PROFESSIONAL STATEMENT

# COST PREDICTION

Global

1st edition, November 2020

RICS

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## RICS professional statement, global

1st edition, November 2020

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# RICS professional standards and guidance

## RICS professional statement

### Definition and scope

RICS professional statements set out the requirements of practice for RICS members and for firms that are regulated by RICS. A professional statement is a professional or personal standard for the purposes of *RICS Rules of Conduct*.

### Mandatory vs good practice provisions

Sections within professional statements that use the word 'must' set mandatory professional, behavioural, competence and/or technical requirements, from which members must not depart.

Sections within professional statements that use the word 'should' constitute areas of good practice. RICS recognises that there may be exceptional circumstances in which it is appropriate for a member to depart from these provisions – in such situations RICS may require the member to justify their decisions and actions.

### Application of these provisions in legal or disciplinary proceedings

In regulatory or disciplinary proceedings, RICS will take into account relevant professional statements in deciding whether a member acted professionally, appropriately and with reasonable competence. It is also likely that during any legal proceedings a judge, adjudicator or equivalent will take RICS professional requirements into account.

RICS recognises that there may be legislative requirements or regional, national or international standards that have precedence over an RICS professional statement.

## Document status defined

The following table shows the categories of RICS professional content and their definitions.

# Publications status

| Type of document | Definition |
|---|---|
| *RICS Rules of Conduct for Members* and *RICS Rules of Conduct for Firms* | These Rules set out the standards of professional conduct and practice expected of members and firms registered for regulation by RICS. |
| International standard | High-level standard developed in collaboration with other relevant bodies. |
| RICS professional statement (PS) | Mandatory requirements for RICS members and RICS regulated firms. |
| RICS guidance note (GN) | A document that provides users with recommendations or an approach for accepted good practice as followed by competent and conscientious practitioners. |
| RICS code of practice (CoP) | A document developed in collaboration with other professional bodies and stakeholders that will have the status of a professional statement or guidance note. |
| RICS jurisdiction guide (JG) | This provides relevant local market information associated with an RICS international standard or RICS professional statement. This will include local legislation, associations and professional bodies as well as any other useful information that will help a user understand the local requirements connected with the standard or statement. This is not guidance or best practice material, but rather information to support adoption and implementation of the standard or statement locally. |

# Foreword

Confident markets and societies are founded on the ability to make decisions based on consistent and comparable information. Professionals working in the built environment have always played a vital role in delivering that confidence, but long-term trends and recent events are adding a critical dimension to their expertise.

Construction projects have long been becoming more complex. Client and capital demands are also increasingly nuanced, and the public agenda now encompasses a conception of value and a breadth of issues that are more extensive than ever before. Now, as the world seeks to build back better and engrain resilience to external shocks into our modes of living, consistent professional methods of measurement and valuation have never been more important to serving the public advantage.

However, cost management professionals are simultaneously having to deal with an increasing array of codes and standards that govern the delivery of cost predictions. There is an urgent need to provide clarity for these professionals, both to support them in being able to deliver their services and to inspire confidence amongst the clients, investors and societies that they serve.

To address these cross-cutting issues, it gives me great pleasure to introduce this RICS professional statement on cost prediction. It intends to cut through existing complexity and support professionals by providing consolidated guidance on best-practice for the cost-prediction process. It also marks a worldwide first for the discipline in its global scope. Its provisions aim to:

- provide a practical framework that draws on the process commonalities across infrastructure, building, refurbishment, or adaptation projects
- address particular, recognised problems in the cost-prediction process that can lead to project budget overruns – primarily the challenges in accessing accurate inputs in a timely manner
- highlight the importance of factors including design completeness, the practice of range estimating, the time required to deal with cost prediction, data sharing and analytics, and the cost-management context for procurement
- embody ICMS, which provides a critical global benchmark for consistency in cost presentation
- recognise that the skills, knowledge, and expertise of the cost management professional are critical for achieving consistent, accurate and trusted cost prediction.

In drawing on the input and expertise of the range of stakeholders involved in cost prediction –including quantity surveyors and other cost-estimate professionals, contractors' estimators, clients, and other interested bodies – this professional statement is a major step forward that I am sure will deliver confidence by enabling activity that is accountable, transparent and socially responsible.

I look forward to the positive outcomes that it will deliver for everyone who lives and works in the built environment.

**Tim Neal FRICS**

**RICS President**

# Glossary

The following terms relate to this professional statement. They do not include legal or other matters as defined in relation to local legislative or regulatory requirements. This glossary should be read in conjunction with the current edition of ICMS.

| | |
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| **Artificial neural network (ANN)** | A computer system that is able to simulate the learning effect of the human brain, performing tasks involving incomplete data sets, fuzzy/incomplete information and for highly complex and ill-defined problems. For example, historical data can be used to train the ANN so that it 'learns' to predict costs. |
| **Baseline costs** | The predicted cost at a given point in time against which all future costs are compared. Baseline costs may be produced at different points in time as the design is progressively refined and the amount of available information increases. |
| **Bills of quantities** | A list of items giving detailed identifying descriptions and quantities of the work comprised in a contract. |
| **Carbon metric** | The calculation used to define measurement, reporting and verification for greenhouse gas emissions. |
| **Client** | The legal entity who pays for the works and services provided. The term 'client' has been used throughout the professional statement to represent the project sponsor/client/owner/agency/operator, but could also include senior management in a funding, client, contractor, or other organisation. |
| **Complexity** | The number of elements, their interactions and the strength of impacts on a defined system with regard to decision making, project control and predictable asset delivery. |
| **Contract sum** | The consideration that the client pays the provider for the works, and any design as defined in the contract. |
| **Cost** | In any transaction 'cost' is what the buyer pays and 'price' is what the seller charges: they have the same value. In this document the term cost is used for the value of a transaction. |
| **Cost plan** | An estimate based on a specific design. A statement showing an apportionment of an estimate or of an agreed budget between cost headings. |
| **Cost prediction** | In terms of this professional statement it is used as an umbrella term and can commonly be taken to mean benchmarking, estimating, cost planning and cost reporting, for both a consultancy and/or a contractor, or other organisation, across building and civil engineering. |

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| **Data analysis** | The process of identifying and analysing historic costs according to a defined standard. |
| **Direct costs** | Costs incurred on labour, material, plant and equipment, etc., i.e. costs that are directly accountable to the project. |
| **Digital twin** | A digital replica of a real process, product or service and, as such, enables data analysis and system monitoring to be undertaken with no impact on the physical version. It provides a bridge between physical and digital worlds. |
| **Estimate** | A prediction or forecast of the resources (i.e. time, cost, materials, etc.) required to achieve or obtain an agreed scope of work (i.e. for an investment, activity, project, etc.). |
| **Final account** | See *out-turn cost*. |
| **First principle estimating** | The method of preparing a cost estimate by calculating the monetary rate, labour hours and rates of productivity required to complete each of the individual tasks within the desired breakdown structure. |
| **Forecast** | An estimate and prediction of future conditions and events based on information and knowledge available at the time of the forecast. Often uses as a synonym for an estimate. |
| **International Construction Measurement Standards (ICMS)** | A high level framework for cost reporting and data collection developed by the **ICMS coalition**. |
| **Indirect costs** | Are costs incurred during construction works that cannot be attributed to any one section of the works; they may be fixed (e.g. the cost of bringing accommodation to the site) or time-related (e.g. the cost of insurance or security personnel). |
| **Main contractor** | The primary/principal contractor appointed by the client to coordinate the construction/site production phase of a project, which may involve more than one subcontractor. |
| **Modern Methods of Construction (MMC)** | MMC is a wide term, embracing a range of offsite manufacturing and onsite techniques that provide alternatives to traditional construction. |
| **Monte Carlo simulation** | A technique to undertake a quantitative risk analysis using a computer-generated simulation to model outcomes.<br><br>(More information in the current edition of **Management of risk**, RICS guidance note). |
| **National cost measurement standards** | Detailed cost measurement standards developed at a national level, e.g. New Rules of Measurement (NRM) for the UK for building works, or CESMM (Civil Engineering Standard Method of Measurement) for civil engineering works. |

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| **Normalisation** | Analysing data into a common structure for comparison purposes. |
| **Order of cost estimate** | An estimate based on benchmark data for a similar type of project based on a defined brief. |
| **Out-turn cost (also known as 'final account', 'actual cost' or 'cost outcome')** | The known cost at the end of a project. Generally, it refers to the actual, total construction cost calculated at the end of the project, which includes the effects of any changes made to the design and the impact of any disruption. It may also refer to the costs incurred over a defined period, such as in life cycle cost. |
| **Price** | The amount the seller charges for a product or service; it is the buyer's 'cost'. |
| **Parametric estimate** | An estimate of cost, time or risk that is based on a calculation or algorithm and uses historical data. |
| **Probabilistic estimating** | An estimate using a range of numbers (e.g. three-point and five-point estimates) with associated probabilities of occurrence for each of the components or, at least, for each of the components that have substantive certainty. This approach recognises that there are uncertainties associated with each project component and so the probabilities of occurrence cover a range of possible values. |
| **Project management** | The discipline of planning, organising, monitoring, controlling and reporting all aspects of a project (or services provided by those involved in project delivery) to achieve defined objectives. |
| **Quality** | A set of inherent characteristics of an object that fulfils requirements (EN ISO 9000-9001-9002). |
| **Range estimate** | The provision of several estimates, for example, a 'most likely' value as well as minimum and maximum values. This may be referred to as a three-point/five-point/probabilistic estimate. |
| **Re-basing** | Re-basing may have different meanings in different contexts. It may mean:<br>• changing the weights in an index<br>• changing the price reference period of an index number series or<br>• changing the index reference period of an index number series.<br>It can also mean using cost indexes to update to a common time base, or location indexes to cater for the impact of location on the cost. |
| **Risk** | The effect of uncertainty on objectives (ISO 31000). An uncertain event or condition that, should it occur, will have an impact on project objectives or business goals. |
| **Statutory or regulatory requirement** | Obligatory requirement specified by a legislative body for a specific jurisdiction. |

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| **Tender** | A commercial offer including contract conditions under which construction work will be carried out. |
| **Three-point estimate** | See *range estimate*. |
| **Uncertainty** | A lack of complete certainty. In uncertainty, the outcome of any event is entirely unknown, and it cannot be measured or guessed; there is no background information on the event. Uncertainty is not an unknown risk. |
| **Value management** | A process to explore how value could be provided for a project at a strategic level by helping to develop the right project brief. Examples include organisational improvement, setting clear goals, improving productivity, creativity and return on investment (BS 12973:2020). |

## Acronyms

| | |
|---|---|
| **AACEi** | Association for the Advancement of Cost Engineering International |
| **AIQS** | Australian Institute of Quantity Surveyors |
| **BCIS** | Building Cost Information Service |
| **CESMM** | Civil Engineering Standard Method of Measurement |
| **CITE** | Construction Industry Trading Electronically |
| **CROME** | Construction, Renewal, Operation, Maintenance and End-of-life costs |
| **BIM** | Building information modelling |
| **IFC** | Industry Foundation Classes |
| **IPMS** | International Property Measurement Standards |
| **ISO** | International Organization for Standardization |
| **NRM** | RICS New Rules of Measurement |
| **NZIQS** | New Zealand Institute of Quantity Surveyors |
| **OECD** | Organisation for Economic Co-operation and Development |
| **PESTLE** | Political, economic, social, technological, legal and environmental |
| **RMM** | UK Rail Method of Measurement |
| **SMART** | Specific, manageable, assignable, realistic and time-related |

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| **UN/CEFACT** | United Nations Centre for Trade Facilitation and Electronic Business |
| **XML** | Extensible Markup Language |

# Mandatory requirements

RICS members and RICS-regulated firms producing a cost prediction report for a client or senior management **must** adhere to the following principles.

- Based upon the briefing and information provided, produce a reliable prediction of costs appropriate for the needs and best interests of the client, the size and complexity of the project and the project stage.
- Consider and agree with the client the appropriate method for reporting costs, recommending the use of ICMS where that would be in the best interests of the client.
- Provide the sources of the data on which the cost prediction is based and a commentary on the dependability of the cost data, unless the data source is subject to confidentiality provisions.
- Identify the key assumptions, including any exclusions and how they can be managed, as well as timing and methodology constraints, made in deriving the predicted cost and the grounds for making them.
- State the change in predicted cost since the last report, and the reason(s) for the change.
- Commensurate with the size and complexity of the project, provide an estimate of the accuracy or level of uncertainty of the cost prediction and how this can be improved through management action.

# 1 Introduction

Major global events, such as the recent coronavirus pandemic, show how risks and uncertainty play into projects in a dramatic way. While these major events are not always foreseeable, systematic processes and skilled professionals provide the best chance of adequately managing their occurrence.

The focus of this professional statement is the prediction of the project and life cycle construction cost for built assets. It embodies ICMS for the collection of data and subsequent reporting, a framework against which construction and life cycle costs are classified, measured, recorded, analysed and presented.

Cost prediction is used for financing, business case, site acquisition, design, tendering and management control decision support from inception to post occupation of the asset. It is also key in making the right informed decisions regarding life safety and sustainability.

Realistic and reliable cost and time targets are crucial at the outset when making any investment decision to ensure value for money and viability of a project. In developing the business case, the client will consider affordability, financial viability, and functionality. Professional advice will be sought on capital construction costs and operation and maintenance costs. Contractors will also need to know the right cost of the works, notwithstanding any commercial adjustment.

When dealing with portfolio's and programmes of work, as opposed to individual projects, cost prediction will benefit from repeatability, data applicability and hence increased certainty. However, this should not militate against the key principles outlined in this professional statement.

At early project stages, the client can become focused on the numeric magnitude of the initial cost prediction, while the context, assumptions and risks associated with immature information are lost. Managing the client's expectations is crucial to the success of a project and involves several processes:

- definition of the project scope
- the setting of realistic/agreed goals
- a detailed plan with specified timelines
- budget agreement and adherence
- identification of common setbacks and
- regular communication.

Risk, uncertainty, bias and behavioural factors also need to be properly considered.

Cost prediction is dynamic and fast moving, and will be increasingly reliant upon digital technologies to collect, analyse, store, update, and exchange data and information. Artificial intelligence, building information modelling (BIM), blockchain, cloud computing and other technologies are changing the way cost prediction and cost management operates. Digital technologies require structure and standards in order to be effective.

There is a need for a common language, a standard, and statement about cost prediction, which describes the basis of the prediction, and that recognises how the modern construction industry operates. Globally, in construction cost, this is ICMS. Examples of common sectoral language from UK industry include CESMM and RMM as well as those published by RICS, namely NRM. Nevertheless, while terminologies used by RICS members and RICS-regulated firms vary, the task remains the same across all sectors of construction: predicting a capital or life cycle cost that is accurate, consistent, and reliable, given the information available.

# 2 Background

## 2.1 Challenges

Cost prediction is dynamic – as the design, engineering and context evolves, more reliability can be placed on the prediction as more information is known. The aim is to predict the cost in terms of the best value bid price, the out-turn cost and the life cycle cost depending on client requirements.

Expectations for the accuracy of a prediction should be realistic and appropriate. Initially, ranges should be used and 'accuracy' will relate to the type of project, design maturity, quality of inputs available and, in turn, the granularity of relevant data used to produce the cost prediction.

Projects are planned and executed in complex market environments. Regardless of how well planned a project is, there are still internal and external factors that determine its success in terms of cost prediction, such as wide and sudden variances in the cost of labour and materials.

Informed cost predictions should go beyond an expression of the scope or quantum of the works. It is necessary to consider other basic project attributes, such as quality and schedule expectations, location, method of project funding and the procurement route. For example, projects with an accelerated project duration that require a rapid production are likely to incur higher costs because of the overlapping of work activities and the need for more mechanisation. The variables associated with these basic project attributes make it vital for RICS members and RICS-regulated firms to provide an accurate cost prediction and recognise project uncertainty.

In addition, design quality, sustainability and complexity are all subjective measures requiring professional judgement. Data should be sufficient to determine the relative importance of these factors when compared with past and proposed projects. The maturity and veracity of the information is an important consideration.

Traditionally, the construction industry has focused on cost prediction being a point estimate, that is, one single number. Conversely, the probabilistic and risk process is that of describing the confidence interval surrounding such a prediction, which may be a matter of professional judgement based on experience, or calculation based upon the available data. A key challenge for practitioners is to instil clients and stakeholders with confidence in their professional ability to predict costs while changing the terms of reference from inferred 'absolutes' such as point estimates, to ranges and likely outcomes.

## 2.2 Aims

The aim of the professional statement is to give an overview of global best practice in cost prediction and implement ICMS globally for RICS members and RICS-regulated firms. Different markets and construction sectors undertake cost prediction in different ways, this professional statement elicits the key principles from these various approaches to signpost best practice from around the world. The objectives are to:

- Outline the importance of the cost prediction process and the skills and knowledge required by RICS members and RICS-regulated firms.
- Define clear and consistent terminology.

- Describe the required inputs for successful cost prediction, their sources and uses, and the processes required to transform them.
- Describe the prediction process at each stage of project realisation, identifying the variability in prediction accuracy, based upon the level of available inputs.
- Integrate ICMS as the standard for cost classification and reporting to support benchmarking and reliable cost prediction.

## 2.3 Scope

In this professional statement, cost prediction is used as an umbrella term for cost forecasting and estimating across clients, consultants and contractors. This professional statement considers cost prediction as a system of inputs, process, outputs and information stages.

Good practice in cost prediction requires:

- standardised and consistent approach to pricing through consistent use of defined terms and nomenclature
- full understanding of the client's objectives and/or requirements
- reference to the completeness of project documentation and relationship to accuracy of the cost prediction and
- a realistic time frame to produce a reliable cost prediction.

Context is the collective characteristics of a project and the environment in which it is realised that might have an impact on its cost. It is defined in ICMS through a series of attributes and values and by the external and internal parameters that an organisation should consider when it manages cost prediction risks. These parameters include:

- Internal context: governance, contractual relationships, capabilities, culture, standards, regulatory and statutory requirements, and taxation.
- External context: local, national, and international markets; as well as external factors that influence project objectives, such as political, economic, social-cultural, technological, legal and environmental factors (sometimes known as PESTLE analysis).

## 2.4 Effective date

This PS is effective from 1 July 2021.

## 2.5 ICMS alignment

ICMS provides principles-based international standards that provide consistency in classifying, defining, analysing and presenting global construction cost data at a project, regional, state, national or international level. Figure 1 shows the ICMS hierarchy.

The benefits of ICMS to the client or senior management are as follows:

- Costs are reported in a global, standardized way to facilitate international, regional and sector comparisons.
- Terminology and nomenclature are standardised across markets and sectors.

- Data collection and analysis is harmonized and linked to common values and attributes.
- Mapping to national standards and other classifications allows detailed costs to be compared at international level and the use of 5D BIM.

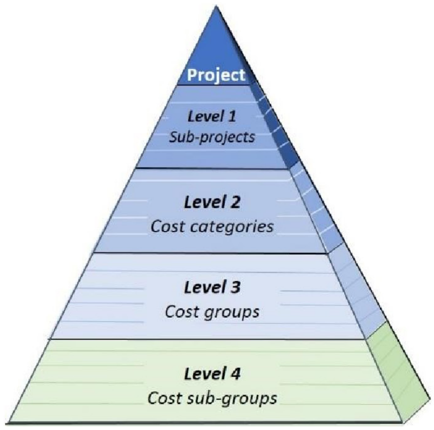


Figure 1: ICMS 2nd edition hierarchy

ICMS incorporates life cycle costs and a framework for construction costs and life cycle costs to be classified, measured, recorded, analysed, and presented. It uses the acronym CROME (construction, renewal, operation, maintenance and end-of-life costs). Figure 2 maps the ICMS 1st edition framework against ICMS 2nd edition (which supersedes ICMS 1st edition) and BS EN 15978:2011 *Sustainability of construction works*. The latter is used in **Whole life carbon assessment for the built environment** (WLCABE) RICS professional statement, but the WLCABE can use ICMS as a framework. Carbon metrics can be used to calculate greenhouse gas emissions associated with the operation of facilities. ISO 16745 provides a set of methods for calculation, reporting and communication (ISO, 2017).

Guidance is provided to convert ICMS to more granular national cost measurement standards and this provides means to report and analyse cost prediction at both a national and international level of detail. ICMS is also **available in XML data standard**.

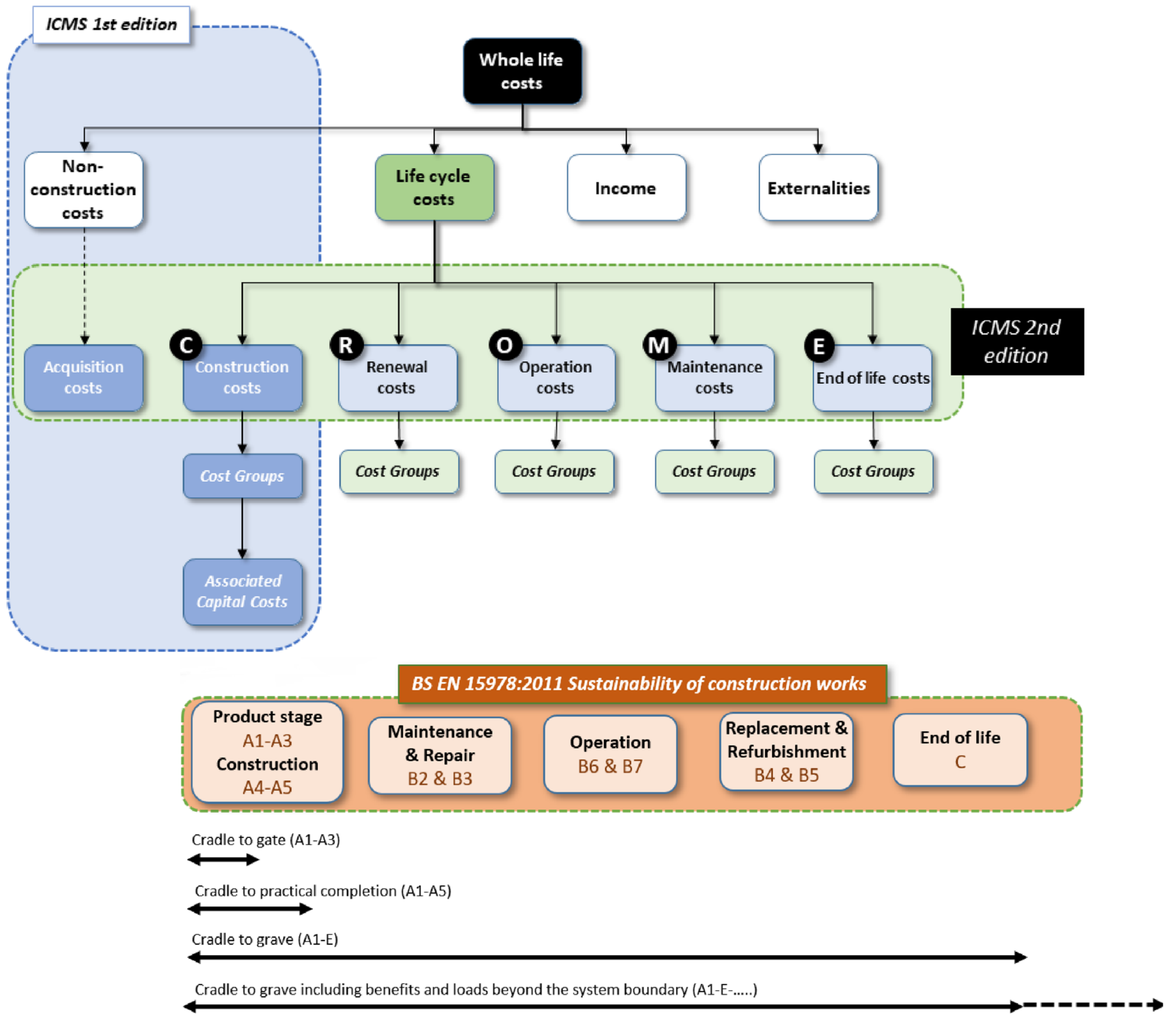


Figure 2: ICMS 2nd edition framework mapped against ICMS 1st edition and BS 15978:2011

## 2.6 Accuracy, reliability and risk

Risk and uncertainty are integral to the cost prediction process. Uncertainty can lead to subjective (based on experience) rather than objective provisions being made for unknowns. Adjustments for bias (see section 3.6) further affect the cost predictions through project delivery. The maturity and availability (timing) of inputs can have a strong impact on the accuracy and reliability of the cost prediction (explained further in section 3).

## 2.7 Collaboration

Cost prediction requires extensive collaboration and progressive refinement as a project evolves. Construction professionals increasingly share information and generate ongoing feedback from project participants – which, in turn, helps to shape project decisions. The collaborative digital workplace is common; security should be in place to protect sensitive and confidential information (see ISO 19650-5 in 2020). Data access and rights should be considered and documented, for commercial and political reasons, but engaging with and sharing information across key stakeholders will generally improve cost prediction accuracy.

## 2.8 Information stages

Although ICMS provides a classification for costs, there is no agreed international process and terminology for cost prediction; organisations have their own classifications. Various professional institution national plans of work exist, across buildings and infrastructure, but there is no global standard for cost prediction. For this reason, this professional statement sets out a model with six levels and five gateways for the cost prediction process (see Figure 3 and Table 1). Each level is characterised by the level of the inputs. The intention of the levels is to provide a framework for cost prediction consistency, so the client is clear about the level of granularity for the cost prediction. It should be noted that these information stages are procurement agnostic; different procurement systems can be applied, but the key issue is the level of inputs.

Figure 3 shows the five gateways, assuming a sequential approach. Each level relates to the cost prediction process and the maturity level of the inputs (design, data, and information) and applies regardless of the need to overlap design and construction and/or the timing of the appointment of the contractor. The process is dynamic with the maturity of the inputs dictating the level of the cost prediction. During inception, design and construction, RICS members and RICS-regulated firms may be predicting the out-turn cost, or the life cycle cost, while, during occupation, they may be predicting life cycle costs only.

The arrows in the diagram reflect the iterative nature of cost prediction, responding to the changing availability and/or maturity of the inputs. In theory it is a sequential process, in practice it is not. Design is iterative; there are always information blanks due to unknown factors and this is where the professional judgement, experience, knowledge and skill of RICS members and RICS-regulated firms are required. Also, design maturity may be more advanced from some aspects (for example, architectural design as opposed to mechanical and electrical services design) at some points in the project than others.

The levels are not distinct stages with clear boundaries due to the dynamic nature of the inputs, depicted by the blue input arrows in Figure 3. Inputs can be data, information, productivity, construction materials, construction methodology or time. Design is an input, not the input.

During this process, it is likely that the maturity of the inputs, scope, specification, design and general context of the project will change. The effect of any change should be evaluated. RICS members and RICS-regulated firms should keep the client informed about the extent of the erosion to the risk and contingency allowance and the likely revised out-turn cost, or life cycle cost of the project, until the cost prediction commission is complete.

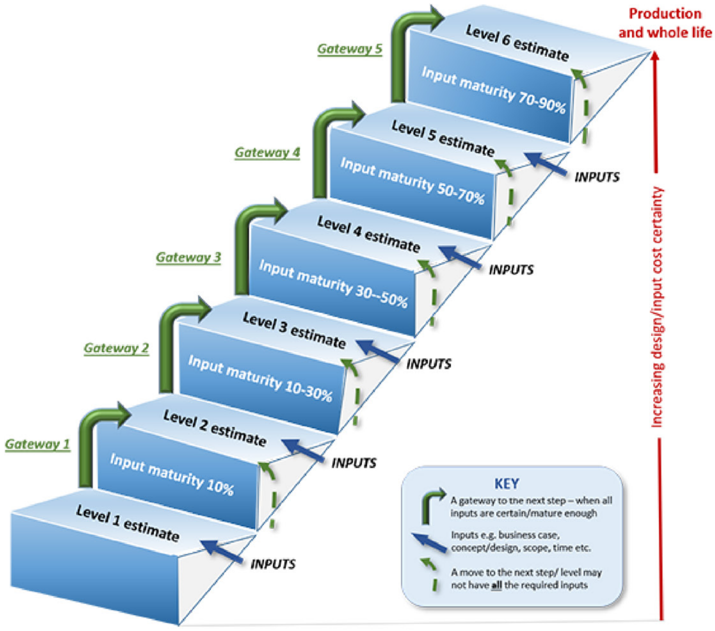


Figure 3: Information stages

During the post-occupation or use period of the asset, RICS members and RICS-regulated firms should review the scope and basis of the life cycle cost predictions as an aid to decision making. The allowance for risk should be kept under constant review to reflect changing circumstances. All the assumptions used in the life cycle cost calculations should be evaluated as more information becomes available through the asset life.

| Level | Description | Key inputs | Gateway | Key outputs |
|---|---|---|---|---|
| 1 | • Different terminologies for this level of estimate include: order of cost, business case and benchmarking.<br>• Appraisal, feasibility, concept, and scope of the project, to facilitate budget determination and feasibility, based on available project information.<br>• Budget is based on client's brief and functional requirements may include concept and sketch design, planning constraints, performance requirements and option selection. Budget constraint may be: affordability of the project, finance availability, or allowance allocated by a public sector client.<br>• Client may require a balance between initial capital cost and life cycle cost of a project. | • Assumptions on which decisions have been taken on design, engineering, market conditions.<br>• Benchmark prices from similar projects, scaled according to differences in size, location, quality, and timing.<br>• Incorporation of factors affecting complexity of project, e.g. working on an existing facility, heritage project, or difficult conditions.<br>• Risk allowance for unknowns, planning approvals, and changing market conditions.<br>• Cost indexes used to normalise and re-base cost information. | Order of cost prediction satisfying the strategy and business case for the budget. | Costs, values and attributes will be typically described at ICMS Level 1: Projects or Sub-Projects. |
| 2 | • Order of cost broken down into cost/design elements at a group level or cost category level. ICMS provides a breakdown for such items.<br>• Incorporates design/client/ performance requirements.<br>• Identify special constraints, e.g. environmental requirements, public engagement on planning, minimising life cycle costs.<br>• Consideration of procurement method and constraints on construction.<br>• Consideration of construction duration and its impact on prices. | • Outline design should define the gross dimensions of the asset and provide a broad specification.<br>• Implications on cost prediction of project duration, e.g. phased completion or tight deadline requirement.<br>• Details relating to planning approvals/constraints and site information available, e.g. soil and geotechnical conditions, availability of utilities, foundation and adjoining structures' requirements.<br>• Cost indexes used to normalise and re-base cost information. | Order of cost prediction with client and design team approval for feasibility of the project. | Costs, values and attributes will be typically described at ICMS Level 2: Cost Categories. |

| Level | Description | Key inputs | Gateway | Key outputs |
|---|---|---|---|---|
| 3 | • Different terminologies for this level of estimate include: cost plan, cost estimate, developed and probabilistic.<br>• Information completeness to be at least 30% (and not <25%).<br>• Predictions may be used for conceptual value engineering purposes.<br>• Once specification data available for major elements, able to adopt more informed approaches, e.g. main quantities. | • Clearly defined scope, with elements of design in the design development stage.<br>• When preliminary design available, drawings and specifications will have progressed so the elements of the asset can be identified and quantified. This allows an 'elemental' estimate in accordance with ICMS categories, with costs assigned to each element of the asset, e.g. demolition, site preparation and formation, substructure, structure.<br>• Costs obtained for specialist contractors for unique items of work. | Cost plan or bid estimate (based on costs for a specific design) – developed prediction shows categories of cost, including any speciality work packages. Allowances for risk and uncertainty should identify key items still to be developed. | Costs, values and attributes will be typically described at ICMS Level 3: Cost Groups. |
| 4 | • Different terminologies for this level of estimate include: cost plan, cost estimate, mature and technical.<br>• Characterised by greater design completeness and a co-ordinated design solution – at least 50% and up to 70% (or higher).<br>• Modifications or scope in design to be identified and costed.<br>• Level 4 predictions may be used in the consideration of specialist contractors' prices at bid stage.<br>• Detailed cost plan or tender is developed. | • Constraints on time and construction method. | Cost plan or bid estimate – detailed cost plan shows that the developed design takes account of how the project has evolved through the design and engineering process. Allowances for risk and uncertainty should identify any key items still to be developed. | Costs will be typically described at ICMS Level 4: Cost Sub-Groups, or National Standards that can be mapped to ICMS. |

| Level | Description | Key inputs | Gateway | Key outputs |
|---|---|---|---|---|
| 5 | • Commonly known as a construction estimate.<br>• 100% design completion is the ideal situation, but unrealistic. This level is for validation to ensure all design changes made are reflected in the cost plan or construction cost report. It should incorporate statutory, regulatory, and client requirements. | • Details of assumptions, allowances and documents used in the cost prediction process should be made available.<br>• Drawings, specifications, performance requirements may be incomplete, affecting the accuracy level.<br>• Once the main contractor is chosen, price is notionally fixed. | Cost plan or bid estimate – final check before negotiation on price for construction work. | Costs will be typically described at ICMS Level 4: Cost Sub-Groups, or National Standards that can be mapped to ICMS. |
| 6 | • Commonly known as life cycle estimate.<br>• During construction design and other inputs will evolve until out-turn cost agreed.<br>• Post-completion estimates of life cycle costs may be periodically required until the end of life of building or asset. Life cycle estimates can be carried out at any information stage and post-completion. | • Check cost prediction against agreed construction price and identify any key differences between prediction and agreed prices.<br>• Monitor site construction to ensure no major deviations from prediction and to consider out-turn price in light of scope and design changes during the production phase.<br>• Monitor impact of inflation and other external influences during production to ensure the client kept informed of likely out-turn price.<br>• Life cycle costing can be carried out at any level/information stage and post-completion. It is used as a decision-making tool for options being considered or where it is demanded by the procurement system (e.g. PFI). | During construction and post-completion. | For post-completion estimates, costs will be typically described at ICMS Level 4: Cost Sub-Groups, or National Standards that can be mapped to ICMS. |

Table 1: Describing the levels with typical inputs, gateways and outputs

# 3 Process

## 3.1 Overview

Cost prediction is a system with:

- Inputs – the values, attributes and quantities.
- Process – the analysis and quantification.
- Outputs – the cost prediction at each of the relevant stages.

The appendices list both the typical scope and examples of inputs and processes.

Critically, the RICS member or RICS-regulated firm should outline with the client or senior management (for example, in a client or contracting organisation) at the onset of the commission the purpose of that advice and ascertain the purpose for which the client or senior management intends to use it.

A briefing in cost prediction should be confirmed in writing and summarise the inputs and outputs. It should also include the processes to be followed where budget alterations are made by the client and their impact on the project. Typically, a brief for cost prediction may include:

- establishing both the capital and life cycle budget
- checking if the design meets the budget limit set by a funding formula
- determining funding requirements for use in the economic feasibility of the project
- conducting a cost and benefit analysis, or to estimate the cost of a project in a bid situation.

This briefing information is essential in assessing the scope of the cost prediction expected by the client or senior management. A misunderstanding could lead to inadequate or incorrect advice. However, it is important to understand that a lot of projects do/do not proceed dependent on the cost prediction, so it needs to be as accurate, informed and transparent as it can be. The scope of items on which the cost prediction is based, exclusions and assumptions, as well as the parameters of the cost prediction, should all be clearly articulated and agreed with the client or senior management.

The briefing needs to establish the parameters of cost prediction – some clients do not want the whole project to be predicted. Some clients or senior management may only require shell and core project costs, excluding fit-out and specialist machinery/equipment and some may want a holistic approach including acquisition and funding/financing costs. Establishing the boundaries of the prediction should be done before the budget setting. Inputs, including data that the client will provide, or via third parties, should be confirmed, since the level of this information will be critical to the accuracy of the cost prediction.

RICS members and RICS-regulated firms should follow a systemised process to develop cost predictions, with accountability at each level. For example, the predicted out-turn cost to the client on project completion may be different to the agreed contract price at the tender stage, due to changes in scope, design and unforeseen circumstances.

Where required, RICS members and RICS-regulated firms should monitor and reconcile costs at each project stage up to the completion of the project and, if commissioned, during the use of the asset. The cost prediction needs to be updated to reflect the contract award cost and a prediction of the value of the out-turn cost throughout the construction period. This involves amending the cost prediction to reflect:

- any contract changes
- changes to the scope and quality of the works
- agreement to any additional costs caused by interruptions to the work and extensions of time
- deflationary or inflationary changes
- determining the extent to which the client's risk and contingency allowance changes throughout the process.

When required by the client, RICS members and RICS-regulated firms should consider the balance of initial capital costs with life cycle costs. Lower initial capital costs may result in higher future operation and/or maintenance costs and important trade-offs should be made explicit. Refer to the current edition of **Lifecycle costing**, RICS guidance note.

Value management may be used in the planning and cost prediction process to achieve best value for the client. Further information on this process can be found in the current edition of **Value management and value engineering**, RICS guidance note.

In summary, effective cost prediction depends on combining a clear definition, with the right skills, with the right data, within the right system (see Figure 4).

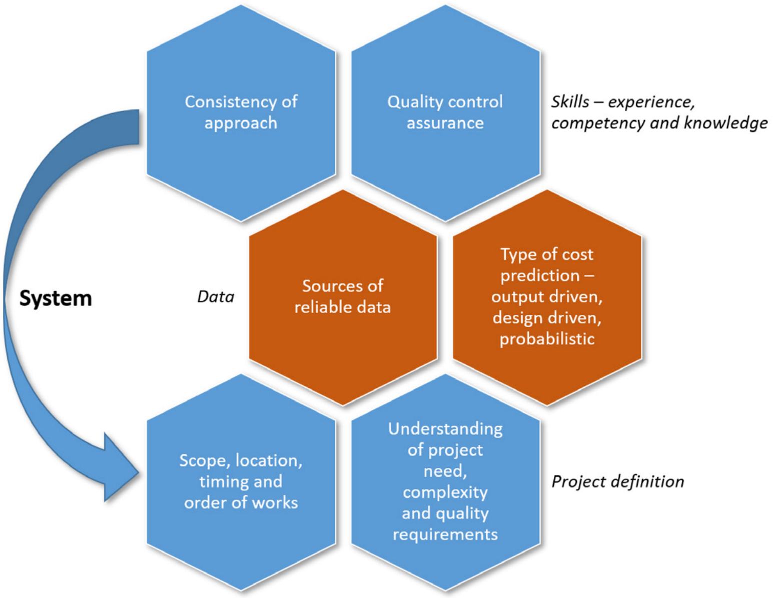


Figure 4: Key factors for consideration in the cost prediction process

### 3.1.1 Inputs

The quantities are driven by the inputs into the cost prediction system, for example, materials, labour, time, quality requirements, special requirements, etc. which will all be at different stages of maturity across the six levels of the cost prediction process. The inputs can come from different sources, including analysed information from past projects. Typical inputs are shown in Table 2 and examples of inputs are shown in Appendix B.

| | |
|---|---|
| Requirement of the project/programme | e.g. functional output (end product), business case, remit/ scope of cost prediction |
| Design (drawings/sketches) | e.g. basis for quantification (concept/design) |
| Design (specification) | e.g. specification/quality |
| Programme (dates/duration) | e.g. time – duration/schedule |
| Programme (narrative/methodology) | e.g. basis for quantification (concept/design) |
| Other project/programme factors/ influencers | e.g. site-related factors, procurement strategy/contract type |
| Assumptions | Associated with each input |
| Exclusions | Associated with each input |
| Life cycle inputs | e.g. reference service lives, energy consumption rates, levels of maintenance, service levels for period of analysis |

Table 2: Typical inputs

Similarly, data gathering and analysis can be viewed as a system as shown in Figure 5. Inputs should be presented on a comparable basis for cost prediction. For comparability of cost data, the following should be considered (see section 4):

- date at which costs are current with stated assumptions
- location
- level of information available about the project and the assumptions
- method and order of undertaking the works
- level for which the cost prediction is being made
- data provenance, (life cycle) status, context, and quality (for example, is the data from estimates, or out-turn costs).

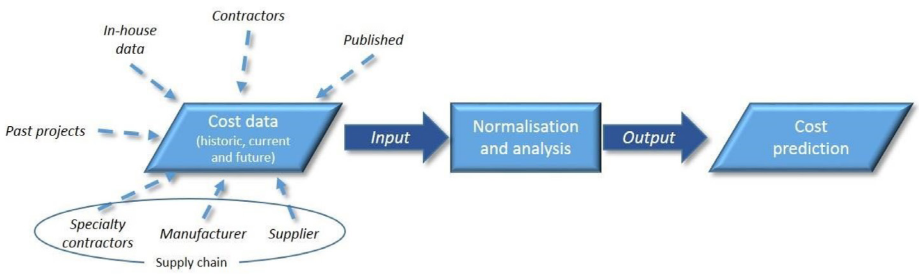


Figure 5: Data analysis system

### 3.1.2 Process

The process is about applying rates and quantification and considering the values and attributes, which, in ICMS describe the project or sub-project. The costs are the product of the quantities and the rates plus allowances for risks (see Figure 6). In an infrastructure project, the cost predictions are often built up from a resourced programme.

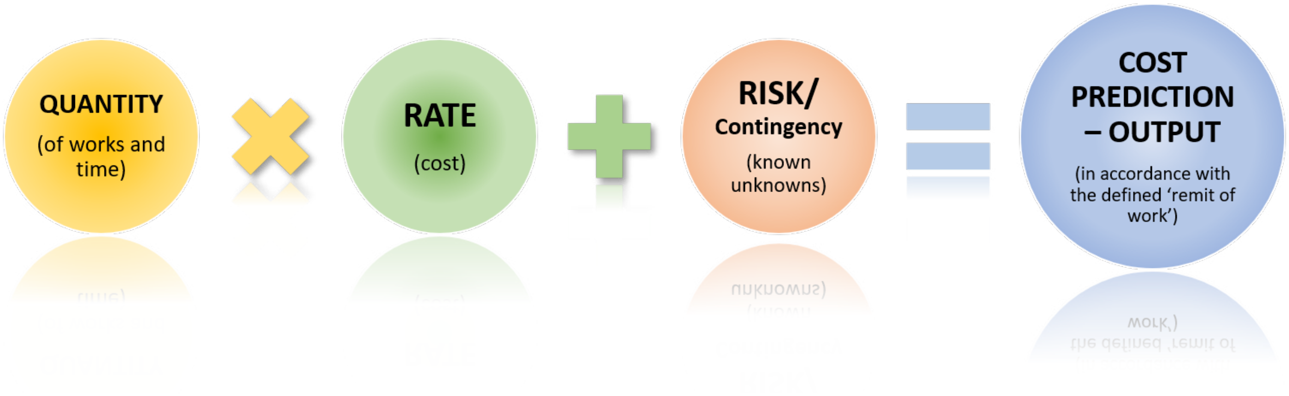


Figure 6: Transformational process

RICS members and RICS-regulated firms will rely on unit costs/resources and should apply these to the relevant quantities. Unit costs can include:

- per unit of floor area (refer to **IPMS**)
- per length of road
- per length of track, reduced to a single equivalent track length, in the case of railways and tramways
- per unit of output
- per unit component or element
- per hour or day of labour and plant
- outputs per hour or day (productivity)
- life cycle costs e.g. £/m$^2$/pa.

Costs can be direct or indirect. Direct costs are those associated with a specific activity or component, while indirect costs are those incurred as a result of carrying out the work but are not themselves part of the work, e.g. project insurances, site hoardings, site cleaning, etc.

The process can use a variety of estimating techniques such as benchmarking, probabilistic estimating, cost planning and first principle estimating depending on the extent and type of data available. The process should take account of:

- market conditions
- inflation and market-specific factors (inflation/deflation)
- site conditions
- procurement route
- location
- special quality requirements
- modern methods of construction and the associated logistical implications

- constraints that might apply, e.g. restricted site access, restricted working hours, working in an occupied building, noise restrictions, working in functioning facilities, e.g. occupied buildings or operating airfields, etc.
- any specific project requirements, e.g. programme, delivery date, phased delivery, etc.
- risk/contingency, i.e. known unknowns
- unknown unknowns, i.e. unidentified (or unimagined) risks.

The accuracy of the data process depends on the maturity, reliability and extent of the input data and the method adopted to transform the data. The cost prediction and data selection are also based partly on expertise and experience. Appendix C shows examples of processes.

The following two flow diagrams are a graphic representation of the cost prediction process/system. Figure 7 is a sequential flow of project and environmental factors that feed into the cost and pricing analysis to produce the cost prediction.

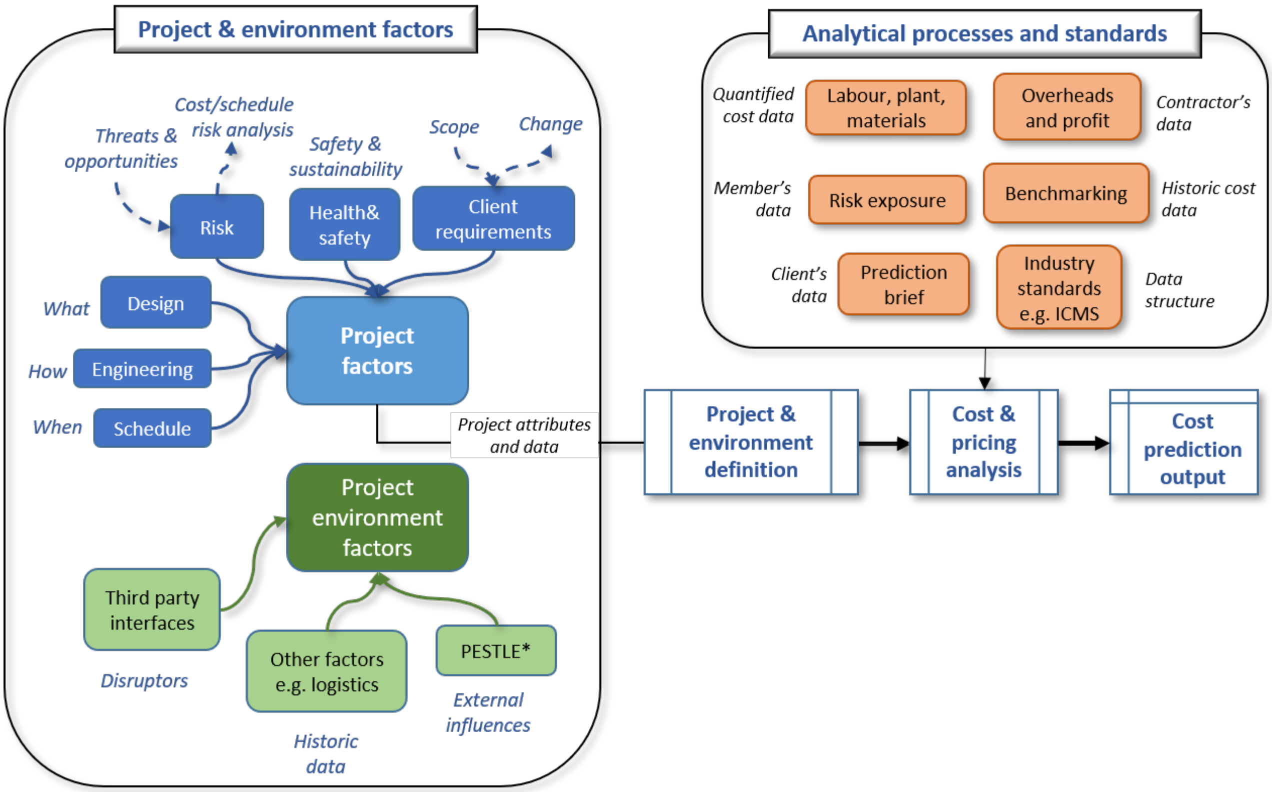


Figure 7: Process flow diagram – a sequential flow of project and environmental factors

Figure 8 highlights the cyclical nature of the process. The transformation triangle identifies the different data and techniques that are used to reach the output stage.

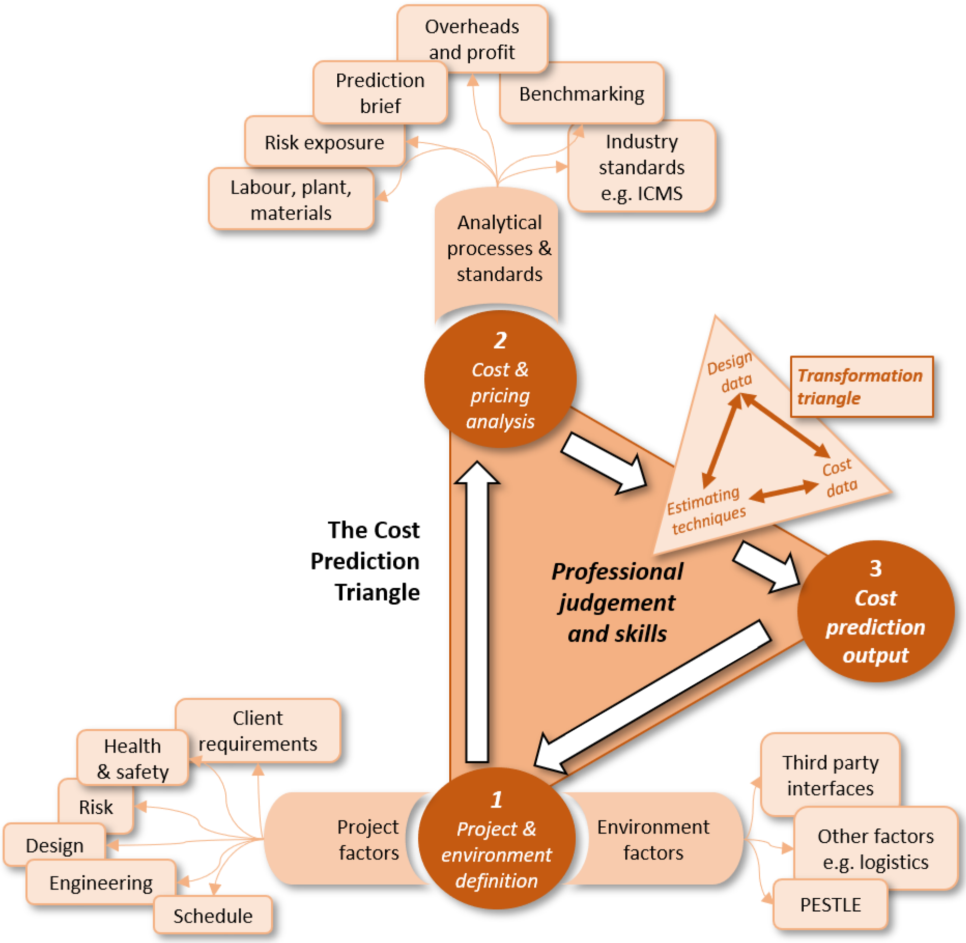


Figure 8: The cyclical nature of the cost prediction process

### 3.1.3 Outputs

Outputs at the different levels in the cost prediction process reflect the maturity of the inputs. In the early levels, some inputs may be sparse and inputs will lack design and specification details, so any assumptions should be clearly defined. As the project data and information evolves, more clarity will be possible at the later levels.

Levels of accuracy and uncertainty should be considered. It is stressed that the indicative accuracy cannot be inflexibly applied and is dependent upon knowledge of a particular market and sector, and the availability and relevance of data. Indicative accuracy will also depend upon factors such as the maturity of inputs (see Table 3), how repetitive or bespoke the design solution is, macro-economic volatility and the forecasting period of the cost prediction (particularly with life cycle costs). It is important to recognise that initial estimates may be produced at different points in the project life cycle and that the uncertainty relating to costs can differ widely across projects. Therefore, both these factors will affect whether an early project estimate is mature, and, if not, when (and how quickly) it is likely to become so.

| | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Information completeness | 10% | 10–30% | 30–50% | 50–70% | 70–90% | Varies |
| Typical prediction method | Historical information, judgement | Parametric estimate | Semi-detailed unit costs | Detail (quantity based) | Detail (based on quantity and full specification) | Economic evaluation |

Table 3: Cost levels in relation to information completeness

RICS members and RICS-regulated firms should submit a client report at every level, if required, to clarify what information has been used and the assumptions made.

For life cycle cost predictions (Levels 1–6), the prediction of future costs for renewal, operation, maintenance and end of life will have key assumptions about the real and nominal discount rates being applied and the life expectancy of components over different periods. Level 6 is a whole-life exercise undertaken from conception to disposal. For more information see the current edition of **Life cycle costing,** RICS guidance note.

## 3.2 Uncertainty

Uncertainty is a lack of complete certainty. In uncertainty, the outcome of any event is entirely unknown, and it cannot be measured or guessed; there is no background information on the event. Uncertainty is not an unknown risk.

Studies have shown that the wide range of data sources that provide cost information increase uncertainty. RICS members and RICS-regulated firms should consider how the data has been collected, by whom, when and for what purpose. Once the data is collected it will need to be normalised to realign the different formats and sources effectively.

Uncertainty occurs for six principal reasons in cost prediction:

1. There is uncertainty in quantifying the impacts of any PESTLE factors during the cost prediction. There is, of course, no better example than the on-going COVID-19 pandemic.
2. Historical costs reflect the unique design and physical characteristics of a project in the market conditions of that time. The costs need updating and re-basing to take account of the impact of time. Two aspects of re-basing are necessary: re-basing to present day costs; and re-basing into the future to take account of inflation and market conditions. Re-basing uses cost indexes, which by their nature contain uncertainty.
3. The ability to interpret design information and project requirements depends on professional experience and situational knowledge. The time given to produce the cost prediction can also affect accuracy and reliability: insufficient time means hasty – and occasionally inaccurate – decisions may be made.

4 Programme delays increase uncertainty. Delays in statutory processes and approvals, site acquisition, design, approval and client decision-making can all change the project's programme and the cost prediction should reflect the impact of these delays.

5 Macroeconomic factors and the cyclical nature of the construction industry. Prices rise when work is plentiful, whereas wages and prices fall when less work is available.

6 Complexity of the project delivery process. Complexity is multi-dimensional – complexity in the design and construction process is difficult to measure and difficult to cost.

Uncertainties can also lead to risks in cost prediction, such as:

- scope and frequent design changes
- unforeseen ground conditions not reflected in the site investigation
- exceptionally adverse weather
- increases in the future cost of energy, climate change, future changes in technology and standards – arising in the renewal, operation, maintenance and end-of-life stages.

Project capital cost can never be certain until project completion when the out-turn cost is agreed. RICS members and RICS-regulated firms should be more than process-driven: an accurate cost prediction requires professional competence, knowledge, skill, experience, and expertise to interpret, analyse, and assemble the relevant information and deal with uncertainty in a transparent way.

## 3.3 Risk

Risk is an uncertain event that affects the achievement of the project's objectives. ISO 31000:2018 defines risk as the 'effect of uncertainty on objectives'.

The cause of any risk needs to be analysed to understand its potential effect (Figure 9). A risk can be measured with its likelihood (probability) and consequence (impact). Sources of risk should be identified with appropriate allowances reflected in the cost prediction, including any methods of analysis.

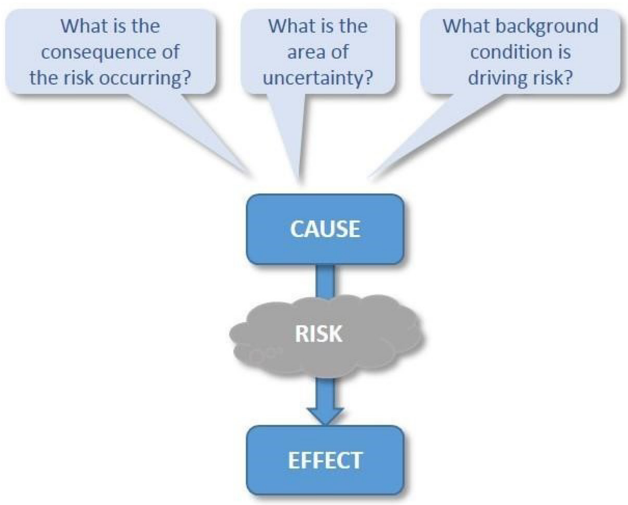


Figure 9: Process of cause, risk and effect

Common practice has been to express risk allowances as a contingency or as a percentage mark-up on the cost prediction to allow for the unexpected. This approach can be improved through a risk management process.

Allowances are added to a project budget as items of possible expenditure, and then monitored throughout the project. The total project budget is a base estimate of known elements plus risk and contingency allowances (the former being the identified and valued risk items, i.e. the risk allowance).

As the cost prediction process moves through the cost prediction stages (Level 1 to Level 5, with Level 6 over-arching this range), project risks will decrease. However, some items identified as risks at an earlier stage might be resolved and their value added into the cost prediction or eliminated if the risk is mitigated at zero.

Risk can present both an opportunity and a threat. An opportunity may arise if there is a change in the brief, the design, the budget or duration. Risk management may be undertaken through the use of value management with the VM facilitator identifying opportunities (as well as risk) in the VM process.

More about risk can be found in the current edition of **Management of risk**, RICS guidance note.

## 3.4 Allowance for risk and uncertainty

This involves assessing the impact of any risk source and the cost implications of each risk event. There are two basic approaches that may be used either together or separately, as required:

- **Qualitative risk analysis** assessing the likelihood of occurrences and their impacts and consequences.
- **Quantitative risk analysis** requires estimating the probability of occurrences and modelling the costs arising from them.

A qualitative risk analysis could be carried out by assigning the likelihood, impact and consequences of each occurrence to the items in the risk schedule, using professional judgement and experience.

In some cases, a more structured quantitative analysis is appropriate: the probability of each occurrence is estimated and a probability distribution of the consequent costs is defined. Typically, these models can only be evaluated by Monte Carlo simulations using specialist software.

Results of such simulations can be summarised by stating a few quantiles of the distribution of projected costs. For example, the project cost has a probability of 50% of exceeding the 50th percentile (P50) or median. Similarly, the costs will have a probability of 90% of exceeding the 10th percentile (P10) and just a 10% probability of exceeding the 90th percentile (P90). A confidence interval can be described by saying that there is a 90% probability that the project value lies between the 5th and 95th percentiles (P5–P95). An example of this approach is shown in Figure 10.

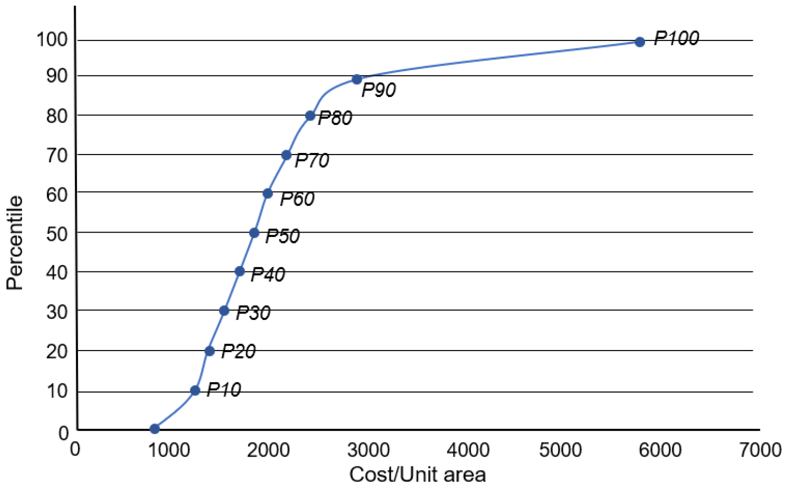


Figure 10: Cumulative distribution of cost for office projects in UK (source: BCIS)

Probabilistic contingency allowances can also be assessed by using a common curve (see Figure 11) at a percentile appropriate to different clients or organisations depending upon their risk appetite.

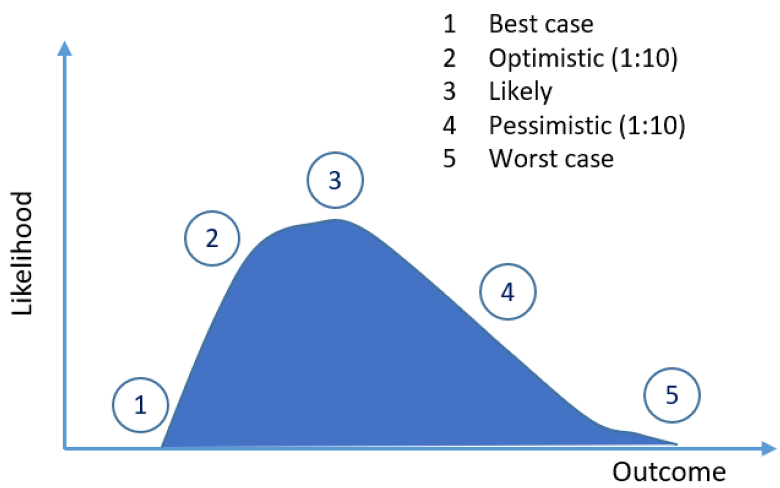


Figure 11: Cost distribution curve

As an approach to predicting 'unknown unknowns', Reference Class Forecasting is a method of estimating based on comparison with other projects in the same Reference Class. It takes an 'external' view of a project estimate based on historical records of similar projects, rather than the more usual 'internal view' in which cost estimates are built up uniquely from scratch for each project. A Reference Class is a class of project for which the distribution of variances from forecast have the same statistical distribution within given limits such as a bridge or tunnel (Flyvbjerg et al., 2016).

The specific and on-going COVID-19 pandemic has resulted in specific data collection to asses the impact of loss of productivity and other factors on costs. The **Construction Leadership Council** in the UK has developed an example toolkit.

## 3.5 Minimising bias

Cost prediction uses rational reasoning to assemble the data and a structured approach to meet the objectives of the client. Bias should be considered in the process and includes the following:

- **Optimism**. A tendency to be over-optimistic, overestimating favourable and pleasing outcomes. Optimism bias is an established fact. Some governments require predictions to include an allowance for optimism bias: 'There is a demonstrated, systematic, tendency for project appraisers to be overly optimistic. To redress this tendency appraisers should make explicit, empirically based adjustments to the estimates of a project's costs, benefits, and duration.' (HM Treasury, **Supplementary Green Book Guidance**, UK, 2003). The phenomenon of optimism bias has growing credence. See also section 6 for further information.
- **Anchoring**. A tendency to rely too heavily, or 'anchor', on one piece of information when making decisions. This can happen when there is a focus on only one type of project from which there is a wealth of historical data for benchmarking.
- **Confirmatory**. A tendency to focus on, remember or search for information in a way that confirms preconceptions. Using data that 'fits' a particular cost prediction/expectation is readily accepted, while counter intuitive data may be rejected.
- **Unconscious**. A bias that we are unaware of, and which happens outside of our control. In cost prediction this could be, for example, where complacency develops by being very familiar with a particular type of project.

These typical biases may lead to:

- trade-offs between the present and the future
- misperception of risk and uncertainty
- poor decision-making
- ignoring lessons learned.

# 4 Data

## 4.1 Data overview

Data used in cost predictions may be quantitative or qualitative, historic or current. RICS members and RICS-regulated firms should consider the following factors when using data:

- origin
- completeness
- validity
- consistency
- timeliness
- accuracy.

Quantitative data expresses an amount, quantity, or range (such as metres or cost), while qualitative data describes the attributes or properties (e.g. form, function, specification, complexity, methodology and programme) that an object possesses. These may be categorised into classes or assigned numeric values to represent the attributes of the object concerned.

Data can originate from any stage in the project life cycle, but clearly market-based data from the supply side of the industry (contractors, subcontractors and suppliers) has more validity in forecasting costs than data without that provenance. Similarly, out-turn costs will have more validity than tender costs.

## 4.2 Putting data, information and knowledge into perspective

Quantitative data has little meaning unless there is an understanding of how it relates to the cost. Unit prices can be derived from pricing principles but should be benchmarked against other projects to ensure there is a range under consideration.

The scope, quality and accuracy of the available data depends principally on what data has been gathered and analysed from previous projects, plus data available for the project under consideration. Consideration should be given to the direct origin of the data – is it obtained from a market-tested construction contract, another estimate, or a construction claim? Clearly, data obtained directly from the market and a consistent approach are preferable approaches.

RICS members and RICS-regulated firms should ensure that the data source is as robust and as relevant as possible, with its source recorded when drawing on data or benchmarks, and that 'comparable' projects are truly comparable, i.e. they have the same attributes and values.

## 4.3 Data structure

For construction and life cycle cost data, ICMS provides a high-level data structure that can be linked and mapped to more detailed international and local market structures published by national bodies and professional bodies. ICMS provides a standardised way of comparing cost data to enable consistent and comparable analysis. Internationally recognised structures for design and asset classification include Omniclass, MasterFormat, UniFormat and Uniclass and ICMS can also be mapped to these.

## 4.4 Data metrics

Once the data has been captured it needs to be normalised. The metrics used can be high-level, for example, a cost per unit area or length, or detailed quantities of individual construction components. They should eliminate the effect of scale, providing constant values which can be directly compared between projects.

## 4.5 Data acquisition

Data is valuable; increasing levels of data has led to better data analytics. Figure 12 shows the evolution of predictive analytics from what has happened to what will happen and how to make it happen. A higher degree of understanding across the process can add to business value. Data has become an important source of revenue for some organisations. However, it is not the amount of data that matters, it is the quality of the data and the ability to analyse it that is important.

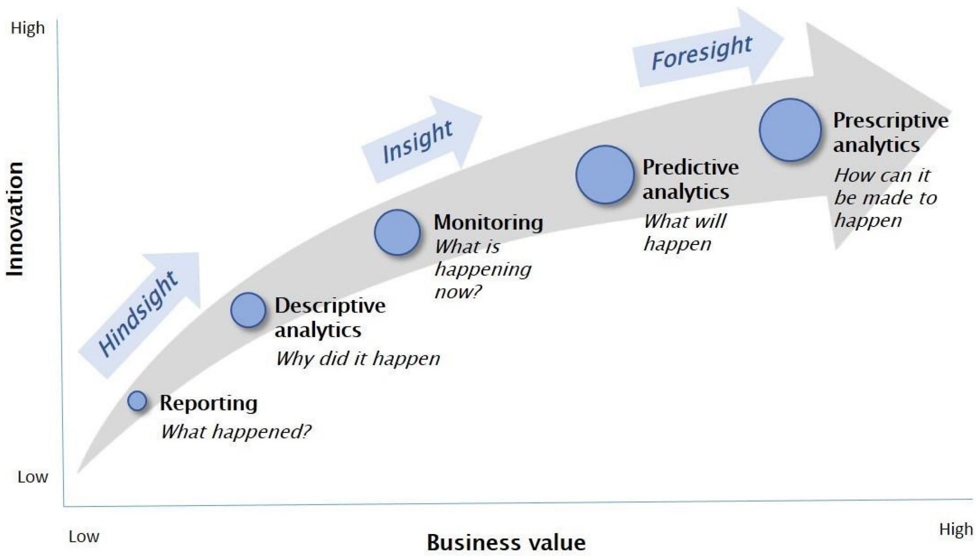


Figure 12: The evolution of business value

Access to good quality data improves decision-making ability and prediction accuracy.

For example, the contract documents can be structured in such a way (using ICMS) that the bid is prepared in a format that will enable future benchmarking. However, although organisations like to have access to shared data there are constraints on sharing data within the industry.

The principal reasons for the scarcity of analysed cost data in the construction industry are:

- commercial sensitivity
- the cost of producing the analysis

- non-disclosure requirements in construction contract documentation
- non-disclosure in client agreements with consultants
- rules of disclosure are complicated and can be difficult to interpret.

Commercial sensitivity arguments against sharing data are sometimes misplaced and should be weighed against the risk reduction provided by sharing. Concerns can be alleviated by anonymising data, but the uniqueness of building projects and the fact that base date and location are fundamental to comparing cost information make this difficult. The exception is public sector work where information is in the public domain or is subject to freedom of information requests. Fees may be payable for access to such information, but it can still provide a valuable source of data.

### 4.5.1 Data provenance and quality

Data analysis, i.e. the process of identifying and analysing historic costs according to a defined standard such as ICMS, should be undertaken routinely. The detail available for analysis is dictated by the format and availability of cost data generated by the procurement and cost control processes associated with the project. Even when documentation is sparse, it is worthwhile analysing and recording what is available to support future cost prediction.

### 4.5.2 Incompleteness

Care should be taken to ensure that the scope and context of any cost item is understood before it is used in the prediction process. This is particularly important when combining cost data from different sources: different standards may both use the term 'roof' but have different rules about which costs are included under this term.

Checks should be made to ensure that costs cover the complete scope of the work. To achieve this, it is useful to compare the cost prediction with high-level functional benchmarks from analysed projects, which can provide checks for completeness.

### 4.5.3 Timeliness

As building technologies and construction regulations develop, construction methods and costs respond. Older data becomes less relevant; long time lags between the date when costs are current and the date when these costs are used for prediction can introduce inaccuracies. As a consequence, the most recent data is most valuable to support cost prediction.

### 4.5.4 The virtuous cycle of data

Reliable and accurate data relies on a constant process of feedback. This can be seen as a virtuous cycle of acquisition of market-tested data, classification and analysis of the data to provide re-usable values and the use of those values to support accurate cost prediction for future projects.

## 4.6 Data sources

To provide a complete framework for accurate prediction, the data should include measures of variability due to inflation/deflation and location, in addition to historic construction cost data. In some jurisdictions more detailed statistical information may be available allowing greater finesse in the prediction process.

Data sources include:

- private cost data sources such as Building Cost Information Services (BCIS), Engineering News Record (ENR) and Data Centre Dynamics (DCD); and price books such as Spon's and RS Means
- international, national and supranational agencies such as the Organisation for Economic Co-operation and Development (OECD) and the World Bank Group
- professional bodies
- clients who collect data about their projects to compare their performance
- consultants
- contractors and material component suppliers
- specialty contractors and service providers.

## 4.7 Data curation

To predict the future, there is a need to understand the past. The pace of change in the construction industry is increasing and the time lag between the predictive 'target' and reference information for future projects will shorten as a result. RICS members and RICS-regulated firms should understand the origin and history of the data that they are using. It is increasingly important to obtain the most recent data by shortening the time between project completion and the analysed data being available for new project cost predictions.

RICS members and RICS-regulated firms should be confident about the provenance and status of historical data. Table 4 shows the steps towards achieving data integrity, representing a typical 'four lines of defence' approach. All these processes are important, but context is critical – without context the data can be rendered meaningless.

| Selection | Logic | Integrity | Context |
|---|---|---|---|
| Ensure only appropriate projects are considered for entry in master data set<br><br>Maintain central register of projects and consistent naming convention of files<br><br>Chase initial files from projects and business network to identify new projects for inclusion | Test completeness to ensure all essential information has been provided<br><br>Test self-consistency to identify any flaws or inconsistencies<br><br>Work with data provider to address any issues before approving data set | Apply cost management expertise and techniques to analyse data<br><br>Identify and explore outliers and rebase data using cost and/or location indices<br><br>Work with data provider to address outliers or any other issues with data | Visualise data in context of master data set of comparable projects<br><br>'Sense check' the data with providers<br><br>Commission manager to approve and 'own' data as valid, accurate and reliable |

Table 4: Achieving data integrity

## 4.8 Re-basing

Baselining is the recording of early project estimates so that they can be compared to actual results later. Baselining may occur more than once.

Re-basing data points, for which different measurement techniques may have been used, is necessary to make all records in the dataset comparable and consistent. It is important that data used in each exercise is re-based consistently, with each provider having a clear understanding of the re-basing requirements. Data points may also need to be re-based if different techniques were used. Other factors to be considered when re-basing are risk, uncertainty, contingency, inflation and international data.

Re-basing is carried out as part of the preparation of a baseline cost prediction.

### 4.8.1 Time

Some markets experience high inflation or deflation due to the macro-economic cycle, or extraneous shocks suddenly causing large changes in the cost of imported construction materials. As such, adjusting costs for time can be dealt with by applying national construction tender price indices (that measure the trends in the cost of construction to the client), which is a well-used and understood process. Historical reference data should be adjusted to a target base date, usually current day price levels. If country-based construction indices do not exist, an alternative method using appropriate economic data should be applied.

### 4.8.2 Location

Regulation, specification and construction methodology vary between regions. A hierarchy of location factors from the target city, country (then region and finally globally) should be used, depending on the reference information available. Adjustment for international locations will also involve currency conversion.

Adjustment of benchmarking data for regulatory variation is not normally undertaken. The context simply needs to be considered. Variability of regulation, specification and other key commercial 'drivers' should be addressed in a predictive model (in the early stage of development).

### 4.8.3 Adjusting for major drivers

Once the major cost, location and time drivers for a given asset or facility type are identified, grouped and classified they can be recorded and their impact on the cost of the project assessed. This process can, and should, be repeated through a series of iterations and the level of accuracy analysed, assessed and visualised. With good sample sizes and rich data sets, the confidence intervals for predictions at an early stage of development could be reduced significantly. The RICS **Building Cost Information Service** can offer advice on these adjustments.

## 4.9 Digital construction

### 4.9.1 BIM

The advent of BIM provides opportunities for standardisation of cost data. However, sharing of BIMs between participants in a project, and the potential sensitivity of cost data and liability issues, makes participants reluctant to embed cost data directly into shared BIM. Therefore, cost information is more likely to be held in separate systems linked to the model rather than in the model itself. Partial solutions for the management of cost data can be seen in the IFC standard for BIM data, which has mechanisms for the quantities, resource costs, and classification necessary for cost prediction.

| Cost prediction level | BIM Level of Detail (LOD) | LOD content |
|---|---|---|
| 1. Level One estimate | 1 | Block model with performance requirements, site constraints. |
| 2.Level Two estimate | 2 | Concept or massing model including basic areas and volumes, orientation and cost. |
| 3. Level Three estimate | 3 | Generalised systems with approximate quantities, size, shape, location and orientation. |
| 4. Level Four estimate | 4 | Technical design model. Accurate and coordinated modelled elements that can be used to estimate costs and check regulatory compliance. |
| 5. Level Five estimate | 5 | Model suitable for fabrication and assembly, with accurate requirements and specific components. |
| 6. Level Six estimate | 6 | Details of how the project has been constructed, for use in operations and maintenance. |
| | 7 | Asset information model for operations, maintenance and ongoing monitoring. |

Table 5: Cost prediction and BIM levels

ISO 19650 Building Information Modelling is an international standard for managing information over the whole life cycle of a built asset BIM. It provides recommendations for a framework for all stakeholders to manage information including exchanging, recording, versioning and organising. It can be applied to the whole life cycle of any built asset and adapted to assets or projects of any scale and complexity. BIM information levels can be aligned to the Information Stages described in Table 5.

Quantification from BIM is one area where additional data can be sourced to support analysis of costs. Some work has been done on standardisation of the extraction of quantities from BIM but, in general, these are literal measurements of dimensions and do not necessarily follow an accepted standard method of measurement (for example, no deductions of columns from the floor area). Counts of items in the design are generally reliable but anomalies can arise when extracting lengths, areas and volumes, depending on the software tools used to prepare the design and extract the quantities. The drawing techniques used to produce a design can also affect quantities extracted from 3D models. Care should be taken to ensure that these quantities are in accordance with the applicable measurement rules.

By leveraging the 3D information model, RICS members and regulated firms can achieve:

- fast and efficient quantity validation and verification
- rapid processing of design revisions and updates
- more reliable and responsive cost information
- quick cost design options to allow early-informed decisions.

While BIM focuses on the design and construction of a building, digital twinning is the representation of how people may interact with the built environment. The value of digital twins is their emphasis on visualisation rather than virtualisation. Cost prediction, and particularly life cycle costing, could thus be more dynamically improved by using real-time data. More information about digital twinning in a UK context can be found at the **Centre for Digital Built Britain**.

### 4.9.2 Artificial Intelligence

Exponential growth of data has brought manipulative technology such as artificial intelligence (AI) and machine learning (ML) to the fore. AI and ML systems learn from data. Their strength is in their ability to deal with large numbers of potential outcomes by quickly modelling multiple scenarios, working with incomplete data and judging new cases based on the learning acquired from previous projects.

AI can assist in the development of company-specific and industry-wide benchmarks to reduce optimism bias and strategic misrepresentation. It can help the estimating process by:

- classifying and categorising unclassified cost data
- developing statistical models for parametric estimating
- identifying reference class projects.

After this process of supervised learning and testing, inputs for a new building project to predict the cost by using the trained artificial neural network (ANN) can be used. All this would still be subject to professional scrutiny and judgement in terms of data inputs and the cost prediction output.

For analogous estimating it is vital to identify comparable historical projects that can be used to estimate the cost of a new project. Identifying and recalling the comparator project can be enhanced by using case-based reasoning (CBR), which is another form of AI.

In CBR, a historical database of projects is used to 'retrieve' a similar project by matching a set of project attributes using a metric called similarity index. The project estimation information and knowledge from the retrieved project are 'reused' to arrive at a preliminary estimate. The values from the retrieved data are called the 'suggested' cost data, and the resulting solution is called the suggested solution. This solution is further improved via the 'revise' process, which leads to the confirmed data for the cost estimate. The new project itself is 'retained' in the historical project database as a learned case or project for future use.

AI-based predictive tools can harness the power of cost data that idly sits in an organisation's estimating systems, cost management systems and procurement systems. These tools can inform early-stage cost advice for new projects and provide more resilient cost estimates. Market conditions and economic factors such as commodity prices can also be brought into the mix to allow professionals to consider an outside view.

With large sample sizes and a 'rich' set of drivers captured, manual or ML and AI techniques can be used to create a predictive model. Whether manual, or AI or ML techniques are adopted, a training set of data will be required to create the model and an application set used to test the accuracy of the model. In terms of whether AI supports, or automates, decision-making, questions of ethics arise (see RICS insight paper **Artificial intelligence: what it means for the built environment** for more information).

# 5 Output

## 5.1 Using ICMS

ICMS provides a high-level cost reporting framework and includes templates that can be used by RICS members and RICS-regulated firms. RICS members and RICS-regulated firms should also refer to the **RICS ICMS Explained user guide**.

Clients may require that costs are reported in their own local corporate 'trading' currency and appropriate dual reporting of costs may be required. Likewise, consideration should be given to the possibility that projects could be reported on a common currency basis.

This cost prediction should be adjusted for external environmental factors, e.g. location and re-basing, and also the size and scale of the project. ICMS has a cost classification function, so that individual cost groups or sub-groups (if applicable) can be identified and tabulated to arrive at the overall project cost.

The standard classification provided by ICMS enables the collection of global cost data to inform cost comparison between markets and cost prediction for future projects. This provides the opportunity for true global benchmarking and prediction of construction costs by RICS members and RICS regulated firms.

When providing the client, or senior management, with more detailed predictions, procurement evaluation and post-contract financial reporting, there will be a clearer means to compare different cost models and run 'what-if' scenarios for a change in circumstances.

At project completion, the out-turn cost should be calculated; this serves as the basis of the final cost reporting to the client. Individual project costs can then be added to a database for reference and future use.

ICMS has been mapped to various other, more detailed, national standards, including NRM, CESMM, Uniclass and Uniformat (See Appendix A of the ICMS Explained user guide).

## 5.2 Communication and dissemination

### 5.2.1 Project culture

The client briefing and the general project culture should be considered. Does the recipient require a confidential system of reporting? Is the project engendering a collaborative culture where information exchange is encouraged in a transparent and consistent way?

If the report is to be distributed in draft prior to issue, the relevant internal and external stakeholders should be identified. The cost prediction will be based upon information from various sources, including design team members, specialist designers and supply chain members. RICS members and RICS-regulated firms should engage with and obtain comments on the cost prediction from these stakeholders. A cost prediction report is not an isolated document – it reflects the strategic planning, design and methodology set by the client and members of the design and construction team.

### 5.2.2 Communicating the report

Ascertain who the audience is for the report – will it be reviewed by the company board, a senior manager or another construction professional (e.g. project manager)? The form of communication should be considered in terms of the project culture and identified stakeholders – different methods of communication may be applicable depending on the stakeholder, timing and formal project requirements. Wherever possible, RICS members and RICS-regulated firms should explain the report face-to-face in a meeting (or virtual conference), rather than by email or post where no dialogue and feedback is possible.

### 5.2.3 Report frequency

The timing and frequency of reporting should be established. Some organisations require reporting in set time periods (e.g. monthly), or timing may be subject to the available information and changes in that information. RICS members and RICS-regulated firms should ensure expectations are managed in terms of the timing and frequency of reporting and that the timing of dependencies, particularly in terms of inputs, is agreed by all relevant participants.

## 5.3 Report presentation

While the report presentation will vary depending on the client or senior management requirements, the project stage and an organisation's corporate templates and quality assurance, the cost prediction report may typically include the following headings and features:

- Project title, client details and date.
- Executive summary with details of changes since the last report and required actions.
- Project description of scope and status.
- Project participants and roles.
- Project timeline and client decision-making milestones.
- Basis of prediction, assumptions and exclusions.
- Estimates and cost predictions for ICMS reporting level as agreed for the project.
- Risk register.
- List of documentation used.
- Description of the interface with BIM models.
- Communication and agreement with design team.
- Communication and agreement with client.
- Recommended management action.

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# Appendix A Typical inputs and processes

| Inputs | Information required in order to prepare the predicted cost |
| --- | --- |
| Functional output (end-product) | Data derived from the activity, purpose or requirements to define the construction/production project. |
| Needs/benefits (business case) budget envelope | The amount of money that is required or available for a purpose/project and the way it can be expended. |
| Briefing (of cost prediction) | The extent of the task/activity that has been assigned by the client. This may include the prediction of capital construction costs, associated capital costs and life cycle costs. |
| Time (duration/schedule) | The time allowed to deliver the remit. |
| Basis for quantification (concept/design) | The expression or measurement of the quantity based on the stage of the design. |
| Specification/quality | A detailed description of the design and materials used to build the project. |
| Assumptions (for each input) | A thing that is accepted as true or as certain to happen, without proof. |
| Exclusions (relate to each input) | An item or eventuality that is specifically not covered or included. |
| Site-related factors (locality, ease of access) | Site or location specific factors that can affect the processes, systems, sequences or methods to deliver the project. |
| Procurement strategy (including contract type) | A plan of action designed to achieve a long-term or overall aim to obtain or deliver the project. This will include the most suitable form of contract or process to meet the needs of the client and to successfully deliver the project. |
| Funding basis/strategy (link to business case) | The money or finance provided, and the basis upon which it is provided, by an organisation or government for a project. |
| Supply market conditions/ construction economy | The supply/demand for a commodity or service at a given point in time in the project. |
| Build methodology | The system, sequence or construction methods used in a project. |

| Inputs | Information required in order to prepare the predicted cost |
|---|---|
| Third party interfaces | The point where an external party's systems/subjects/organisations meet and interact. |
| PESTLE | The impact of political, economic, social, technological, legal and environmental issues on the cost of the project. |

| Process | A series of necessary actions or steps to prepare the predicted cost based on the information provided |
|---|---|
| Quantification – design ['the works'] | The expression or measurement of the quantity based on the inputs and the project design. |
| Quantification – duration | Quantification of the timescale to develop and complete the works. |
| Quantification – locality | Measure of synonymous or inter-related works/activities related to the project location. |
| Quantification – facilitation | Quantification of supplementary or enabling works to facilitate/deliver the project. |
| Rates – design ['the works'] | The cost based on the available inputs, measurements and design. |
| Rates – duration | Time related costs associated with the duration of the project works. |
| Rates – locality | Costing of synonymous or inter-related works/activities related to project location. |
| Rates – facilitation | Costing of the supplementary or enabling works to facilitate/deliver the project. |
| Productivity (factor on rates) | Rate of production by an individual/workforce based on project duration and restrictions. |
| Review/validation | Relevant tests/comparisons against benchmarks for all elements of the cost prediction output. |
| Experience/judgement | Review, reflection and validation with peer review where possible. |
| Benchmark | Test the output against a standard or point of reference with which things may be compared. |
| Assumptions | A list of things that is accepted as true or as certain to happen, without proof, that is included in the cost. |
| Exclusions | A list of items or eventualities not covered or included in the cost. |
| Risk | A probability or threat of liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, errors or oversights and that may be avoided through pre-emptive action. |

| Process | A series of necessary actions or steps to prepare the predicted cost based on the information provided |
|---|---|
| Temporary works | Non-permanent work or activity that is necessary for the completion of the permanent construction work or project. |
| Complexity | The relative intricacy of a project or subproject by reference to its form, design, site constraints, method or timing of construction. |

# Appendix B Examples of inputs

| Inputs | Definition and likely content |
|---|---|
| Functional output (end product) | Hotel with x nr of rooms |
| | Office with x $m^2/ft^2$ of GIFA |
| | Hospital with x nr of beds |
| | School suitable for x nr of pupils |
| | Station to support x nr of passenger trips per annum |
| | Railway route to support/increase x nr of trains per hour/Estimated Million Gross Tonnes Per Annum (EMGTPA) |
| | New station to support housing development/'new town' |
| | Power station to provide x Kw increase in capacity |
| | Refinery to provide capacity for transforming x barrels of oil into x per year |
| | Road average speed to be increased by an average of 10 mph between locations x and y |
| Business case/client requirement (level one) | Helps to prioritise key outputs of the capital expenditure and the relationship to the benefits they may provide (can help to understand the output priorities when solution options are being developed and costed) |
| | Understanding of the benefits possible/desired can help to define a potential 'funding envelope/budget' |
| Briefing (of cost prediction) | Cost output requested by client in ICMS breakdown |
| | Remit (technical work scope) that the 'designers' are provided to produce a solution for capital cost, life cycle cost, acquisition costs, or all three |
| | Capital cost and/or life cycle costs |
| Programme (duration) | Anticipated duration to deliver the client remit - to represent all of the defined remit or only the capital cost element |
| Concept/design | Words, Sketch, CAD, BIM |
| Assumptions | Input assumptions (not pricing assumptions), e.g. the site will be fully available for works to start from date x |
| Exclusions | Input exclusions, e.g. the cost should not include 'local' taxation requirements – this will be addressed by the funding client |
| Locality – ease of access | City, field, island, etc. |
| | Road locked, rail locked, no existing transport access, etc. |
| Procurement strategy (including contract type) | For capital cost this will affect the apportionment of risk between end client/funder and the delivery organisation and supply chain |
| | Is the client funding directly, indirectly (banks/markets/PFI(PPP), etc.) |

| Inputs | Definition and likely content |
| --- | --- |
| Funding basis/strategy | Funding in stages or in full – interim finance and or time delays, e.g. pre-defined government stages |

# Appendix C Examples of processes

| Process | Definition and likely content |
|---|---|
| Quantification – design [the works] | Quantity derivation of the scope to a level of detail dependent upon the stage of maturity of the inputs |
| | Recognised method of measurement should be used, e.g. NRM |
| Quantification – duration | Quantification of the timescale to develop and complete the works (weeks, months, years, etc.) |
| | Also provides sequence of work activities that can help to inform the risk register |
| Quantification – locality | The 'measure' and quantification of works that impact the main works delivery, e.g. land area purchase needed, consents and planning requirements, etc. |
| Quantification – facilitation | Time related costs, e.g. design project management – during development stages and client's representative |
| | Plant and/or off-site equipment that will form part of the final deliverable, e.g. processing plant equipment, trains |
| Rates – design [the works] | The main works (not limited to the cost of design) pricing the quantified measure of the works appropriate to the project maturity/level of detail available |
| Rates – duration | Time-related costs that 'price' the 'duration', e.g. time-related contractor preliminaries |
| | Some sectors may use this as their primary pricing 'perspective', i.e. price the programme rather than pricing a quantified bill of quantity |
| Rates – locality | The costing of the quantified works that impact the main works delivery, e.g. land area purchase needed, consents and planning requirements, etc. |
| Rates – facilitation | Quantification of the time-related costs, e.g. design project management – during development stages and client's representative |
| | Quantification of the plant and/or off-site equipment, etc. that will form part of the final deliverable, e.g. processing plant, equipment, trains |
| Productivity (factor on rates) | Key variable to set a basis of productivity of aspects of the works, e.g. piles per shift, $m^2$ brickwork per shift. Key when working hours are restricted, e.g. railway works where price is derived by shift cost |
| | Direct dependency on the planned programme (schedule/duration) of works depending upon the level of maturity of the programme |
| Review/validation | Relevant tests/comparisons against benchmarks for all elements of the cost prediction output |
| Experience/judgement | Review/governance before release to client |

| Process | Definition and likely content |
|---|---|
| Benchmark | Test the output produced against benchmarks to validate and/or result in review and update of the cost prediction output |
| Assumptions | Lists/statements that describe the scenario that the cost prediction is based upon – included in the cost |
| Exclusions | Lists/statements that describe the scenario that the cost prediction is based upon – not included in the cost |

# Delivering confidence

We are RICS. Everything we do is designed to effect positive change in the built and natural environments. Through our respected global standards, leading professional progression and our trusted data and insight, we promote and enforce the highest professional standards in the development and management of land, real estate, construction and infrastructure. Our work with others provides a foundation for confident markets, pioneers better places to live and work and is a force for positive social impact.


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