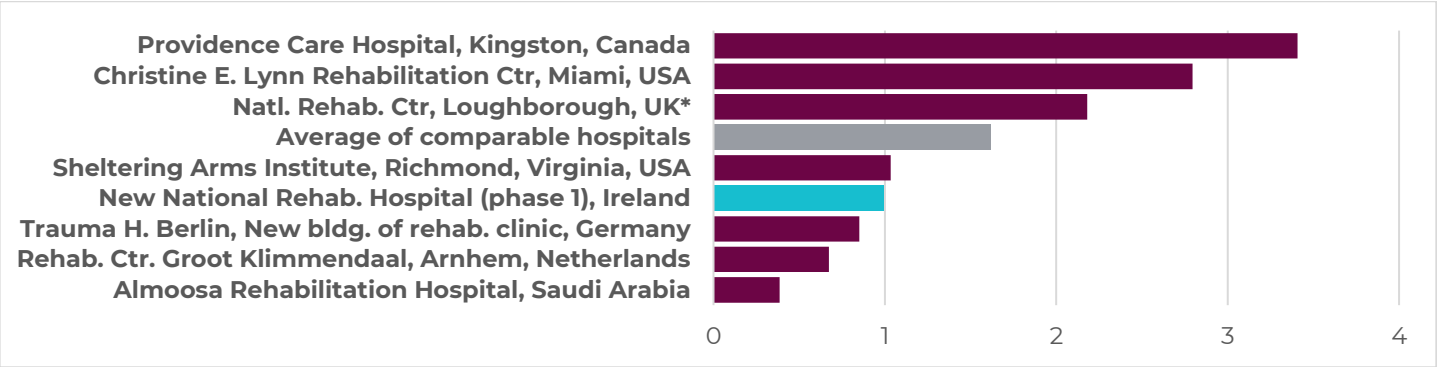
Sources: Author's analysis based on the sources listed in the appendix.

9. Rehabilitation Hospitals

Rehabilitation relates to interventions designed to optimise functioning and reduce disability in individuals with health conditions (WHO, 2023b).

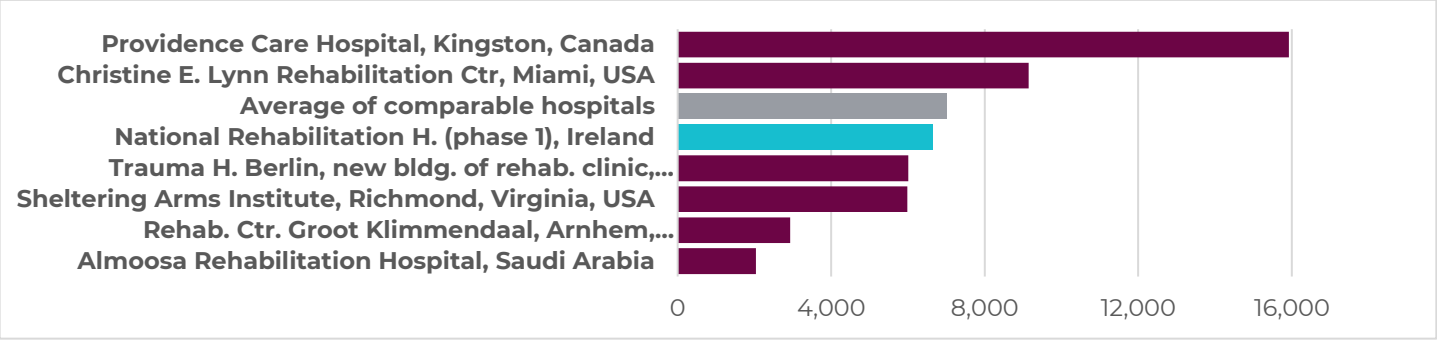
See a comparison of construction costs for new rehabilitation hospitals in Figures 17 and 18.

Figure 17: Comparison of rehabilitation hospitals by estimated cost per bed (in 2024 $ PPP)



Sources: Author's analysis based on the sources listed in the appendix. An asterisk (*) is used when the reported price is an indicative budget or tender price rather than actual outturn cost.

Figure 18: Comparison of rehabilitation hospitals by estimated cost per m² (in 2024 $ PPP)



Sources: Author's analysis based on the sources listed in the appendix.

10. Site, Design and Environmental Risks

At an early stage of a new hospital construction project, there should be a clear identification of risks. This may include a comprehensive assessment and quantification of their impact and likelihood, a definition of the responses to each risk, the allocation of ownership, the establishment of monitoring arrangements, and response plans (PwC, 2019). As the work progresses, the level of uncertainty and risk is generally reduced by successive stages of project development, design, and risk management.

10.1 Brownfield or urban site risk

Brownfield and urban sites pose challenges for hospital construction, including site clearance, remediation, and the need for enhanced electrical infrastructure (Dolphin, 2012). Urban projects often require deep basements for parking and the re-routing of underground services. Access limitations, material delivery constraints, and dust and noise restrictions may further complicate construction (Rudberg & Ekeskär, 2016). Other brownfield site considerations include traffic and heritage impacts, as well as constraints on converting existing facilities into construction zones. These issues intensify if construction occurs next to an operational hospital, as continuous access is required for ambulances and staff.

In contrast, greenfield sites (undeveloped land) offer greater flexibility for phased openings, future expansion, and extended hospital lifespans. However, greenfield sites may lack proximity to populations, workforce access, and existing infrastructure, critical for patient services and operational efficiency. Lastly, the use of brownfield sites aligns with the National Planning Framework's aim of ensuring compact growth and sustainable development for public services up to 2040.[47]

10.2 Delay risk

Delays cost money and may endanger the viability of a hospital construction project.[48] In the pre-construction planning phase, it is important to avoid letting long debates on future clinical strategy delay the development of the scheme. Technology and models of care will likely have changed by the time a new hospital building is commissioned (Edwards, 2020). Delays in releasing design drawings can be an additional issue (Huynh, Le, Le-Hoai, & Nguyen, 2024).

During the construction phase, programme delays caused by the client may lead to additional cost claims from contractors. Conversely, delays in the construction program caused by the contractor can result in substantial costs for the client. These costs arise from the need to maintain internal and external resources and specialists, and they also affect subsequent workstreams that depend on the completion of construction of a preceding phase. To mitigate this risk, it is important to monitor the schedule closely against a baseline plan, assess delays rigorously before agreeing to them and manage the schedule to minimise slippage (Dolphin, 2012); (PwC, 2019).

Contractual tools like liquidated damages (i.e., compensation paid by the contractor to the client for contractor delays based on a genuine pre-estimate of loss) may be used to encourage

[47] See the Government of Ireland – Project 2040 – Draft First Revision to the National Planning Framework – July 2024.
[48] 'Investment Fragility' refers to the vulnerability of a financial investment becoming non-viable (Shine, Hennessy, & Walker, 2021)

adherence to schedules,[49] and detailed subcontractor reports (providing updates on the progress and performance of subcontractors) may help to maintain transparency and keep completion dates on-track. However, there is some debate as to whether these measures are sufficient to provide an incentive for the contractor to adhere to a schedule in large-scale construction project.

10.3 Design maturity risk

In the design phase of a hospital, a strategic brief is developed to outline the client's functional goals. Complex designs can increase construction challenges, affecting schedules and costs (VA, 2012). Achieving a balanced consensus among stakeholders is essential, as a narrow focus on clinical or financial aspects can lead to 'scope creep' or compromises to the new facility's long-term functionality.[50,51] Inadequately developed requirements or insufficient user engagement can lead to cost increases and delays later on in the project (Mazars, 2018).

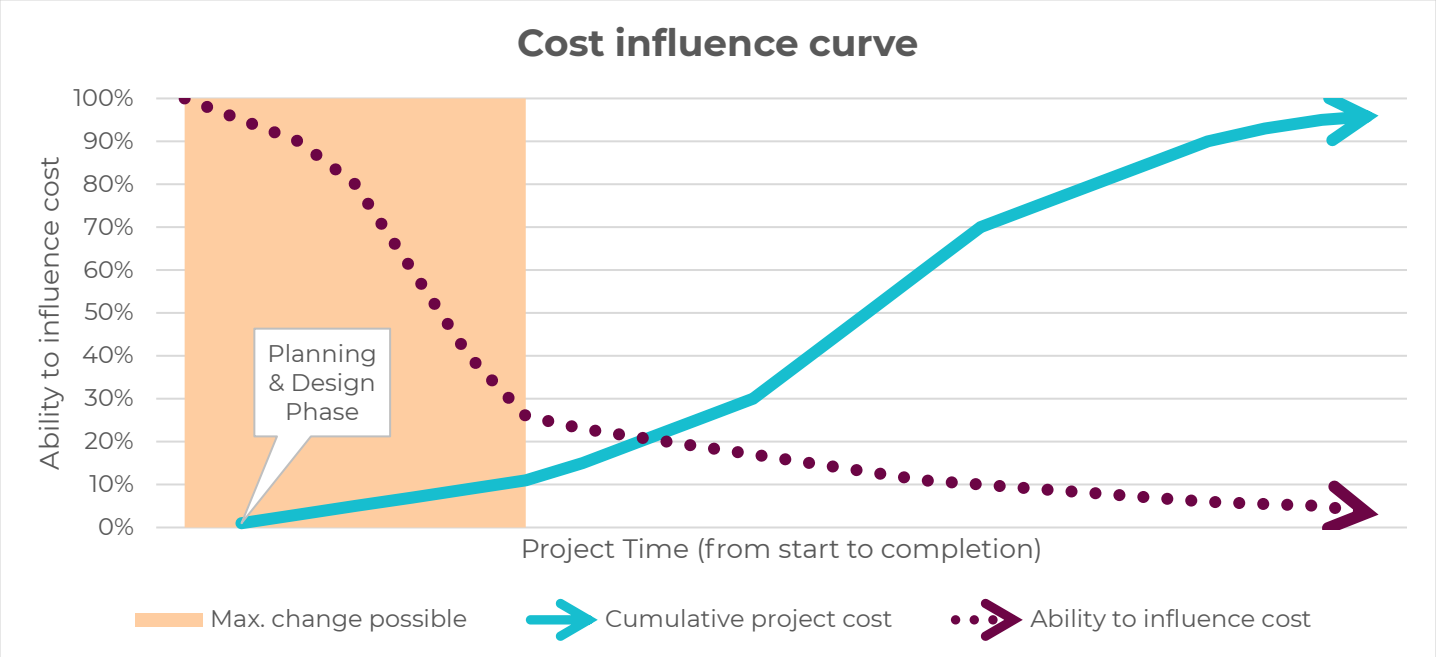
High-quality, mature designs, backed by accurate requirements, risk studies, and detailed room data sheets, are useful before major construction begins, including engaging planners and estimators, conducting cost risk studies, developing room data sheets,[52] and identifying likely contingencies. Spatial modelling and virtual prototypes may be used to simulate and troubleshoot the design, aligning it with clinical and operational needs (Edwards, 2020).

Pre-construction peer reviews can help validate design assumptions. It should be noted that a client design will be used for Ireland's new National Maternity Hospital, which will be subject to two verifications by independent third parties.[53]

As shown in Figure 19, early in the hospital project (i.e., during the planning or design phases) is when the ability to influence the outcome is the greatest and the costs are the lowest (APM, 2017).

[49] See the Committee of Public Accounts debate 30/05/2024 'Financial Statements 2022: National Paediatric Hospital Development Board'.
[50] As the project progresses, requirements are continuously refined, integrating contractor-selected materials and products, in line with public procurement rules.
[51] This iterative design process requires input from various stakeholders, including patients, to ensure functionality, cost-effectiveness, and maintainability (Grunden & Hagood, 2012).
[52] Room data sheets provide an activity-based approach to building design and include data on personnel, planning relationships, environmental considerations, design character, space requirements and graphical layouts (DoH UK, 2014).
[53] Joint Committee on Health 09/10/2024.

Figure 19: Cost Influence Curve diagram



Source: APM (2017)

Design errors that emerge mid-construction can further impact budgets and timelines (Balali, Moehler, & Valipour, 2022). To mitigate risks, familiar and reliable products are recommended over First of a Kind (FOAK) solutions. However, it is important to note that public procurement rules may limit the client entity in specifying the products that must be used, only the general specifications are set out.

It should also be noted that design costs typically represent a fraction of the lifetime cost of a building (Edwards, 2020). They are likely to be only 0.3 to 0.5% of whole-life costs (Rechel, Wright, Edwards, Dowdeswell, & McKee, 2009a).

10.4 Experience and corporate memory risk

There are benefits associated with having a steady 'pipeline' of new hospital construction projects rather than intermittent major building programmes. For example, in the UK, the dearth of hospitals constructed for about 15 years during the 1980s and 1990s meant that many of the people who were involved in hospital redevelopments in the early 2000s had little previous experience of large-scale service planning or capital development (Edwards, 2020). In the 16 years from 1999 to 2014, the NHS opened new facilities at approximately 100 hospitals. Thereafter, hospital building again slowed, with only six new hospitals constructed in the period from 2015 to 2020. Subsequently, in October 2020, the UK government announced its New Hospital Programme i.e., the intention to build 40 new hospitals by 2030 (NAO, 2023).

The standard of construction required in health infrastructure projects is much higher than that in other types of general construction. The entire team, including the client, the designers, and the contractors, should employ senior members of staff with industry experience in healthcare infrastructure projects, and all aspects of finishing. For the client, having a high level of expertise internally may help to bring an appropriate level of challenge to decisions made by contractors and

designers, enhance oversight and ensure cost certainty (PwC, 2019). For the contractors it is important to have key experienced staff in fit-out, commissioning[54] and validation roles. In addition, because project duration is much longer for hospitals than a typical construction project, a staff succession plan may be required, as well as a retention policy for key members of staff.

The availability, capability, and capacity of healthcare infrastructure construction skills in a small country like Ireland is a risk. Large overseas contractors may be unwilling to establish operations in Ireland for a short or medium-term project. In Ireland and the UK, some firms within the construction industry may view healthcare projects as risky to deliver, due to their complexity and the high demands placed on internal and supply chain expertise. In addition, the Irish construction industry is experiencing very significant activity across several sectors e.g., residential, life science plants and data centres.[55] Therefore, skilled labour shortages are a challenge.

10.5 Flexibility risk

Flexibility is an important concern in relation to the construction of new hospital buildings (Edwards, 2020).[56] Large hospital construction projects may be planned for years in advance of the commencement of construction, and are designed to have a lifespan of 30 to 100 years or more (De Neufville, Lee, & Scholtes, 2008).[57] During this time, demands on the infrastructure are likely to change significantly due to new forms of medical technology, changes in regulations, the reorganisation of healthcare services (e.g. 'shifting left'), demographic shifts, or evolving disease patterns. It is common for hospital buildings to have to accommodate several of these changes during their useful lives (Olsson & Hansen, 2010).

It is important to note some keys terms in relation flexibility and adaptability e.g., Adaptable Design,[58] Convertible Space,[59] Flexible Design,[60] Reconfigurable Space,[61] and Transformable Space.[62]

Designs should be flexible enough to adapt to changing circumstances and demands. This can enhance the economic value of the infrastructure (De Neufville, Lee, & Scholtes, 2008). Future-proofing solutions include Horizontal Expansion,[63] Interstitial Floors,[64] Loose Fit Room Sizes,[65] Shell

[54] A hospital can be 'commissioned' when the building is ready and all tools have been installed (Bhatia et al, 2023).
[55] See the Linesight Ireland Country Insights and Commodity Report Q1 2023 and Ireland Country Commodity Report Q2 2023.
[56] Other concerns include issues such as resilience, safety, affordability, and surge capacity.
[57] A hospital lifespan of 75 to 100 years is more exceptional. There are variances in international practices.
[58] Adaptable Designs allow for the physical re-arrangement of building elements, services, and furniture (Burke, 2014).
[59] Convertible Space refers to a building being able to accommodate changing functions through some rebuilding work, but reducing the cost and time required by anticipating future needs (Edwards, 2020).
[60] Flexible Design enables different activities to be accommodated in a given space without physical re-arrangement taking place.
[61] Reconfigurable Space means being able to move or re-equip clinical areas to much higher specifications without major building works, and without adding very high or unnecessary costs to modify the initial building. This may be helpful in the long-term but may require some redundancy and spare capacity in the engineering of a new build hospital.
[62] Transformable Space refers to designs that allow internal walls and services to be moved, meaning that buildings can be reconfigured as needs evolve with minimal additional building work.
[63] Horizontal Expansion can be facilitated by initial master planning and by providing circulation models that allow easy future expansion. Should the project consist of a restrictive site with no space for future expansion, a logical solution is to use an appropriate alternative site (Burke, 2014). Greenfield sites are preferred as they allow for expansion. A minimum of 20% expansion capacity is generally recommended for new hospital construction projects although much larger levels of space may be even more for beneficial in the long run.
[64] Interstitial Floors allow services to be expanded, rerouted, and changed with lower costs for electrical and engineering services (Edwards, 2020). However, these are rarely used due to the cost of increasing the height of the building, the impact on the cost of the vertical surfaces, and the extra challenges associated with achieving planning permission if the building is very tall. Interstitial Floors are typically only used on very complex projects.
[65] Choosing room sizes that are slightly larger than the minimum specified allows for easier change of use.

Space,[66] Soft Spaces,[67]and Vertical Expansion.[68] These measures generally add to the overall cost of a new build hospital, but may represent value for money in the longer term by reducing the costs and challenges associated with delivering future expansion.

10.6 Non-standard building risk

Hospitals are specifically designed to meet healthcare needs, rather than being constructed as standard buildings (Daza et al, 2017). They have high servicing requirements, contain expensive equipment, and have long design and construction periods (Symons, 2021). Key considerations include specially adapted operating theatres, uninterrupted power supply systems, water treatment systems, hot water systems, temperature-controlled medicine rooms, positive or negative pressure isolation rooms, medical gas pipeline systems,[69] and ventilation systems (Waluszewski, Håkansson, & Snehota, 2019); (PwC, 2019); (Garg, 2023). There may be special infrastructure requirements such as large doors or removable walls for rooms housing Magnetic Resonance Imaging (MRI), Computerised tomography (CT) or Linear Accelerator (LINAC) equipment. Similarly, wall adaptions can facilitate their movement and eventual replacement. Hospitals also need to have particularly strong fire safety measures in place as patients have mobility issues and are therefore difficult to evacuate quickly in an emergency (Wei-Wen et al, 2011).

Internationally, a lack of control over quality or an insufficient articulation of the quality standards expected can be an issue in hospital construction schemes. In certain projects it may help to set out a 'book of parts' to ensure that standards of fixtures, fittings and finishes are clear and adhered to (Edwards, 2020).

An additional risk is the ability of the construction supply chain to respond to the specified quality requirements. In Ireland, clinical facilities ordinarily adhere to the UK's Health Building Notes (HBNs) and Health Technology Memoranda (HTM).[70] The recommendation for clean and dirty corridors for accessing operating theatres in Ireland and the UK is not present in all countries.[71] In addition, fire safety measures such the recommendation for both fire protected walls and a sprinkler system are not present in all countries (e.g., some countries will use 'either/or' instead of having both of these fire safety measures).[72] The level of redundancy is also relatively high e.g., the need for two back-up cables for each functioning cable to kick in if there is failure. It should be noted that the extent of adherence to HBNs and HTM recommendations may vary depending on the type of project under construction. Furthermore, despite numerous standards, guidance, and tools for developing hospital requirements, some new hospitals still fail to provide state-of-the-art facilities that meet clinical expectations (Symons, 2021). The hospital building standards developed by other countries may be more up-to-date and offer greater levels of flexibility e.g., Sweden's Guidance and Guidelines.[73]

[66] The construction of additional interior space without improvements or finishes helps to accommodate future expansion.
[67] Soft Space means building storage and administrative offices in close proximity to high-tech departments to enable them to expand at a future point in time with minimal upheaval or cost.
[68] Buildings can be designed for future vertical expansion. This can be costly if spare lift capacity and necessary structural components are not included in the initial build. In densely developed areas, vertical expansion is often the best option.
[69] These include oxygen, medical air and blended oxygen/nitrous oxide mixture. See the UK Dept. of Health webpage.
[70] See the NHS England website for further information on the Health Building Notes and Health Technical Memoranda.
[71] This recommendation may not have been used in all recent projects.
[72] This is dependent on the fire certificate and not mandatory.
[73] Swedish Healthcare Building Guidelines and Guidance.

10.7 Planning risk

Town planning issues such as height restrictions and transport issues may exist (e.g., getting approval for the required level of car parking spaces). Environmental issues may also exist due to the natural heritage and fauna surrounding the land zoned for development (KPMG, 2019).[74]

Conducting detailed Programme Planning before the initial commencement of construction may be beneficial. There may also be benefits associated with preparing a detailed Critical Path Analysis,[75] loaded with a labour histogram and a cost histogram,[76] to be used as a relevant monitoring tool. Planning assumptions should be rigorously challenged to ensure they are evidence based (Edwards, 2020).

The Department of Public Expenditure, NDP Delivery and Reform's Infrastructure Guidelines set out the value for money guidelines for the evaluation, planning and management of public investment projects in Ireland (PBO, 2024).[77]

10.8 Supply chain and logistics risk

Logistics and supply chain management expertise is important for large-scale capital projects. Many problems in construction (e.g., high costs, waste, and waiting time) can be mitigated through better managed supply chains and logistics management. The geographical position of the construction site and changing site layouts may need special solutions for unloading, inspection of incoming materials, and storage. The delivery and handling of construction materials should be coordinated with site resources, including the return flows of waste and excess materials (Rudberg & Ekeskär, 2016).

11. Communication and Coordination Risks

This section outlines communication and coordination risks which affect new hospital construction projects.

11.1 Communications risk

Effective communication among key stakeholders is beneficial during hospital construction projects. To ensure this, procedures should be developed and disseminated to clearly communicate roles and responsibilities to contractors (PwC, 2019). The co-location of on-site contractors and designers is strongly advised, at least when teams are newly formed (De Melo et al, 2016). However, unless it is written into contract, it may be difficult to get key contractor and design decision-makers to co-locate on site.

11.2 Project management risk

Project management expertise (be it internally developed or externally sourced) and the use of appropriate tools or software is important for large-scale capital projects (GAO, 2018); (PwC, 2019). Important aspects of managing large-scale projects include the use of trained staff, the

[74] In February 2019, a £466 million hospital project on the island of Jersey was overturned by politicians because of concerns over its impact on heritage, nearby residents, and its appearance (Singha, 2020).
[75] This is a project management technique for scheduling in construction. It identifies the longest stretch of dependent activities and determines the shortest time possible to complete the project, as well as 'slack' or float time.
[76] These are stacked bar charts or graphs that are used for resource allocation in projects.
[77] See the PBO 2024 note on Capital Spending and the Government of Ireland webpage on Infrastructure Guidelines.

development of strong initial requirements (VA, 2012), robust internal controls, detailed project execution plans, change management systems, a formal gateway process, assurance framework, robust project systems (PwC, 2019) and information control (NAO Malta, 2020). These processes may help to avoid problems such as fragmented reporting, fragmented risk registers, and inconsistent document configuration.

11.3 Standardisation and information management risk

There are several challenges in managing standardised information during large-scale construction projects (e.g., common software and metrics), workforce alignment, cost forecasting, estimation methods, cost trending reports and document management arrangements e.g., configuration control, revision control, and naming conventions (GAO, 2018); (PwC, 2019).

11.4 Co-location and research integration risks and opportunities

Locating all acute services for a region on a single site, rather than splitting acute services across multiple sites, can have a number of benefits, including:

- **Medical Equipment**: Access to a wider range of medical equipment.
- **Enhanced Patient Experience**: Their continuity of care is more seamless as opposed to having to attend multiple sites over the course of their episode of care and associated follow-ups.
- **Economies of Scale**: In relation to clinical support and non-clinical support services.
- **Operational Efficiencies**: The disruption caused and associated travel time for moving between sites is reduced.
- **Research and Collaboration**: Consolidating specialist services and staff on one site presents greater opportunities for collaboration and research both within specialties and also on a multi-disciplinary basis (KPMG, 2019).[78]
- **Other Health Factors**: Less transfer of patients between facilities will minimise hospital-based cross-contamination (WHO, 2023a).

It is important to note terms such as 'Standalone Hospital',[79] 'Co-location',[80] and 'Tri-location'.[81] The advantages of co-location proposals must be balanced against the respective design compromises necessary to achieve them (Dolphin, 2012). However, there may not be an adult hospital which offers the entire range of subspecialist services to fully complement the needs of a children's, maternity, or other type of hospital.

[78] A commitment to research-led clinical care, the consolidation and integration of research activities, and the provision of adequate research facilities may help to ensure that a hospital provides outstanding patient care, attracts high quality staff, and becomes a hub for medical advances (Curtis, 2015). The new NCH has circa 4,000m^2 of space dedicated to third level education and research.
[79] A 'Standalone Hospital' is physically isolated from other healthcare facilities.
[80] Co-location is defined as a children's, maternity or other type of hospital being located adjacent to (or within a practical walking distance) of an adult hospital. Co-location of new hospitals is the norm internationally (McKinsey, 2006).
[81] Tri-location involves, for example, having an adult, children's and maternity hospital located together on the same site. This is considered to be an optimal situation (Balali, Moehler, & Valipour, 2022); (Dolphin, 2012). It can also facilitate continuity of care for adolescents or young adults with chronic disease (e.g., from a children's to an adult hospital), the improved clinical care of ill-mothers (e.g., from a maternity to an adult hospital) and easy transfer of sick new-born babies (e.g., from a maternity to a children's hospital).

12.Financial Risks

Around the world, hospital construction projects often experience mis-performance, exceeding their estimated cost, missing deadlines, suffering quality problems and experiencing yield-benefit shortfalls (Love & Ika, 2022). This section outlines common financial risks which affect new hospital construction projects.

12.1 Change order process risk

Construction projects often require changes to building design as they progress. Client organisations should seek to minimise change once construction has started and streamline the change order process to avoid project delays. Approving change orders promptly is crucial. To mitigate risk, it is important to ensure that all parties fully understand their contractual position to avoid claims and minimise liability amounts (GAO, 2018);(PwC, 2019). Contractor engagement and claims management processes may help in this regard.

In addition to having a strict change control system, it is also important to have rapid responses to contractor Requests for Information (RFIs). Often these requests, if not responded to promptly, will lead to challenges and claims.

The Government of Ireland has an established a policy for public works contracts that is designed to streamline the procurement process and ensure the efficient use of public funds. This policy is implemented through the Capital Works Management Framework (CWMF).[82,83]

12.2 Cost control risk

Complex and unique building projects such as new hospitals can never be fully de-risked. Some evolution in cost should always be anticipated. To mitigate the risk of cost escalation, processes such as the development of periodic cost trending reports, conducting a quarterly total cost-to-complete exercise (including key judgments, assumptions, and calculations), and establishing clear reporting arrangements to promptly capture and address cost implications should be implemented (PwC, 2019).

12.3 Cost forecasting risk

There are challenges associated with cost forecasting in large-scale capital projects such as:

- **Optimism Bias**: Project managers may exhibit an overly optimistic outlook, underestimating costs, and overestimating benefits. For this reason, the proposed elective hospitals in Cork and Galway use an optimism bias factor of 36%.[84] The UK Green Book provides recommended adjustment ranges for optimism bias in hospital development programs. Specialist hospitals fall within the "Non-standard Buildings" category, suggesting an optimism bias range of 4% to 51% at the Outline Business Case (OBC) stage (PwC, 2019).[85]

[82] See the Office of Government Procurement's Capital Works Management Framework.
[83] For major capital projects, there may be instances where derogations, or exemptions, from the standard procedures are necessary. These derogations can be due to the unique complexities and risks associated with large-scale projects. For further information see Dáil Éireann Debate 'Government Construction Contracts Committee' 05/03/1209 and Circular 1/16 Derogation Documents.
[84] See the Cork elective hospital preliminary business case (2022) and the Galway elective hospital preliminary business case (2022).
[85] See UK Government 'Supplementary Green Book Guidance - Optimism Bias'.

It is important to integrate risk contingency funding and optimism bias into the budgeting process e.g., a substantiated risk assessment and a separate allocation for optimism bias.

- **Project Development Failures**: Inadequate planning and a lack of thorough project simulations can increase risks. There are benefits associated with conducting extensive planning, project simulation and consideration of risks before the commencement of a capital project i.e., the approach of 'slow thinking and fast acting'. Rushing to start projects may lead to delays and cost overruns (Connolly & Newman, 2023).[86]
- **Strategic Misrepresentation**: This occurs when cost forecasts are intentionally distorted due to various pressures within an organisation e.g., project managers or stakeholders might present overly optimistic cost estimates to ensure that a project gets approved or to secure the necessary funding.
- **Timing**: A long period of time may pass between the design, approval, and commencement phases of a project. Over a protracted period of time, health, environmental and procurement policies may change, which can have cost implications.
- **Premature Price Anchoring**: It is important not to anchor around a certain envisioned price too early in the project. Potential contractors could potentially view the price as a 'floor'. The envisioned cost range for the project should be set at an appropriate time e.g., once it is known roughly what price the market is willing to deliver at.

Cost forecasting data should be validated and benchmarked against similar projects to ensure accuracy.

(1) Benchmarking: This relates to measuring the cost of comparable items e.g., the identification of comparable hospitals.

(2) Reference Class Forecasting: This predicts the outcome of a planned action based on actual outcomes in a reference class of similar interventions to the one being forecast (Shine, Hennessy, & Walker, 2021). Reference Class Forecasting produces ranges, rather than point estimates. It follows four steps: (i) identification of a reference class of past, similar projects., (ii) establishment of a probability distribution for the selected reference class for the parameter that is being forecast, and (iii) comparison of the specific project with the reference class distribution, in order to establish the projected range of outcomes for the specific project, and (iv) incorporating the relevant risk uplift required into the project's cost forecasts (Connolly & Newman, 2023).

Implementing incentives for accurate forecasting and effective project management can improve outcomes. Ex-post evaluations may provide insights into what went wrong and what worked well, helping to refine forecasting techniques (Connolly & Newman, 2023).

12.4 Procurement, tender evaluation, and contract management risk

There is a risk associated with a lack of construction firms bidding for a new hospital project. Across the EU single market, the level of competition for public contracts to deliver works, goods and services has declined in recent years. In 2021, there was a zero response or 'no call for bids' from the market on approximately 15.8% of all procurement procedures (in the construction sector it was

[86] Large infrastructure projects can take years of planning, design, and development. When they finally receive the go-ahead, there is often a strong desire to proceed quickly.

approximately 10%) (ECA, 2023). 'Single Bidding' for projects increased from 23.5% (in 2011) to 41.8% (in 2021) in the EU, and within the construction sector specifically it increased from 7% to 14%. In Ireland single bidding has increased from 19% to 30%. The number of bidders per tender competition almost halved, decreasing from an average of 5.7 bidders to 3.2 bidders in the ten-year period (ECA, 2023).[87]

The costs faced by potential tenderers should be recognised. A lack of reimbursement or incentives for bids may deter potential contractors from participating in the tender process, especially given the costs associated with preparing a bid for a major capital project. These sorts of schemes may not be particularly common in Ireland. This can limit competition and potentially lead to less optimal outcomes for the procuring entity. Some countries and territories have reimbursement policies for losing bids (EPEC, 2011).[88] A poor tender response may contribute to the market attaching a premium to the project (PwC, 2019). This may reflect the transfer of too much risk to the builder and the importance of balancing risk and levers in the contract to ensure deliverability, versus attractiveness of a contract to draw in sufficient number of tenderers.

The tender evaluation and selection criteria for a new hospital construction contract should be appropriately weighted between price and other criteria. Relying too heavily on price may encourage the excessively low pricing of bids (PwC, 2019). While historic performance of a potential contractor is not a factor that is generally considered (as tenders are generally considered on the presentation of the documents submitted during the tender process to ensure that all subjectivity is removed from the process), in some circumstances past poor performance may be a 'discretionary exclusion ground'.[89,90] However there is some debate on how enforceable the 'discretionary exclusion ground' is, the extent to which it is subject to challenge, and the high bar required for its application.[91]

A key aim of a construction deal or contract is the allocation of risk (other important factors are cost, quality, and time). Risk sharing contracts play a pivotal role in major capital projects in the Engineering, Procurement, and Construction Management (EPCM) sector. Risk sharing arrangements are intended to incentivise both the client entity and the contractor to manage their respective risks effectively.

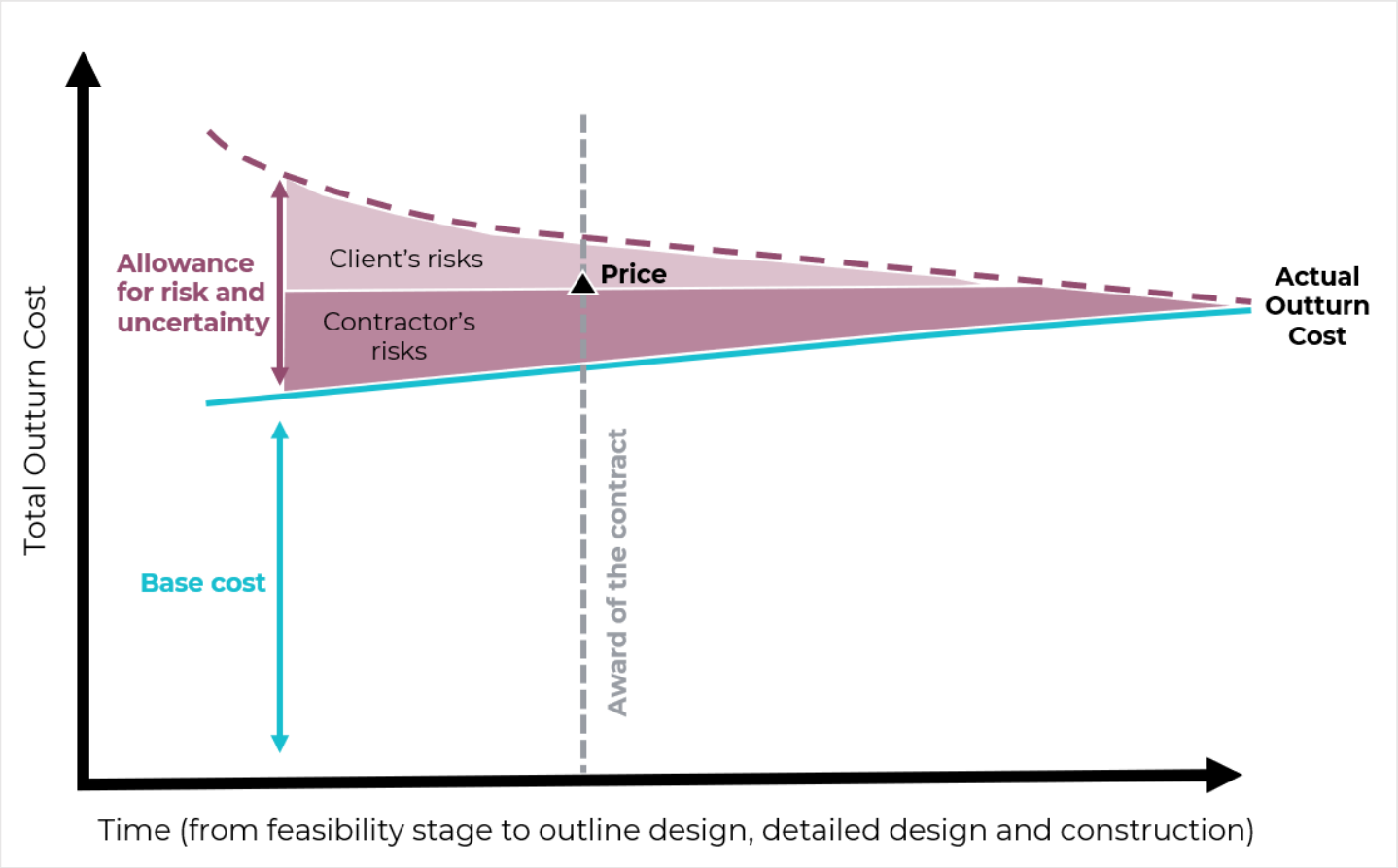
By the time the parties are ready to enter into a contract, they have to decide and articulate which risks are to be carried by the contractor and which are to be retained by the client e.g., the specific events that may entitle the contractor to delay the completion date, or 'compensation events' which can cause the price to change (Patterson & MacDonald, 2018). Some of the major risks for contractors include labour cost inflation and material cost inflation. Often the client will buy these risks out – and adjusts the contract cost to buy these out. As shown in Figure 20, the following costs should be considered:

- **Base cost**: This is the best estimate of the cost of delivering the works at any point in time. When planning, budgeting, and managing projects it is important that a sound baseline cost estimate is first established, including the allocation of reasonable contingencies.

[87] See also the 'ECA dashboard to Special Report 28/2023'.
[88] Also see the websites of Australian state-level governments such as New South Wales and Victoria.
[89] See the Office of Government Procurement's Public Procurement Guidelines for Goods and Services (2023).
[90] See Public Procurement 2020: A practical cross-border insight into public procurement.
[91] See the LLG article 28/10/2022 'Exclusion of Bidders due to Poor Past Performance'-

- **Allowance for risk and uncertainty**: This is on top of 'baseline cost' and should include an estimate of the cost of uncertainties, and an estimate of the consequences of specific risks that might impact on the cost of delivering the works. Contingency funds and management reserves should not be used to facilitate scope creep. If the need for a scope change occurs, it should be accepted that it falls outside the original budget and should be estimated separately (Lawrence, 2007).
- **Actual outturn cost**: This will be known only when the project is completed.

Figure 20: General principles of project risk allocation



Source: Patterson & MacDonald (2018)

12.5 Other financial risks

Inflation and other financial risks can have an impact on building costs (De Marco & Mangano, 2013); (Huynh, Le, Le-Hoai, & Nguyen, 2024). This is particularly relevant for large healthcare projects as where the construction periods tend to be much longer than other projects.

A multiannual budgeting approach can potentially enhance the effectiveness of procurement and capital expenditure projects. Single-year budgeting may restrict the ability to support medium- or long-term projects and may encourage a 'use-it-or-lose-it' mentality, leading to less disciplined spending patterns.[92]

[92] Capital budgets are treated differently from current allocations. Ireland used to have five-year capital envelopes that are now subsumed into the National Development Plan (NDP) and are usually held steady year on year to allow for the fact that capital projects are multi-annual and spend is unpredictable or 'lumpy'. Unlike for current budgets, there is a provision for unspent capital to be carried over from one year to the next up to a max of 10% of the overall capital allocation for a government department.

13.Technological Risks

This section outlines common technological risks which affect new hospital construction projects.

13.1 Information and communications technology risk

There are financial and operational risks associated with the implementation (e.g., configuration and installation) of ICT and patient management systems in new hospitals (QAO, 2014). These systems are critical for day-to-day hospital operations. Without robust digital infrastructure and systems, there is a greater risk of unnecessarily prolonged hospital stays, compromised quality of care for patients transitioning between acute and community sectors, and delayed reorientation of service delivery from acute hospitals to community-based services (DoH, 2024a).[93,94]

Some commentary suggests that the Irish health system has been a relative laggard in relation to ICT, procurement, and financial systems.[95] In addition, Ireland is starting to roll out health identifiers across the health system. Therefore, Ireland may be in a 'catch-up' period. This means that ICT requirements will be substantial in all upcoming hospital construction projects.

13.2 Medical equipment integration risk

There is a need for flexibility to adapt to new technologies and the challenges posed by complex and evolving medical technology.[96] Therefore, it is important to integrate medical equipment planning into the design and construction phases of new hospital schemes. This may help to ensure coordination between medical needs, facility design, and equipment procurement. It may also help to prevent late design changes, delays and cost overruns (VA, 2012); (GAO, 2013); (GAO, 2018). When the construction of a new hospital takes too long, technological advancements in equipment can outpace the building's progress. This results in a 'new' facility designed for outdated equipment, which then requires retrofitting to accommodate the latest technologies (Eller, 1996).

Furthermore, the depreciation of medical equipment and technology are important cost risks. Lastly, there are key interdependencies between ICT, EHRs[97] and medical equipment that have impacts on design, construction, and commissioning.

14. Operational Risks

This section outlines common operational risks which affect hospital buildings.

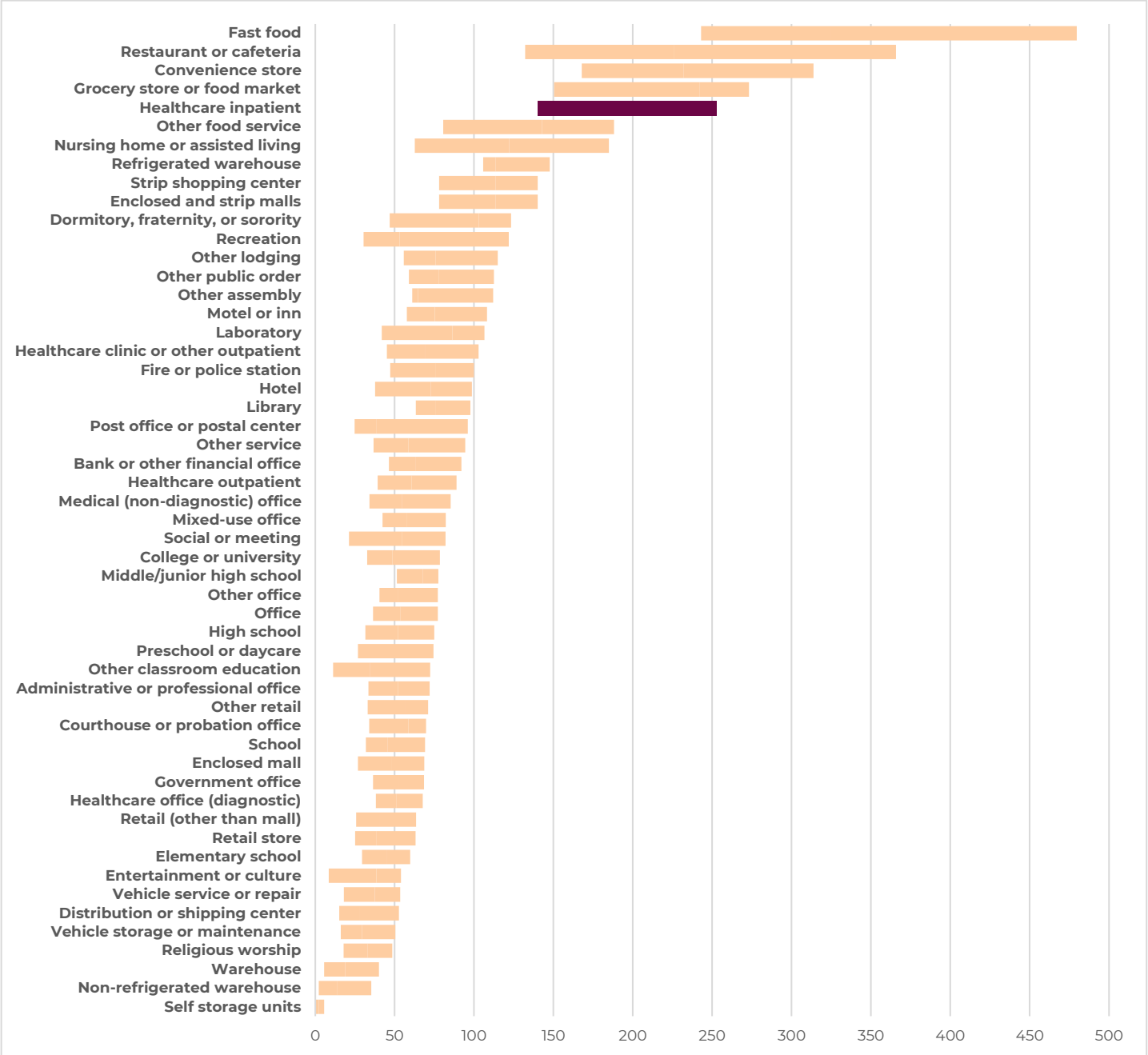
14.1 Energy efficiency and climate risk

Hospitals are energy intensive. They are occupied continuously (i.e., 24/7) by many people. Medical requirements necessitate the strict control of heating levels and indoor air parameters, especially in operating theatres and treatment rooms. Specialist medical equipment, sterilisation, laundries,

[93] See DoH (2024) 'Digital for Care — A Digital Health Framework for Ireland 2024-2030'.
[94] Approval processes, the acknowledgment of dependencies, and the development of contingency plans helps to mitigate these risks. Note the DPENDER circular on 'Arrangements for Oversight of Digital and ICT Initiatives in the Civil and Public Service' in this regard.
[95] OECD 2022 report Health Data Governance for the Digital Age.
[96] It may be difficult to replace outdated equipment after several years (e.g., fitting in large new equipment if it is manufactured and assembled offsite).
[97] Electronic Health Records replace traditional paper-based health records with electronic records that capture care encounters for an individual across different healthcare providers. Companies operating in the sector include Epic, Cerner, Meditech and Allscripts.

and food preparation further increase energy use (Morgenstern, Raslan, & Ruyssevelt, 2016); (Kiss, 2011). As shown in Figure 21, 'healthcare inpatient' buildings are one of the leading commercial building types in terms of energy intensity per square foot in the United States.

Figure 21: Building energy consumption per square foot (British thermal unit '000s)



Source: US Energy Information Administration - Commercial Buildings Energy Consumption Survey 2018. The US has a wider range of temperatures and climatic zones compared with Ireland. Therefore, this chart may not be representative of building energy use in Ireland e.g., US energy use may be more focused on cooling rather than heating technology.

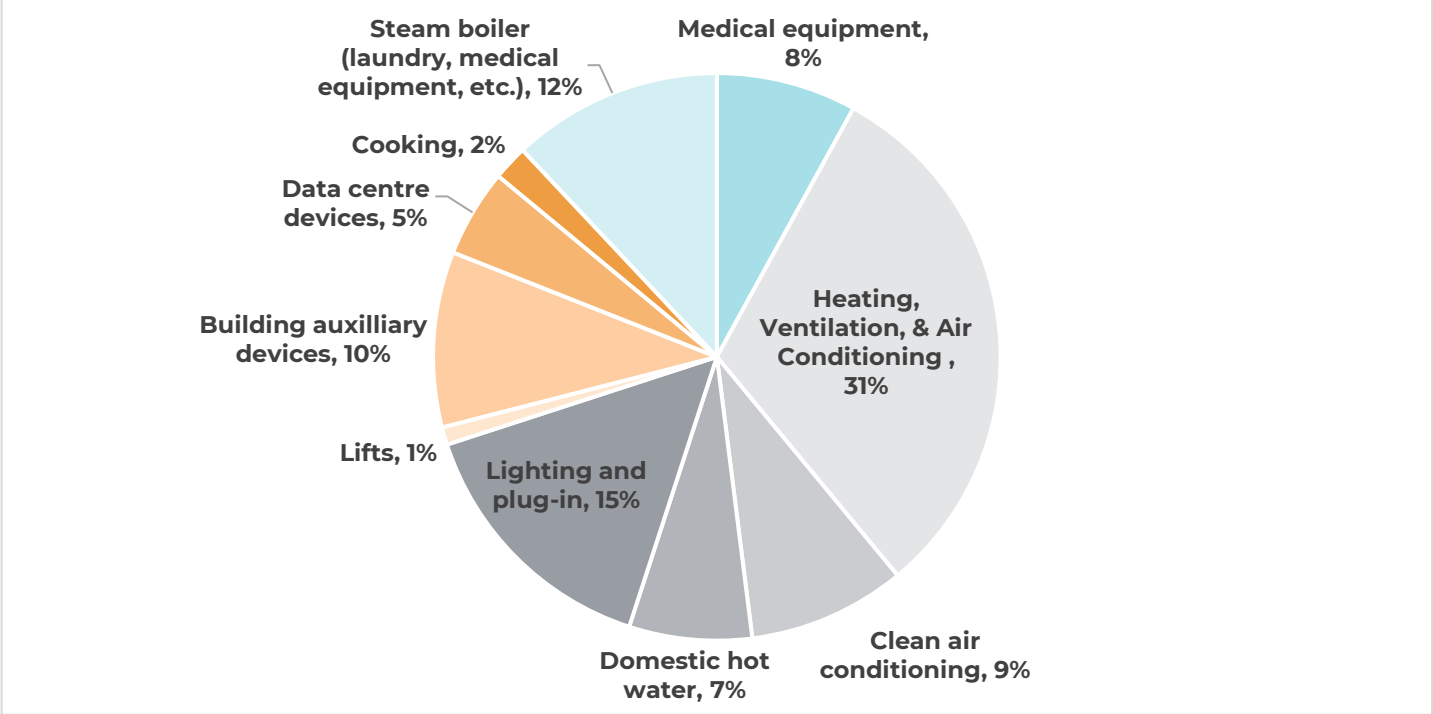
Within the European Union, the healthcare sector is responsible for 4.7% of greenhouse gas emissions (Lau, et al., 2024). Globally, more than half of the health sector's climate footprint is attributable to energy use (Karliner, Slotterback, Boyd, Ashby, & Steele, 2019). Therefore, it is important to improve energy efficiency and sustainable building practices in the sector (HSE, 2023). Just 28% of the top 120 energy-using facilities in the HSE's estate portfolio exceed a B3 Display Energy Certificate rating (Shine & Hennessy, 2022). The HSE aims to have a net carbon zero estate

by 2050 (HSE, 2022). The new NCH is expected to deliver a 60-70% reduction in energy running costs compared to the existing children's hospitals.[98]

Energy efficiency offers benefits to hospitals such as cost savings, a reduced environmental impact, and increased operational resilience (e.g., by implementing energy-efficient equipment and systems, hospitals can reduce their reliance on external energy sources during power outages or disruptions). By optimising building design, hospitals can ensure proper insulation, efficient windows, energy efficient lighting and energy-efficient roofing materials to minimise heat gain or loss (Tomanek, 2024). However, hospital designs need to reconcile the conflicting aims of energy efficiency and meeting guidance standards for air quality e.g., having a mechanical ventilation system with an optimal number of air changes per hour, or opening windows to boost air flow, may be clinically beneficial, but may also make achieving Building Research Establishment Environmental Assessment Method (BREEAM) Excellent more difficult (QEUH Ind. Review, 2020).

See Figure 22 for a disaggregated breakdown of energy use by item in medical buildings.

Figure 22: Energy consumption by item in medical buildings



Source: Shen et al (2019)

The new NCH is expected to deliver a 60-70% reduction in energy running costs compared to the existing children's hospitals.[99]

14.2 Maintenance risk

While maintenance is not an upfront cost for a hospital (or any infrastructure) construction project, it is often a consideration when developing business cases.

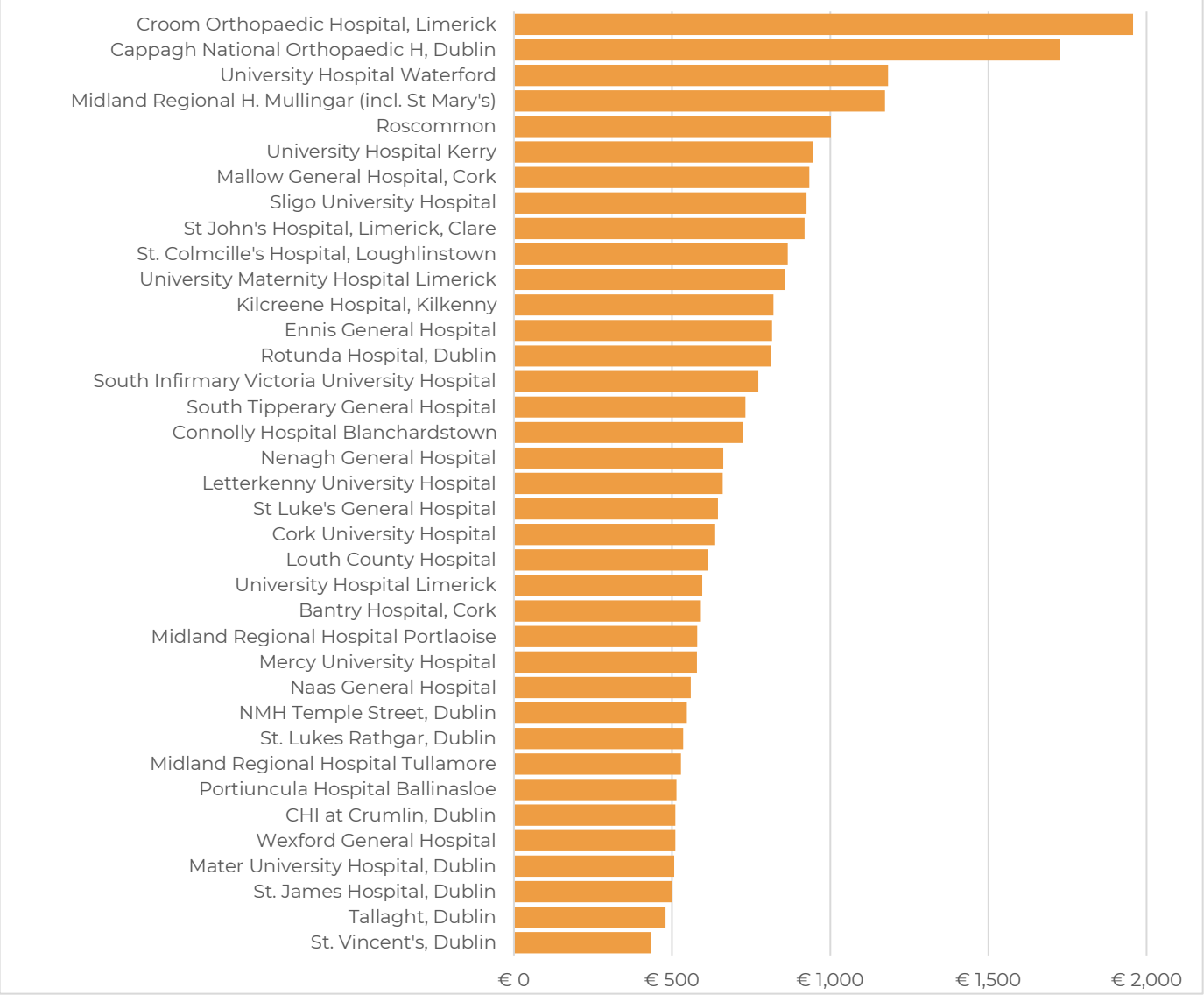
Maintenance encompasses all technical, administrative, and management actions that maintain or restore an entity to perform its required function. The performance of a hospital building relies on its continuous and planned periodic maintenance (Lavy & Shohet, 2004). Hospital maintenance

[98] See the NCH 2018 Annual report.

is complicated by the need to keep systems continuously operational. Adequate levels of maintenance can reduce the need for substantial reconstruction or new buildings. It also helps ensure that the benefits assumed prior to construction are realised over the 30-to-100-year lifespan of the hospital building, rather than decreasing annually. Notably, annual maintenance costs are generally lower for more recently constructed buildings (Shohet, 2006). It is important for hospital designs to include enough space for maintenance staff to inspect areas of ducting, piping, and other plant (QEUH Ind. Review, 2020).

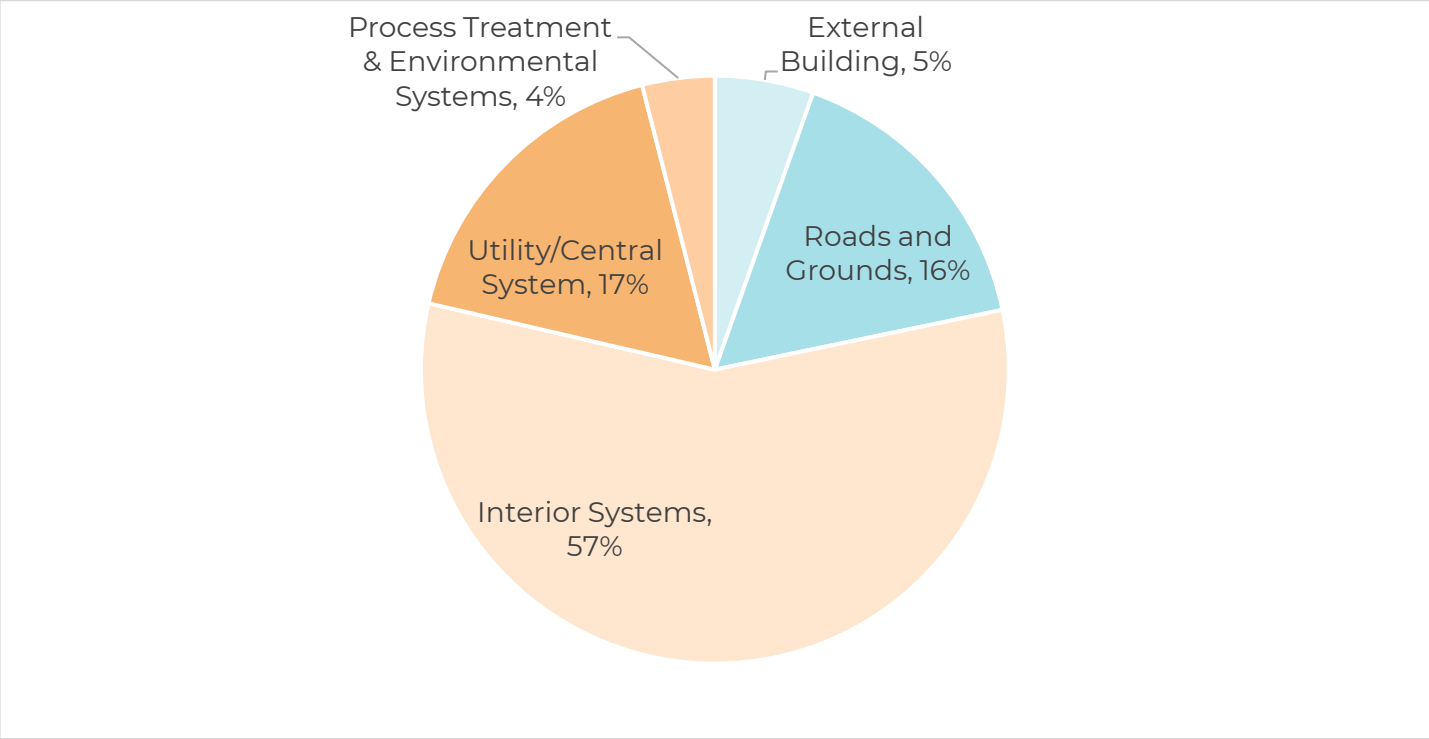
See Figures 23 and 24 for an overview of the maintenance costs per square metre in a selection of hospitals and a breakdown of typical hospital maintenance budgets.

Figure 23: Total compliance and five-year maintenance costs per square metre by hospital in Ireland



Source: Shine & Hennessy (2022) and author's analysis.

Figure 24: Breakdown of typical hospital maintenance budgets



Source: Author's analysis based on IFMA (2010)

The HSE's approach to maintenance is not standardised (HSE, 2022). This inconsistency hinders the development of essential maintenance services. Additionally, condition surveys indicate that the rate of degradation exceeds current maintenance investment, leading to a deteriorating estate (HSE, 2022).[100]

15.Conclusion

The analysis of hospital construction costs shows that the NCH is above average compared with other hospitals in the dataset, whether measured by cost per bed, per square meter, or in total. However, it is not the highest cost hospital in the dataset. The proposed new elective hospitals in Cork and Galway have relatively high upfront costs per square meter compared to similar hospitals elsewhere.

The whole lifecycle cost of hospital buildings, encompassing both capital and operational expenditures over 30 to 100 years, is predominantly driven by operational costs, particularly labour costs. Capital expenditure for a new hospital building constitutes approximately 5% to 10% of its lifetime operational expenditure. This underscores the importance of considering long-term operational efficiency and sustainability in hospital design and construction.

Developing a high-quality, peer-reviewed, and mature design before commencing a major construction project reduces the risk of cost overruns. Effective project management supports the successful delivery of large-scale capital projects.

Flexibility in hospital design is another key consideration. Hospitals should be designed to allow for future alterations and expansions, integrating medical equipment planning alongside new facility design to reduce late design changes, delays, and cost overruns. Brownfield sites pose challenges

[100] See the 'HSE Capital & Estates Strategy 2022-2050' p10.

such as site clearance, decanting, and remediation works, while greenfield sites offer fewer constraints and greater flexibility for phased construction, but may lack the synergies, clinical benefits, and workforce access found in co-located or urban sites.

15.1 Potential Further Research

- **Data standardisation**: In recent years, at intergovernmental level, there have been significant efforts made towards the development of standardised, comparable, and comprehensive health expenditure data across countries e.g., the System of Health Accounts guidelines.[101] The construction of hospitals is an important part of health expenditure. To compare hospital construction costs and floor areas across countries, a consistent dataset is essential. Clear guidelines on reporting costs (e.g., VAT, land, equipment) and floor areas (e.g., gross, internal, usable) would be valuable. Advancing this research and establishing common, clear definitions and reporting elements for costs would be beneficial.
- **Hospital Construction Guidelines**: Instead of using the UK's HTM and HBNs, which may be infrequently updated, the use of alternative hospital building standards should be considered e.g., Sweden's Guidance and Guidelines.[102]

[101] See the OECD 'A System of Health Accounts guidelines' webpage.
[102] Swedish Healthcare Building Guidelines and Guidance.

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Appendix: Links to sources of data

Name of Hospital	Country /Juris.	Cost or central cost estimate in local currency in millions (year of completion or year of cost estimate)	Area Square Metres	Beds (or max. bed capacity)
National Children's Hospital, Ireland (NCHI)*	**IRL**	€1,794 (2024) [IV]	170,285 m^{2,P}	473
National Maternity Hospital, Ireland*	**IRL**	€750 (2024)	50,000 m^2	244
Cork Elective Hosp. (St Stephens), Ireland*	**IRL**	€828 (2022) [IV]	27,022m^2	TBD
Galway Elective Hosp. (Merlin Park), Ireland*	**IRL**	€695 (2022) [IV]	22,360m^2	TBD
Nat. Forensic Mental Health Service, Portrane, Ireland	**IRL**	€170 (2020)	24,000 m^2	170
Bon Secours Private H Limerick, Ireland*	**IRL**	€190 (2023)	19,405 m^2	150
New National Rehabilitation Hospital (Phase One), Ireland	**IRL**	€89 (2024)	18,000 m^2	120
Lady Cilento Children's Hosp., Australia	**AUS**	$1,447 (2014)	73,000 m^2	359
Gold Coast Uni. Hosp., Australia	**AUS**	$1,762 (2014)	170,000 m^2	905
Sunshine Coast Public Uni. Hosp., Australia	**AUS**	$1,872 (2014)	160,000 m^2	738
New Royal Adelaide Hosp., Australia	**AUS**	$1,800 (2016)	175,000 m^{2,P}	800
Fiona Stanley Hospital, Western Australia	**AUS**	$2,000 (2014)	150,000 m^2	783
Perth Children's Hospital, Western Australia	**AUS**	$1,200 (2018)	120,000 m^2	298
Royal Children's Hospital Melbourne, Australia	**AUS**	$850 (2015)	165,000 m^2	334
Maitland Hospital, Australia	**AUS**	$470 (2022)	50,000 m^2	339
Blacktown Mt Druitt Hosp. Redevelopment, Australia	**AUS**	$322 (2014)	32,000 m^2	
New Monash Children's Hospital, Melbourne, Australia	**AUS**	$250 (2018)	28,000 m^2	230
New Women's and Children's Hospital, Adelaide*	**AUS**	$3,200 (2022)	140,000 m^2	434
Dubbo Base Hospital Redevelopment Stages 3 & 4, Australia	**AUS**	$150 (2022)	20,000 m^2	
Dubbo Base Hospital Redevelopment Stages 1 & 2, Australia	**AUS**	$91.3 (2015)	9,574 m^2	
Wyong Hospital Redevelopment, Australia	**AUS**	$200 (2024)	17,000 m^2	
Prince of Wales H, new Acute Services Building, Australia	**AUS**	$933 (2024)	55,000 m^2	
Rouse Hill Hospital, Australia*	**AUS**	$700 (2024)		300
Chris O'Brien Lifehouse, Australia	**AUS**	$260 (2013)	43,500 m^2	
New Bundaberg Hospital, Queensland, Australia*	**AUS**	$1,200 (2024)	56,000 m^2	320
Kinder- und Herzzentrum, Innsbruck, Austria	**AUT**	€197 (2015)	51,285 m^2	216
Kepler Universitätsklinikum Kinderzentrum, Austria*	**AUT**	€220 (2024)	17,000 m^2	148
Ghent University Paediatric Hospital, Belgium	**BEL**	€29 (2011)[EV]	16,000 m^2	104
MontLégia Hospital, Belgium	**BEL**	€188 (2020)[EV]	100,000 m^2	720
UZ Leuven University Hospital, Belgium	**BEL**	€67 (2019)[EV]	31,000 m^2	223
Centre Hospitalier de l'Université de Montréal, Canada	**CAN**	$2,692.8 (2010)	334,000 m^2	772
CAMH Phase 1C redevelopment project, Ontario, Canada	**CAN**	$685 (2017)	60,851 m^2	235
Segal Family Health Centre, Vancouver, Canada	**CAN**	$82 (2014)	12,250 m^2	
New Prince Edward County Memorial Hospital, Canada*	**CAN**	$153.8 (2024)	8,919 m^2	23
Oakville Hospital, Ontario, Canada	**CAN**	$2,270 (2015)	148,640 m^2	457
Jim Pattison Outpatient Care & Surgery Ctr., Canada	**CAN**	$237 (2011)	17,498 m^2	
A. Child Comprehensive Cancer Ctr., Calgary, Canada	**CAN**	$1,400 (2024)	127,000 m^2	160
The Ottawa Hospital, New Campus, Canada*	**CAN**	$2,000 (2022)	232,258 m^2	641
Humber River Hospital, Tornto, Canada	**CAN**	$1,760 (2011)	167,225 m^2	656
Joyce Children's Health Centre, Hamilton, Canada	**CAN**	$70.5 (2015)	16,723 m^2	
Teck Acute Care Centre at BC Children's & BC Women's Hospital	**CAN**	$676 (2014)	59,400 m^2	
St. Paul's Hospital, Vancouver, Canada	**CAN**	$2,174 (2021)	185,000 m^2	548
Etobicoke General Hospital, Toronto, Canada	**CAN**	$358 (2016)	23,225 m^2	
Michael Garron Hospital redevelopment	**CAN**	$560 (2024)	60,386 m^2	515
Royal Inland Hospital – Phil and Jennie Gaglardi Tower, Phase 1	**CAN**	$417 (2022)	27,000 m^2	107
Cortellucci Vaughan Hospital, Ontario	**CAN**	$1,600 (2021)	111,485 m^2	350
Brockville General Hospital Redevelopment, Phase 2	**CAN**	$131.2 (2020)	16,258 m^2	93
Groves Memorial Hospital, Fergus, Ontario	**CAN**	$144 (2020)	13,565 m^2	45
Winnipeg Women's Hospital	**CAN**	$232.9 (2019)	36,090 m^2	173
Grandir en Santé project at Sainte-Justine Hospital, Montréal	**CAN**	$446 (2011)^	130,000 m^2	450
Sudbury Regional Hospital	**CAN**	$225.4 (2010)	139,355 m^2	
Western Memorial Regional Hospital, Newfoundland	**CAN**	$750 (2019)	55,742 m^2	164
West Park Healthcare Center P3 Redevelopment, Toronto	**CAN**	$1,200 (2024)	67,819 m^2	314
Jim Pattison Children's Hospital	**CAN**	$285.2 (2017)	34,930 m^2	176
McGill University Health Centre, Glen site	**CAN**	$1,343 (2008)	250,000 m^2	
Stanton Territorial Hospital Renewal P3, Yellowknife	**CAN**	$350 (2017)	26,012 m^2	100
Patient Care Tower Project, Penticton Regional Hospital	**CAN**	$312.5 (2019)	26,700 m^2	84
Comox Valley & Campbell River Hospitals	**CAN**	$606.2 (2014)	72,160 m^2	248
Baie-Saint-Paul Hospital, Quebec	**CAN**	$245 (2018)	34,840 m^2	150
Providence Care Hospital, Kingston	**CAN**	$810 (2016)	57,785 m^2	270

Jewish General Hospital – Pavilion K	**CAN**	$429 (2020)^	56,000 m²	327
Markham Stouffville Hospital	**CAN**	$200.4 (2014)	36,230 m²	308
Surrey Memorial Hospital – Critical Care Tower	**CAN**	$512 (2011)	32,515 m²	151
Niagara Health System - St. Catherine's General Hospital and Walker Family Cancer Center	**CAN**	$759 (2013)	92,900 m²	374
Bridgepoint Hospital, Toronto	**CAN**	$622 (2013)	63,175 m²	472
Colchester East Hants Health Ctr, Nova Scotia	**CAN**	$155 (2012)	34,190 m²	124
North Bay Regional Health Centre (NBRHC)	**CAN**	$551 (2010)	69,710 m²	388
Royal Jubilee Hospital – Patient Care Centre	**CAN**	$252 (2011)	29,725 m²	500
The Lois Hole Hospital for Women, Edmonton	**CAN**	$210 (2010)	33,445 m²	
Santiago Military Hospital, Santiago de Chile	**CHL**	€111.6 (2008)	86,350 m²	330
Curicó Hospital, Maule Region, Chile	**CHL**	€241.7 (2021)	109,152 m²	400
Dr. Gustavo Fricke Hospital, Viña Del Mar, Chile	**CHL**	€129.9 (2017)	92,000 m²	554
International Clinical Research Centre, St Anne's UH, Brno	**CZE**	€40.4 (2015)	35,792 m²	239
Kinder- und Jugendklinik Freiburg, Germany	**DEU**	€169 (2024)	25,000 m²	156
Waldkliniken Eisenberg Hospital, Germany	**DEU**	€68 (2021)	16,500 m²	246
Med. Ctr Replacement, Ramstein Air Base, Germany*	**DEU**	$1,590 (2024)	91,509 m²^	160
Zentrum für Frauen- und Kindermedizin, Leipzig	**DEU**	€61.9 (2007)	31,500 m²	
Zentrum für Konservative Medizin, Leipzig	**DEU**	€100.4 (2009)	52,300 m²	
ViDia Christliche Kliniken, Karlsruhe	**DEU**	€200 (2022)	43,000 m²	341
Uni-klinikum des Saarlandes, Klinik für Innere Medizin, Homburg, Germany	**DEU**	€150 (2013)	44,300 m²	
Kreiskrankenhaus, Schotten, Germany	**DEU**	€25 (2013)	11,810 m²	140
Kopfzentrum am UKSH Campus Kiel	**DEU**	€103 (2022)	22,000 m²	90
Heidekreis-Klinikum, Bad Fallingbostel	**DEU**	€222 (2023)	22,500 m²	354
Klinikum der Zukunft, UKSH Lübeck, Germany	**DEU**	€246.8 (2019)	65,000 m²	
Uni-Klinikum Bonn, Herzzentrum, Germany	**DEU**	€122 (2024)	14,300 m²	180
Klinikum Dortmund OP-Zentrum im Grünen	**DEU**	€25 (2022)	7,715 m²	
Neubau Haut- und Augenklinik, Uni Düsseldorf*	**DEU**	€60.2 (2016)	29,439 m²	
Klinikum Memmingen, Germany*	**DEU**	€468 (2024)	75,231 m²	489
Zentralklinikum Lörrach, Germany*	**DEU**	€343 (2021)	89,600 m²	677
Vivantes Auguste-Viktoria-Klinikum, Berlin, Germany	**DEU**	€140 (2024)		212
Zentralklinikum Georgsheil/Uthwerdum, Germany*	**DEU**	€638 (2024)	40,000 m²	814
U-klinikum Würzburg Kopfkliniken & Frauen-Mutter-Kind ctr.	**DEU**	€822 (2022)	60,500 m²	500
Psychotrauma Center Bundeswehr Hospital Berlin	**DEU**	€42.978 (2024)	12,640 m²	
Trauma Hospital Berlin, New building of rehabilitation clinic, Germany	**DEU**	€70 (2021)	21,400 m²	151
Bonn Eltern-Kind-Zentrum, Germany	**DEU**	€112 (2020)	25,950 m²	180
Neubau des universitären Herzzentrums, Hamburg, Germany*	**DEU**	€200 (2020)	72,000 m²	388
München Harlaching, Germany*	**DEU**	€255 (2024)	31,000 m²	550
New Hauner, Children's Hospital, Munich, Germany*	**DEU**	€420 (2023)	19,200 m²	200
Sana Kliniken Landkreis Biberach, Germany*	**DEU**	€110.8 (2017)	16,800 m²	410
UKL Heidelberg, Children's Hospital, Germany	**DEU**	€76.2 (2008)	19,900 m²	
Rems-Murr-Klinikum, Winnenden, Germany	**DEU**	€122 (2023)	69,689 m²	
Vivantes Klinikum Neukölln, Germany	**DEU**	€226 (2022)		268
New Hospital Herlev, Denmark	**DNK**	€390 (2018)	56,585 m²	243
New Hospital North Zealand, Denmark	**DNK**	€707 (2018)	115,000 m²	576
New Hospital Hvidovre, Denmark	**DNK**	€249 (2018)	31,400 m²	
New Rigshospitalet north wing, Denmark	**DNK**	€334 (2018)	68,000 m²,P	
New Mental Health Ctr, Sct. Hans, Denmark	**DNK**	€89 (2018)	21,000 m²	126
New University Hospital Aarhus, Denmark	**DNK**	€1,121 (2018)	375,000 m²	797
New Regional Hosp. West Jutland, Denmark	**DNK**	€584 (2018)		
New University Hospital Aalborg, Denmark	**DNK**	€763 (2018)	170,000 m²	
New Psychiatric Hosp. Slagelse, Denmark	**DNK**	€180 (2018)	44,000 m²	200
New Odense Uni. Hosp., Denmark	**DNK**	€1,169 (2018)	250,000 m²	855
Regional Hospital in Gødstrup, Denmark	**DNK**	NOK 3,150 (2022)	148,000 m²	499
Sant Joan University Hospital, Reus, Spain	**ESP**	€107.4 (2010)	98,475 m²	
Rey Juan Carlos Hospital, Madrid, Spain	**ESP**	€232.2 (2012)	94,705 m²	260
Los Arcos del Mar Menor University Hospital, Murcia, Spain	**ESP**	€59.1 (2011	61,352 m²	329
Burgos University Hospital. Castilla y León. Spain	**ESP**	€210.6 (2011)	264,403 m²	744
U. of Toledo Medical Centre (Chut), Castilla-La Mancha	**ESP**	€208.1 (2019)	245,859 m²	1,142
Doctor Negrín UH of Gran Canaria. Las Palmas, Spain	**ESP**	€136.6 (2012)	193,382 m²	861
Cuenca University Hospital. Castilla-La Mancha, Spain	**ESP**	€102.4 (2021)	114,704 m²	498
Fuerteventura Virgen de la Peña General H. Las Palmas	**ESP**	€65.2 (2017)	36,744 m²	249
Villalba General Hospital. Madrid. Spain	**ESP**	€54.6 (2013)	69,066 m²	
Outpatient Activities Centre De Octubre UH, Madrid	**ESP**	€69.3 (2011)	89,759 m²,P	
North Estonia Medical Centre	**EST**	€173.5 (2010)	57,336 m²	
Tallinn Hospital, Estonia*	**EST**	€520 (2021)[IV]	127,000 m²	

Helsinki Nat. Children's Hosp., Finland	**FIN**	€224.5 (2018)	48,000 m²	140
Nova Hospital, Finland	**FIN**	€500 (2020)	108,345 m²	368
Tampere Psychiatric Clinic, Finland	**FIN**	€97.5 (2024)	29,000 m²	184
Institut Imagine, Paris, France	**FRA**	€115 (2014)	19,000 m²	
Private Hospital Villeneuve d'Ascq, Lille, France	**FRA**	€41 (2012)[EV]	22,700 m²	225
Voiron Hospital, France	**FRA**	€115 (2021)	28,000 m²	229
Lariboisière New Hospital, France*	**FRA**	€180 (2022)[EV]	54,000 m²	630
Centre Hospitalier Universitaire, Nantes, France*	**FRA**	€1,250 (2023)	220,000 m²	
CHU de Reims, France*	**FRA**	€230 (2022)	58,000 m²	
Argenteuil Hospital, France*	**FRA**	€235 (2024)	77,000 m²	500
Femmes Parents Enfants H Timone, Marseille, France*	**FRA**	€200 (2024)	45,000 m²	399
Clermont-Ferrand Teaching Hospital, France	**FRA**	€138.5 (2007)	70,000 m²	565
Paris-Saclay hospital, France	**FRA**	€141 (2020)	45,000 m²	416
Centre Hospitalier de Melun, France	**FRA**	€202 (2014)	51,000 m²	507
Hong Kong Children's Hospital	**HK**	HKD 12,986 (2013)	165,000 m²	468
New Acute Hospital, Kai Tak, Hong Kong*	**HK**	HKD 36,567 (2024)	500,000 m²	2,400
Gleneagles Hong Kong Hospital	**HK**	HKD 3,000 (2017)	46,750 m²	500
Duna Medical Centre, Budapest, Hungary	**HUN**	€50 (2020)	22,000 m²	154
New Syracuse Hospital, Italy*	**ITA**	€145 (2024)	65,219 m²	425
Altovicentino hospital, Santorso, Italy	**ITA**	€118 (2011)	97,132 m²	450
Galeazzi Hospital, Italy	**ITA**	€200 (2022)	150,000 m²	
Acute Hospital, Ambulatory facility & Health Village, Jersey	**JEY**	£710 (2024)	51,000 m²	134
Anti-Aging Life Center Chaum, Seoul, South Korea	**KOR**	$135 (2011)^	18,580 m²	
New Maternity Hospital, Al-Sabah, Kuwait	**KWT**	KWD 240 (2017)	350,000 m²	780
Kuwait Children's Hospital*	**KWT**	KWD 260 (2017)	595,000 m²	792
A2 Building, Pauls Stradins Clinical Uni. Hospital, Latvia	**LVA**	€140 (2020)	37,726 m²	
Mater Dei Hospital, Malta	**MLT**	€583.1 (2008)	267,076 m²	825
Rehab. Ctr. Groot Klimmendaal, Arnhem, Netherlands	**NLD**	€20.8 (2009)	13,800 m²	60
Erasmus MC H. & Education Ctr., Rotterdam, Netherlands	**NLD**	€1,200 (2017) [EV]	207,000 m²	578
Meander Medisch Centrum, Amersfoort, Netherlands	**NLD**	€195 (2013)^	112,000 m²	600
Medisch Spectrum Twente, Netherlands	**NLD**	€112.285 (2016)	78,400 m²	620
Deventer Ziekenhuis, Deventer, Netherlands	**NLD**	€220 (2015)	82,350 m²	377
Ziekenhuis Bernhoven, Uden, Netherlands	**NLD**	€101.2 (2012) [EV]	56,335 m²	350
Sint Antonius Hospital, Utrecht, Netherlands	**NLD**	€85 (2014) [EV]	56,220 m²	220
Radboud UMC Medical Faculty, Nijmegen, Netherlands	**NLD**	€255.96 (2022) [EV]	128,500 m²	485
Jeroen Bosch Hospital, 's-Hertogenbosch, Netherlands	**NLD**	€403.5 (2011) [EV]	116,000 m²	730
Hospital Reinier de Graaf Gasthuis, Delft, Netherlands	**NLD**	€150 (2015) [EV]	57,000 m²	470
Princess Máxima Ctr. for Pediatric Oncology, Utrecht, Netherlands	**NLD**	€191 (2019)	45,000 m²	
Akershus University Hospital, Oslo, Norway	**NOR**	€1,000 (2014)	118,000 m²	565
St. Olav's Hospital, Trondheim, Norway	**NOR**	NOK 14,000 (2013)	223,000 m²	834
LHL Hospital Gardermoen, Norway	**NOR**	NOK 1,200 (2017)	30,000 m²	
New University Hospital in Oslo, Norway	**NOR**	NOK 15,400 (2020)	140,000 m²	
Glasblokkene Trinn 2, Bergen, Norway	**NOR**	NOK 5,400 (2023)	50,000 m²	
Haraldsplass Hospital, Bergen, Norway	**NOR**	$55 (2018)^	14,200 m²	187
New Stavanger University Hospital, Norway*	**NOR**	NOK 11,300 (2024)	125,000 m²	640
New Dunedin Hospital, New Zealand*	**NZ**	$1,700 (2023)	92,000 m²	421
Paediatric Hospital, Medical University of Warsaw, Poland	**POL**	€138 (2015)	55,000 m²	535
MU Gdańsk, Invasive Medicine Centre, Poland	**POL**	PLN 480 (2011)		311
MU Gdańsk, Non-Invasive Medicine Centre, Poland	**POL**	PLN 600 (2021)		700
Hospital de Lisboa Oriental, Portugal	**PRT**	€380 (2024)	180,000 m²	875
Madeira Central Hospital, Portugal	**PRT**	€350.8 (2021)	172,093 m²	625
Sidra Medical and Research Centre. Doha, Qatar	**QAT**	€1,841.5 (2013)	378,000 m²	384
Bucharest Metropolitan Hospital, Romania	**ROM**	RON 4,704 (2019) [IV]	247,000 m²^	1,000
Cluj Regional Hosp., Romania	**ROM**	€580 (2023)	176,638 m²	849
Almoosa Rehabilitation Hospital, Saudi Arabia	**SAU**	$90 (2019)^	56,671 m²	300
NKS Hosp. Stockholm	**SWE**	€2,250 (2015)	330,000 m²	730
New Skane in Malmo, Sweden*	**SWE**	SEK 14,200 (2024)	108,000 m²	254
Queen Silvia's Children's Hospital, Gothenberg, Sweden	**SWE**	SEK 1,900 (2021)	33,000 m²	
Kinderspital Zürich, Switzerland	**SWI**	£517 (2024)^	96,000 m²	200
Inselspital, Uni. Bern, Switzerland	**SWI**	CHF 670 (2023)	84,000 m²	532
Hôpital Riviera-Chablais, Rennaz, Switzerland	**SWI**	CHF 390 (2019)	60,000 m²	350
Kantonsspital Baden, Switzerland	**SWI**	CHF 545 (2016)	m²	400
Neubau Felix Platter Spital, Basel, Switzerland	**SWI**	€201 (2019)	44,181 m²	320
Bürgerspital Solothurn, Switzerland	**SWI**	CHF 273 (2021)	57,000 m²	240
Hôpital des Enfants, Lausanne, Switzerland	**SWI**	CHF 170 (2024) [IV]	13,405 m²	85
Cleveland Clinic Abu Dhabi, United Arab Emirates	**UAE**	$1,300 (2015)^	409,234 m²	490
King's College Hospital, Dubai	**UAE**	AED 734 (2019)	24,500 m²	100
Omagh Hospital and Primary Care Complex, UK	**UK**	£105 (2017)	22,900 m²	62
Sheffield Children's Hospital, UK	**UK**	£25 (2017)	10,000 m²	

Louisa Martindale Building, Brighton, UK	**UK**	£500 (2023)	62,375 m²	
Cleveland Clinic Private Hospital, London, UK	**UK**	$320 (2022)	30,193 m²	213
Alder Hey Children's Hospital, Liverpool, UK	**UK**	£167 (2015)	60,000 m²	270
Evelina London Children's Hospital, UK	**UK**	£60 (2005)	16,000 m²	120
Northumbria Specialist Emergency Care Hospital, UK	**UK**	£95 (2015)	29,000 m²	210
Queen Elizabeth II Hospital Glasgow, UK	**UK**	£840 (2015)	175,000 m²	1,109
Mittal Children's Medical Centre, London, UK	**UK**	£321 (2014)	26,800 m²	240
Circle Reading Private Hospital, UK	**UK**	£50 (2013)	10,000 m²	30
Circle Birmingham Private Hospital, Edgbaston, UK	**UK**	£41.4 (2020)	18,000 m²	170
Baird Family Hospital and ANCHOR Centre, Aberdeen, UK*	**UK**	£261.1 (2024)	31,450 m²	
Cancer Centre at Guy's, London, UK	**UK**	£160 (2016)	20,000 m²	
New QEII Hospital, Welwyn Garden City, UK	**UK**	£22 (2015)	8,500 m²	
Royal Liverpool Uni. Hosp., UK	**UK**	£800 (2023)	96,000 m²	640
Midland Metropolitan Uni. Hosp., UK*	**UK**	£600 (2023)	80,000 m²	670
Moorfields Eye Hosp., London, UK	**UK**	£400 (2023)	39,500 m²	
Cambridge Cancer Research Hosp., UK*	**UK**	£300 (2023)	26,000 m²	
Women & children's Hosp., Cornwall, UK*	**UK**	£300 (2023)	24,500 m²	
Natl. Rehab. Ctr, Loughborough, UK*	**UK**	£100 (2023)		70
The Grange Uni. Hosp., Wales	**UK**	£350 (2020)	55,000 m²	560
Children's Hosp., Royal Victoria, Belfast*	**UK**	£589.6 (2024)	54,000 m²	155
Regional Maternity Hospital, Belfast*	**UK**	£97.1 (2024)	17,000 m²	
South West Acute Hosp., N. Ireland	**UK**	£270 (2012)	69,000 m²	232
Leeds Teaching Hospitals, UK*	**UK**	£1,500 (2023)	94,000 m²	
Watford General Hosp., UK*	**UK**	£1,500 (2023)	120,000 m²	1,000
Whipps Cross Uni. Hosp., UK*	**UK**	£750 (2023)	77,000 m²	600
Hillingdon Hosp., UK*	**UK**	£750 (2023)	79,000 m²	489
North Manchester General Hosp., UK*	**UK**	£750 (2023)	100,000 m²	
Princess Alexandra Hosp., Harlow, UK*	**UK**	£750 (2023)		546
St. Mary's Hosp., UK*	**UK**	£2,000+ (2023)		840
Royal Preston Hosp., UK*	**UK**	£1,500 (2023)		
Royal Lancaster Infirmary*	**UK**	£750 (2023)		
West Suffolk Hosp., UK*	**UK**	£750 (2023)		
Kettering General Hosp., UK*	**UK**	£750 (2023)		
North Devon District Hosp., UK*	**UK**	£750 (2023)		
Milton Keynes Hosp., UK*	**UK**	£500 (2023)		
Balfour Hosp., Orkney, Scotland	**UK**	£65 (2021)	16,248 m²	49
Edinburgh, Royal Hosp. Children & Youth, UK	**UK**	£150 (2009)	50,000 m²	242
Royal Manchester Children's Hospital, UK	**UK**	£500 (2009)^		371
Circle/Solis Bath UK - Private Hospital	**UK**	£21 (2012)^	6,400 m²	28
Royal Papworth Hospital, Cambridge, UK	**UK**	£165 (2014)	40,000 m²	300
Spire Manchester Hospital	**UK**	£63 (2017)	12,077 m²	
NHS Highland – National Treatment Centre, Inverness, UK	**UK**	£48.6 (2023)	8,305 m²	24
NHS Fife - Elective Orthopaedic Centre, UK	**UK**	£33.4 (2022)	6,084 m²	
New University Hospital Monklands, Airdrie, Scotland*	**UK**	£700 (2023)^	120,000 m²	485^
New Dumfries Hospital, Scotland	**UK**	£212 (2017)^	65,032 m²	344
UCSF Mission Bay, USA	**USA**	$640 (2015)	81,568 m²	289
Children's Hosp. of Pittsburgh of UPMC, USA	**USA**	$625 (2009)		296
VA Denver, USA	**USA**	$1,675 (2017)	102,192 m²	215
VA Louisville, USA	**USA**	$925 (2017)	88,473 m²	104
VA New Orleans, USA	**USA**	$1,084.5 (2017)	148,644 m²	120
VA Orlando, USA	**USA**	$620 (2015)	111,483 m²	134
Childrens Hospital (Arthur Blank) Atlanta, USA	**USA**	$1,500 (2020)	185,805 m²	446
Helios Health Campus, Las Vegas, USA*	**USA**	$1,200 (2022)		600
UCSF, Helen Diller Medical Ctr., USA*	**USA**	$4,332 (2024)	81,754 m²	
University of California, Davis Medical Centre, USA*	**USA**	$3,740 (2024)	92,903 m²	
Cooper University Health, New Jersey expansion, USA	**USA**	$3,000 (2024)		
Ohio State University Wexner Medical Ctr. hospital tower	**USA**	$1,900 (2020)	176,516 m²	
Fort Bliss, El Paso, William Beaumont Army Med Ctr., USA	**USA**	$1,370 (2019)	104,980 m²	135
Indiana University Health, Indianapolis, USA*	**USA**	$4,000 (2024)	195,096 m²	864
Mayo Clinic, Rochester Minnesota, expansion, USA*	**USA**	$5,000 (2023)	222,967 m²	
New Stanford Hospital, USA	**USA**	$2,000 (2019)	76,552 m²	
MetroHealth Glick Center, Cleveland, USA	**USA**	$946 (2022)	71,257 m²	388
Children's Hosp. of Philadelphia tower, USA*	**USA**	$2,100 (2024)	120,774 m²	480
Mass. Gen. Hosp. tower, USA*	**USA**	$1,880 (2022)		506
New Children's Health hospital, Dallas, USA	**USA**	$5,000 (2024)	436,644 m²	552
UCLA Outpatient Surgery & Med. Office Bldg., Santa Monica	**USA**	$28 (2012)^	4,645 m²	
Milstein Family Heart Ctr. NewYork-Presbyterian H., USA	**USA**	$140 (2010)^	15,300 m²	45
Cleveland Clinic L. Ruvo Ctr. Brain Health, Las Vegas, USA	**USA**	$80 (2010)	6,000 m²	
Ann & Robert H. Lurie Children's Hospital, Chicago, USA	**USA**	$915 (2012)^	116,590 m²	288
Randall Children's H. at Legacy Emanuel, Portland, USA	**USA**	$158 (2012)	31,030 m²	165

Nemours Children's Hospital, Orlando, Florida, USA	**USA**	$397 (2012)	58,527 m^2	95
Alfond Medical Center, Maine USA	**USA**	$322 (2013)	59,458 m^2	
Sutter Health Eden Medical Center, USA	**USA**	$320 (2012)	21,368 m^2	130
Brigham and Women's Faulkner Hospital, Mass., USA	**USA**	$150 (2022)		86
Banner University Medical Center Phoenix, USA	**USA**	$599 (2018)	40,550 m^2	
Fort Leonard Wood Hospital, USA*	**USA**	$381.3 (2022)	21,870 m^2	
Morris Cancer Center, Rutgers, New Jersey, USA	**USA**	$750 (2024)	47,380 m^2	96
Helena Theurer Pavilion, Hackensack, New Jersey, USA	**USA**	$714.2 (2022)	49,239 m^2	225
Sutter Health California Pacific Medical Center, USA	**USA**	$2,100 (2019)	94,296 m^2	274
University of Iowa Stead Family Children's Hospital, USA	**USA**	$392.7 (2019)	47,102 m^2	190
VA Omaha Ambulatory Care Center	**USA**	$86 (2020)	14,586 m^2	
Rush University Medical Ctr. Rubschlager Building	**USA**	$450 (2023)	45,300 m^2	
Christine E. Lynn Rehabilitation Ctr, Miami, USA	**USA**	$170 (2020)	22,008 m^2	72
Hubbard Center for Children, Nebraska, USA	**USA**	$450 (2016)	46,452 m^2	
Children's of Mississippi Sanderson Tower, USA	**USA**	$180 (2017)	31,587 m^2	
Lackland Air Base Wilford Hall Ambulatory Care Ctr, USA	**USA**	$457 (2024)	59,830 m^2	
Children's Hospital of Richmond at VCU, USA	**USA**	$350 (2019)	46,452 m^2	
Dell Children's Specialty Pavilion, USA	**USA**	$113 (2020)	15,013 m^2	
Denver Outpatient Medical Centre, USA	**USA**	$157 (2019)	27,221 m^2	
Scottish Rite for Children, Dallas, USA	**USA**	$157 (2018)	32,051 m^2	
Baptist MD Anderson Cancer Ctr. Outpatient Building	**USA**	$184 (2018)	54,134 $m^{2,P}$	
Phoenix Children's Hospital, USA	**USA**	$450 (2012)	71,535 m^2	334
Carl R Darnall Army Med. Ctr. Replacement Hospital, Texas	**USA**	$534 (2015)	87,050m^2	122
Hawaii State Hospital Forensic Patient Care Facility	**USA**	$140 (2018)	16,723 m^2	144
VHC Health – Outpatient Pavilion, Arlington, USA	**USA**	$250 (2023)	23,226 m^2	
Behavioral Health & Wellness Center at Children's Hospital & Medical Center Omaha	**USA**	$89 (2023)	9,964 m^2	48
Dartmouth Hitchcock Medical Center Patient Pavilion	**USA**	$150 (2023)	22,390 m^2	
VCU Health Adult Outpatient Pavilion, Richmond, USA	**USA**	$384 (2021)	96,619 m^2	
The New Valley Hospital, Paramus, New Jersey, USA	**USA**	$831 (2022)	82,684 m^2	
Intermountain Spanish Fork Hospital, Utah, USA	**USA**	$150 (2018)	14,616 m^2	30
Intermountain Utah Valley Hospital tower, Utah, USA	**USA**	$430 (2015)	43,664 m^2	232
Sheltering Arms Institute, Richmond, Virginia, USA	**USA**	$99.5 (2020)	19,695 m^2	114
UCSF Benioff Children's Hospital Oakland, USA*	**USA**	$1,490 (2024)	25,781 m^2	
Jennie Sealy Replacement Hospital, Galveston, USA	**USA**	$438 (2016)	73,858 m^2	
New Parkland Hospital, Dallas, USA	**USA**	$1,270 (2015)	195,100 m^2	862
Sidney & Lois Eskenazi Hospital, Indianapolis	**USA**	$750 (2013)	111,484 m^2	327
IU Health Bloomington hospital, USA	**USA**	$500 (2021)	57,600 m^2	185
Grady Health System Correll Pavilion, Atlanta, USA	**USA**	$237 (2023)	55,270 m^2	
Indu and Raj Soin Medical Center, Dayton, Ohio, USA	**USA**	$135 (2011)	26,500 m^2	300
Redwood City Replacement Hospital, USA	**USA**	$224 (2014)	26,075 m^2	
Oregon State Hospital, Salem	**USA**	$311 (2013)	78,970 m^2	620
Penn Medicine – Princeton Medical Center, NJ, USA	**USA**	$522 (2012)	58,500 m^2	319
Oregon State Hospital, Junction City	**USA**	$83.5 (2015)	20,440 m^2	174
UPMC Mercy Pavilion, Pittsburgh, USA	**USA**	$450 (2023)	38,090 m^2	
OHSU's CHH 2, South Waterfront, Portland, USA	**USA**	$360 (2019)	37,161 m^2	
Valleywise Health Medical Center, Pheonix, USA	**USA**	$935 (2024)	62,245 m^2	233
Fulton State Hospital Nixon Forensic Center, Missouri, USA	**USA**	$211 (2024)	41,806 m^2	300
Malone Family Tower, Maine, USA	**USA**	$588.4 (2021)	26,013 m^2	
Lucile Packard Children's Hospital Stanford, USA	**USA**	$1,400 (2017)	48,402 m^2	
Pavillion III, Johns Hopkins Health Care & Surgery Ctr., USA	**USA**	$80 (2019)	10,219 m^2	
San Leandro Medical Center, USA	**USA**	$550 (2014)	68,748 m^2	
Aurora Health Care, Pleasant Prairie, Wisconsin, USA	**USA**	$130 (2018)	18,581 m^2	
Providence Medical Park, Spokane Valley, USA	**USA**	$44 (2014)^	12,449 m^2	
Trinity Health, Southwest Minot	**USA**	$500 (2020)	74,321 m^2	148
Reeves County Hospital District, Picos, Texas	**USA**	$80 (2022)	13,061 m^2	25
McLaren Greater Lansing Replacement Hospital	**USA**	$258 (2022)	52,025 m^2	240
Grande Prairie Regional Hospital	**USA**	$850 (2021)	64,000 m^2	243
Adventist White Oak Medical Center	**USA**	$400 (2019)	44,525 m^2	236
St. Michael Medical Center, Silverdale	**USA**	$500 (2020)	49,775 m^2	248
St. Louis University Hospital Med. Campus Renewal Project	**USA**	$550 (2020)	78,820 m^2	316
Women's & Children's Ctr,, Moses Cone H., Greensboro, USA	**USA**	$100 (2020)	18,180 m^2	141
Duke University Hospital – Central Tower Project	**USA**	$265 (2021)	45,522 m^2	350
Anderson Pavilion, Children's Hospital Los Angeles	**USA**	$636 (2011)	42,735 m^2	317
Le Bonheur Children's Hospital, Memphis	**USA**	$340 (2010)	55,740 m^2	255
Franciscan Health Crown Point Hospital, Indiana	**USA**	$200 (2024)	55,741 m^2	199
Mohawk Valley Health System Wynn Hospital	**USA**	$481 (2023)	65,217 m^2	373
St. Mary's Medical Center, Duluth	**USA**	$900 (2023)	88,630 m^2	346
Loma Linda University Medical Ctr. Troesh Medical Campus	**USA**	$1,200 (2021)	91,895 m^2	440
Cone Health Heart & Vascular Ctr., Greensboro	**USA**	$160 (2024)	14,864 m^2	

Ronald Reagan UCLA Medical Center	**USA**	$914.3 (2008)	120,775 m²	500
Marquette General Hospital & Clinical Services Building	**USA**	$340 (2019)	58,807 m²	243
Franciscan Health Michigan City Hospital	**USA**	$243 (2019)	40,880 m²	123
Million Ocean Tower, Community Memorial H, Ventura	**USA**	$275 (2018)	30,195 m²	250
Irwin Army Community Hospital	**USA**	$343 (2016)	51,280 m²	47
Martin Army Community Hospital, Fort Benning	**USA**	$390 (2014)	69,585 m²	70
Mercy West Hospital, Cincinnati	**USA**	$270 (2013)	59,920 m²	250

Note: Data sourced from media articles are denoted with a caret symbol (^). NCHI data are based on information received from the NPHDB. Forecast/indicative cost data relating to non-complete hospitals (i.e., non-outturn figures) are denoted with an asterisk symbol (*). Hospitals where car parking facilities are included in the square meters figure are denoted with a P. Where VAT is included in the cost it is denoted with 'IV'. Where VAT is excluded from the cost it is denoted with 'EV'.

Other hospitals:

Name of Hospital	Country	Cost per m2
Holte Hosp., Norway	**NOR**	€2,950.66 (2014)
Østfold Hosp., Norway	**NOR**	€4,871.91 (2014)
Østmarka Hosp., Norway	**NOR**	€3,642.35 (2014)
Ohio State Wexner Medical Ctr., USA	**USA**	€2,558.94 (2014)
Children's Hosp. of Buffalo, USA	**USA**	€2,497.98 (2014)
Uni. Princeton Medical Ctr., USA	**USA**	€2,749.22 (2014)
High complexity hosp., Italy	**ITA**	€2,200 (2021)
Medium complexity hosp., Italy	**ITA**	€2,100 (2021)
Low complexity hosp., Italy	**ITA**	€2,000 (2021)
Whangarei Hosp. NZ	**NZ**	$20,000 (2022)
New build low cost, NZ	**NZ**	$15,136 (2023)
England - London Central General Hospital	**UK**	€4,425 (2018)
Scotland – General Hospital	**UK**	€3,556 (2018)
Malta – SAMOC	**MLT**	€1,736 (2016)
Romania example hospital	**ROM**	€1,619 (2018)
Hopital Necker Enfants-Malades, Paris, France	**FRA**	€2,360 (2018)

Contact Details

For queries, contact Peter O'Connor (peter.oconnor@oireachtas.ie).

Parliamentary Budget Office
Leinster House,
Kildare Street,
Dublin 2,
D02 XR20