



2016-03-11

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Recommended Citation

Cunningham, T. (2016) *The Function and Format of Bills of Quantities:an Irish Context*. Report prepared for Dublin Institute of Technology, 2016.

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THE FUNCTION AND FORMAT OF BILLS OF QUANTITIES – AN IRISH CONTEXT

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Introduction

The production of bills of quantities (referred to as bills for the rest of the study) as a means of obtaining tenders has traditionally been viewed as perhaps the primary function of the quantity surveying profession. Hore, O’Kelly and Scully (2009) trace the historical development of bills in Ireland from the mid eighteenth century. They report that, at that time, it was customary for the various master-craftsmen to submit their labour and material accounts on completion of their work. (This procedure resembles contemporary cost reimbursement payment arrangements). In the course of time, it became common practice for ‘measurers’ or ‘surveyors’ to prepare these accounts. This arrangement, however, provides building sponsors with little certainty as to out-turn costs and exposes them to the risk of exaggerated and extravagant payment claims from unscrupulous contractors.

The increased demand for building work in the wake of the Industrial Revolution (Hughes, Champion and Murdoch 2015) and Napoleonic Wars (Cartlidge 2013) led to the emergence of the general building contractor in Great Britain and Ireland. Contractors developed the practice of submitting all inclusive estimates covering the work of all trades, based on the architect’s designs, before being appointed to carry out the work. The contractors came to employ quantity surveyors (QS) to carry out this function. As the practice of competitive tendering became established, contractors began to combine to appoint a mutually acceptable surveyor to produce a bill on their behalf which each of them would then price (Hore *et al.* 2009). The surveyor’s fee was included in all of the contractors’ tenders and the successful contractor would pay the surveyor’s fee. Building employers quickly realised that as they were, in any event, indirectly paying for the production of a bill, that it would be more beneficial for them to appoint a QS directly as a consultant (Lee, Trench and Willis 2011) and supply the competing contractors with bills for tendering purposes. This approach was instrumental to the development of the modern quantity surveying profession and the approach remains in widespread use to this day.

More recently in the UK, changing employer requirements have led to the greater use of ‘non-traditional’ procurement arrangements which do not require bills to be provided to tendering

contractors. In particular, the increasing use of design-build approaches together with the growing preference among particular employers for arrangements such as drawings and specification contracts, which transfer the quantities risk to contractors, has resulted in a steady decline in the use of bills. Anecdotal evidence suggests that this trend is apparently being replicated, although to a lesser extent, in Ireland.

Cartlidge (2013) comments that bills are occasionally criticised in some circles as being outdated and unnecessary in the modern procurement environment. He believes however, that despite the decline in their use that *'the bill of quantities remains unsurpassed as a model on which to obtain bids in a format that allows: ease of comparison between various contractors, transparency, an aid to the quantity surveyor in valuing variations, calculating stage payments and the preparation of the final account.'* Ashworth, Hogg and Higgs (2013) note that a large proportion of UK contracts still use some form of quantification.

The quantification and costing of construction work remains a core competence required of all chartered quantity surveyors. Cartlidge (2009) argues that the ability to measure, quantify and analyse the items of labour, materials and plant necessary to construct a new project is still a much sought after skill and many would argue that it is the core of the quantity surveying profession. The Sweett Group, a large (leading) multi-national construction cost consultancy company, emphasises their ability to produce bills in-house. They claim that this capability is *'increasingly unusual amongst leading Cost Consultancy firms'*.

This study reviews the nature and use of bills, comments on their contents and format, and explores their use during the various stages of the construction development process. The study discusses the various benefits claimed for the use of bills and in turn examines potential difficulties and criticisms resulting from their use. The information and discussion aims to enable readers to appraise the need for, and usefulness of, bills in their daily practise.

The Nature of Bills of Quantities

'Bills of Quantities shall fully describe and accurately represent the quality and quantity of work to be carried out' (ARM4, 2009) on a building contract. Bills are prepared from the project drawings, schedules and specifications produced by the various design team members, together with answers to queries raised by the QS during the tender documentation process. Bills consist of a schedule of the items of work to be carried out under the contract, with quantities entered against each item. The work descriptions and quantities are normally prepared in accordance

with a particular standard method of measurement. In Ireland the Agreed Rules of Measurement 4th Edition (ARM4) (2009) are the most widely adopted standard method of measurement for building works. When read in conjunction with the tender drawings, bills provide a comprehensive written and quantified description of the works and the conditions under which they will be carried out. Bills may be presented in a range of formats, in Ireland they are usually presented in elemental format (see below).

The Use of Bills of Quantities

Whether a bill is required for a particular project depends on the form of contract to be used. Bills are most widely used where the project is procured under the so-called ‘traditional’ procurement approach, where the employer provides the design which is then constructed by a contractor. There are two principal options associated with the traditional procurement approach: the contract may be arranged on a ‘**with quantities**’ basis, **or** it can be arranged on a ‘**without quantities**’ basis. Bills are typically required where a contract is let on a ‘with quantities’ basis. Contracts arranged on a ‘without quantities’ basis are commonly referred to as ‘drawings and specification’ contracts and bills tend not to be provided under this arrangement. ‘With quantities’ contracts are associated with substantial building projects; whereas drawings and specification contracts tend to be confined to minor works projects.

Bills are generally not provided for design-build procurement arrangements, as under this approach each contractor formulates its own individual proposals in response to the employer’s requirements. The contractor is normally required to provide the employer with a contract sum analysis to support the proposals and the employer may have stipulations regarding the format in which the contract sum analysis may be presented.

Likewise, management procurement approaches where the management contractor is appointed during the design stage, render the need for comprehensive bills unnecessary. Nevertheless, the individual work package contracts constituting the Management Contracting and Construction Management arrangements may be tendered on a ‘with quantities’ basis and ‘mini-bills’ are provided to the various work package subcontractors.

In Ireland, ‘traditionally’ procured private sector building projects are predominantly executed under one of the Royal Institute of Architects in Ireland (RIAI) Standard Forms of Building Contract. The two most widely used RIAI Forms are commonly referred to as the ‘Yellow’ Form and the ‘Blue’ Form. The ‘Yellow’ Form is used where quantities form part contract, and these

contracts require bills. The ‘Blue’ Form is used where quantities do not form part of the contract – these are drawings and specification contracts and do not require bills.

The Liaison Committee Code of Practice for Tendering and Contractual Matters (The Liaison Committee 2006) is regarded as representing best tendering practice for private sector Irish projects. The Code recommends that bills should ‘always’ be provided as tender documents where quantities form part of the contract. The Code notes that contracts may be arranged on a drawings and specification basis in the case of minor building works, but does not specify a monetary threshold in relation to what constitutes ‘minor works’. The Code adds that where quantities do not form part of the contract that a bill or schedule of items should, nevertheless, be included in the tender enquiry. The decision as to whether to contract on a ‘with quantities’ basis requiring a bill is a matter of professional judgement which should consider all the particular factors affecting the project.

In Ireland, the public sector works contracts refer to a ‘Pricing Document’ rather than to a bill *per se*. Guidance on this matter is provided in the *Capital Works Management Framework, Guidance Note, Public Works Contracts, GN 1.5* (Department of Public Expenditure and Reform 2013). The Guidance Note explains that ‘*the Pricing Document enables the Employer to prescribe to prospective tenderers the way they should break down their tendered lump-sum price and to provide details of other tender cost information*’. The value and type of the project determines the appropriate form of contract, and this in turn, determines the need for, and format of the Pricing Document.

- Traditionally procured building contracts with a value exceeding €5 million use the ‘major works’ PW-CF1 Form.
- Projects with a value ranging from €500,000 to €5 million, in the absence of exceptional circumstances, use the ‘minor works’ PW-CF5 Form.
- Projects not exceeding €500,000, in the absence of exceptional circumstances, use the ‘short form of contract’ PW-CF6.

A Pricing Document is provided to the tendering contractors when a contract is let under the PW-CF1 or PW-CF5 Forms. The format of the Pricing Document may vary at the employer’s discretion. For example, it may consist of a formal bill, a pricing schedule, a contract sum analysis, or a single page pricing summary. Guidance Note GN 1.5 adds, however, that ‘*a Bill of Quantities is normally provided as the ‘primary pricing document*’. GN 1.5 continues: ‘*In order to avoid increasing tenderers’ overheads, employers should continue the practice of carefully considering the circumstances that warrant the use of a Bill of Quantities when using PW-CF1,*

... and PW-CF5 forms of contract' (DPER 2013 p.130). The Department of Education and Skills (2013 p.9) is more definitive, stating that the Pricing Document for contracts over €1 million is to be a "*Bill of Quantities –ARM4 with Dept of Finance and DoES approved amendments*" (or as subsequently amended).

The 'major works' Form PW CF-1 and 'minor works' Form PW CF-5 are both, in essence, 'with quantities' contracts and the Pricing Document constitutes a part of the contract documentation for the particular project. However, under both contracts, the Works Requirements (comprising the drawings, schedules and specifications etc.) take precedence and prevail over the Pricing Document in the event of discrepancies or conflict between the various documents. In addition, the contract conditions contain mechanisms to transfer the risk of inadequate work descriptions and erroneous quantities to the contractor. These provisions individually, or taken together, can effectively mean that these Forms operate as 'without quantities' contracts.

The 'short form of contract' PW-CF6 is a 'without quantities' contract arrangement. Contractors tendering for projects using this Form are not automatically provided with a pricing document. Guidance Note GN 1.5 states that '*A Bill of Quantities should not be listed [as part of the documentation provided to contractors] but a pricing document derived from a Bill of Quantities or Schedule of Rates may be included to obtain the rates and prices.*' The Guidance Note continues '*In the case of PW-CF6 a Bill of Quantities may be provided as a tender document or tenderers may be required to prepare one as part of their tender submission but in either case it should not be included as a contract document.*'

The Functions of a Bill of Quantities.

The Aqua Group consider that bills '*have two primary functions. Initially they are used as a tender procurement document to provide a uniform basis for competitive lump sum tenders. Subsequently they become contract documents serving as schedules of rates for the pricing of variations*' (Hackett, Robinson and Statham 2006 p.191). The information contained in bills, however, means that they can be used for a range of purposes, particularly by the contract administrator, the QS and the contracting organisation. The principle functions and applications are explored below.

A Tender Document

One of the distinguishing characteristics of the ‘traditional’ procurement approach is the use of competitive tendering as the principle means of appointing building contractors. Competitive tendering is the norm for appointing private sector contractors and is, in the absence of exceptional circumstances, mandatory for public sector construction projects. Bills are, in essence, tender documents. They are provided to contractors in order to assist them in pricing the proposed project. Providing bills avoids the need for the tendering contractors to measure their own quantities, thereby eliminating work duplication, and reducing the amount and cost of abortive work carried out by the unsuccessful tenderers. On an industry wide basis, these costs can become substantial, particularly where open tendering arrangements are employed or where long tender lists are approved. Abortive tendering costs must eventually be recovered in the form of an increased overhead, which in turn is ultimately passed onto building employers.

As the bills are produced by an independent impartial consultant, identical information is provided to each contractor. Parity of tendering is a key principle of sound tendering practice and the bill creates a ‘level playing field’ amongst the tendering contractors. This principle continues during the tendering period when answers to queries regarding the bills are circulated to all of the tendering contractors. In addition, any contractor who amends the bill without authorization risks having its tender disqualified. The bill, therefore, provides a uniform and transparent basis on which the tenders can be sought, obtained, compared and evaluated.

As noted above, bills of quantities for Irish building contracts are typically compiled in accordance ARM4. This method of measurement is agreed between the professional bodies representing quantity surveyors, the Society of Chartered Surveyors Ireland, (SCSI) and the Construction Industry Federation (CIF) representing contractor’s interests. The Rules are considered to provide sufficient detail to enable contractors to accurately price the building work. In the process of measuring the works, the QS extracts the cost significant information contained in the specification and ‘translates’ this into concise work descriptions. Occasionally the specification may be incorporated in the bill as a separate preamble section (see below). Bill descriptions, therefore, are typically brief and to the point. This characteristic eases the contractor’s task of pricing the work. Descriptions which do not provide full information or depart from the measurement rules must be specifically brought to the attention of the contractor and be described as being not in accordance with ARM4. The rates tendered by the contractor for the various measured items include allowances for waste, general overheads and profit.

A Contract Document

The contract documents record the details of the agreement between the employer and the contractor. The form of contract sets out the conditions under which the work will be carried out and identifies how the principle commercial risks are to be distributed among the contracting parties. The drawings show the scope and detail of the work to be carried out. The bills fully describe and accurately represent the quality and quantity of the work for pricing purposes.

Where bills of quantities are used for tendering purposes they normally become one of the contract documents. The priced contract bills, however, may be different to the tender bills which may need to be adjusted in order to incorporate post-tender amendments arising from further design development, negotiations, or to make cost reductions where the tenders exceed the project budget.

As noted above, bills of quantities are a contractual requirement where the RIAI ‘Yellow Form’ is used, and they typically constitute the Pricing Document where the ‘major works’ and ‘minor works’ public works contracts PW-CF1 and PW-CF5 are used. On smaller contracts where bills of quantities do not form part of the contract, each contractor must measure the works from the tender drawings and specifications in order to submit a price. Here, the contractor will typically measure Builders Quantities¹ as a means of quantifying the work.

Ideally, bills are prepared from fully completed designs, which enables the tendering contractors to quote a lump sum price for the project. This approach provides a high degree of cost and time certainty for employers. On many occasions, however, the full extent of the works cannot be established in advance. For example, ground conditions may require deeper foundations than those shown on the drawings, or the project may involve renovations and refurbishment of an existing building. In these instances, on private sector projects, approximate quantities (also referred to as provisional quantities or provisionally measured (see below) may be included in the bill to cover the likely extent of such works. Such quantities are remeasured on completion of

¹ There are many different approaches used to produce Builders Quantities and there are no mandatory standards of the type set out in ARM4. The quantities are generally not measured as accurately as a tender bill of quantities, they must, however, be sufficiently accurate to enable the Contractor to submit a competitive tender by avoiding the risk of over-measurement. A characteristic of this approach is the grouping together of a number of related work items to form single composite work descriptions. These items would otherwise have to be measured separately in accordance with ARM4. This speeds up the measurement process considerably.

the work and valued at the relevant bill rates. Alternatively the likely cost of such work may be covered by provisional sums and valued in accordance with rules for valuing variations in the contract. Likewise where the employer wishes to appoint particular specialist subcontractors (referred to as nominated subcontractors), prime cost sums (PC Sum) may be included in the bills to cover the subcontractors' cost. It should be noted that the use of PC and provisional sums enable the contract to proceed to site earlier than would otherwise be the case. However, their use undermines cost certainty and, as a result, their use is currently prohibited on public works contracts.

An Aid to Effective Contract Administration.

The bill of quantities plays an important role in the day-to-day financial administration of building contracts by acting as a schedule of rates by which work can be valued.

Interim Payments

The principal Irish standard form building contracts all provide for the contractor to be paid on account as the work progresses. Interim valuations are carried out at four week (RIAI) or monthly (PWC) intervals. The contractor's QS assesses the quantity or percentage of work that has been carried out on the site for each item in the bill and values these at the corresponding rates. The employer's QS checks this valuation and prepares a recommendation for payment to the architect who issues an Interim Certificate authorising payment to the contractor. The bills therefore provide an effective and agreed basis for valuing work in progress, which helps to avoid disputes in this area.

Variations

Most building contracts experience variations which can arise for a variety of reasons. Where the original design or specification is altered the Contract Sum must be adjusted accordingly. The Irish standard forms of contract provide that additional work which is similar in character and carried out in similar conditions to that described in the bills shall be valued at the relevant bill rates. Where the varied work is not of a similar nature or is carried out under dissimilar conditions, bill rates may form a basis for valuing the work. This process involves adjusting the material or productivity component of the relevant bills rates as appropriate. Where there is no basis in the bill for valuing the varied work, rates taken from bills for other local contracts may be used as a basis for agreeing the value of the work. Bills in these cases provide a clear basis for negotiating the value of the varied work.

Fluctuations

The vast majority of Irish building contracts are awarded on a 'fixed price' basis whereby fluctuations in material and labour prices are not adjusted in the final account. The Public Works Contracts are let on a fixed price lump sum basis with no provision for cost inflation or reduction unless the contract time exceeds 36 months, - this is only likely to apply to the largest public works building contracts. Likewise it is standard practice for private sector employers to 'buy out' the inflation risk by negotiating a fixed price premium with the prospective contractor before work commences. Nevertheless, the RIAI contract provides that fluctuations in labour material and plant costs are adjustable. In these instances the bills will included a schedule of basic material costs which acts as a benchmark to value subsequent fluctuation claims.

A Basis for Estimating and Planning the Cost of Other Projects

During the design stage of a project, priced bills for previous projects provide much of the data used to forecast the likely cost of the evolving design. Early project budgets are often based on a cost per square metre of floor area or cost per unit derived from the cost analyses of similar projects. These are adjusted to reflect the prevailing market conditions and to accommodate particular factors such as design complexity, specification levels and location factors affecting the project's costs. These forecasts, although approximate, are sufficient to inform decisions as to whether a scheme is feasible or not.

As the design develops a cost plan is usually produced which allocates the budget among the various building elements (see below). Cost plans seek to optimise the cost balance of the design thereby generating value for money for the building employer. Analysis of bills from similar projects enables the employer and design team to appraise the relative merits of various design options as part of this process. The rates contained in the cost plans are, likewise, sourced from priced bills for similar projects and adjusted accordingly. This cost plan acts as a guideline for cost control and checking of the final design on which the project will be tendered.

A Resource for the Contractor in Managing the Works

Bills may be used by contractors for a range of purposes during the construction phase of a project.

Ordering Materials

Although many bills specifically state that they are not to be relied on for ordering materials, they nevertheless often form the basis on which the contractor's buying department prepares their schedules of materials for purchase or requisition. The contractor, however, must be aware of the following considerations when ordering materials from bills.

- Quantities stated in bills are measured net fixed in position with no allowance made for factors such as waste, laps, consolidation or shrinkage. As a consequence quantities given in the bill are frequently considerably less than the contractor needs to buy to complete the work.
- The units in which materials are bought and the units in which measured items are billed are sometimes not the same. For example hardcore is measured in cubic metres but is purchased in tonnes.
- Post contract variations may mean that the billed quantities are no longer correct.

Procuring Sub-contractors.

Most large and medium sized building contractors often sublet the majority of their work to 'domestic' sub-contractors. Outsourcing work allows main contractors to expand their business and to take on more profit making work, with the subcontractors providing the necessary resources, expertise and equipment. The use of bills facilitates this approach, by enabling the contractor to break down and repackage the bill content and obtain quotations from the various sub-contractors, without undue effort. As the bills have been compiled formally in accordance with ARM4 the sub-contractors do not have to 'interpret' ambiguous descriptions or quantities which may originate in a 'Builders Quantities' type bill. This promotes more accurate estimating.

Bills of quantities also cater for arrangements where the employer wishes to appoint 'nominated' subcontractors to carry out works of a specialist nature, for example, mechanical and electrical engineering installations. In these instances PC sums are included the bills to provide a budget for such work and the contractor is provided with the opportunity to price for profit and any special facilities (attendances) required by the various nominated sub-contractors.

Planning and Programming the Works

The contractor's prices for the various work items in the bill reflects the amount of time the estimator has allowed to complete each unit of work (this is referred to as the labour constant for

the particular item). The contractor can therefore calculate how long it will take to complete the individual work items by multiplying the labour constant by the billed quantity. By analysing the significant time-related work items in the bill, the construction planners can design a planning framework and formulate a programme for constructing the building. The bill, therefore, assists in producing a detailed statement of how the work will be carried out and identifying the necessary resource requirements.

Advantages of Bills of Quantities

The above discussion identifies that the bills of quantities can have numerous practical and beneficial applications during the design, tendering and post contract stages of the development process. However the bill also provides other benefits.

Bills Support Lump Sum Contracts and Cost Certainty

One of the chief benefits claimed for bills is their support in the arrangement of lump sum contracts. Under these arrangements, *all other things being equal*, the contract sum and the final account should be the same. Under ideal conditions, these have the potential to deliver a high degree of cost and time certainty for building clients. This logic underpinned the introduction of the GCCC Public Works suite of contracts in 2007.

Lump sum contracts are suitable where the design has been completed and the works can be ‘fully’ measured in advance. These contracts are characterised by the contractor’s commitment to complete the whole of the work for a specific sum. They operate most successfully where full design/production information is available at contract award stage. Where bills form the basis of the lump sum, they should fully describe the quality and quantity of the work.

The contractor carries the risk for pricing the work. If the contractor prices the work too low, the tendered rates will not be adjusted and the contractor must bear the loss arising from the underpricing. Hughes, Champion and Murdoch (2015) make the following comment in relation to lump sum contracts and rates in bills:

However, one thing remains constant. In all cases, the contractor offers to do the work for a price, not for reimbursement of cost. A contractor who estimates too low is held to the bargain, even if the job runs at a loss. Similarly, for a contractor who estimates too high, the bargain still holds, despite the employer paying over the odds. ... It applies as much to every rate in a bill as it does to the whole contract sum. This is one reason that the bills play such an important role in the management of construction contracts.

Under this arrangement the employer bears the quantities risk; the contractor bears the pricing risk. Incorrect quantities are corrected, incorrect pricing is not.

Bills Prompt Design Teams to Complete the Design

The previous section indicates that lump sum arrangements operate best where the design has been fully developed.

One of the employer's primary duties under the traditional procurement arrangement is to provide the design to the contractor. This is normally achieved by appointing a professional design team to formulate the works requirements. Employers, quite rightly, expect their brief to be as fully developed as is practicable in the circumstances. Incomplete investigations and designs can only generate incomplete quantities. One of the major benefits of employing quantity surveyors to measure bills is that the QS will often spot gaps in the design information and will query the design team as to what is required, and will press them to finalise the outstanding information. This interrogation of the design resolves instances of what otherwise would resurface as contractors' requests for information during the construction stage. These could have the potential to delay or disrupt the contractor's progress; a problem avoided is a problem solved.

In the recent *Report on the Review of the Performance of the Public Works Contract* (Referred to after as the '2014 GCCC Review' (Government Committee for Construction Contracts, 2014) the Committee recognized the benefit of this interrogation process commenting that '*In preparing the bill, the quantity surveyor would typically 'interrogate' the designers to ensure all the information is available to prepare the bill and this process acts as a natural review of the tender documents*' (p.12).

Bills Provide an Equitable and Clear Allocation of the Quantities Risk

'If it's not in the bills, it not in the price'

An important decision required under the traditional procurement process relates to whether it is the employer rather than the contractor who bears the cost of measurement errors or shortcomings. This is referred to as the 'quantities risk'. In the past, best practice guidance such as that provided by the Liaison Committee (2006) has advocated that projects, other than those for minor works, should be let on a with quantities basis. Under this arrangement, the employer bears the quantities risk. A guiding principal of risk management is that risk should be allocated

to the party best placed to manage it. It is suggested here that the employer *is* in the better position to manage this risk.

In the first instance bills are typically measured by consultant quantity surveyors, one of whose defining areas of expertise is the measurement of building works. This expertise is likely to result in a more systematic and accurate approach to measurement than would be undertaken by a contractor. In addition, the QS is likely to have developed an in-depth knowledge of the project during the design development phase. The design process is iterative and the QS typically revisits the evolving design on a number of occasions in order to report and provide cost updates to the employer and the design team. This process allows the QS to absorb and reflect on the unique aspects of the project over an extended period. The QS is likely therefore, to develop a more realistic sense of contingency items and allowances than the contractor for items such as unforeseen ground conditions, areas of incomplete design, and additional alteration/refurbishment work in existing buildings.

On the other hand, where contractors bear the quantities risk and consequently have to measure the work, they must balance the risk of under-measuring the work and tendering a loss-making price against over-measuring the work and probably losing the tender competition. This is a complex balancing act that is usually carried out within tight timescales. Without a bill, the contractor must first quantify the works in order to price it. In this pressurized environment it is not difficult to envisage errors and/or omissions occurring. In addition, competition influences contractors to discount contingencies in order to remain competitive. Where the quantum of work turns out to be more than expected, the contractor is likely to try to recover these losses by other means. What may initially appear to be a ‘bargain’ rarely comes with no-strings-attached.

A particular difficulty arises for contractors where a bill is supplied under a without quantities contractual arrangement. In these instances the status of the bill is reduced to that of a schedule of rates and the contractor assumes the risk of under-measured quantities. The consultant QS in these instances is not liable to the employer for inaccurate quantities and may be tempted to adopt a more ‘commercial’ approach to measurement than would be required by standard methods of measurement such as ARM4. In this regard *The 2014 GCCC Review* reports that ‘*In many instances under the public works contracts this practice [of producing a bill] has become a much more cursory exercise since the risk posed by errors can be transferred to the contractor.*’ The Author has been informed that in these situations, contractors often choose to measure the Works Requirements themselves, in order to check the quantities supplied in the Pricing Document (bill). This additional work, at the very least, undermines the basic purpose of

providing a bill. The usefulness of providing a potentially unreliable ‘aid’ in these instances is questionable and adds to the risk borne by contractors.

The summary conclusions of the GCCC Review (2014), referred to above, suggests that risk (amongst which is the risk of under-measured quantities) *‘is not being priced in many tenders for a variety of reasons and, where risk arises it is leading to claims [and] ... is not being bought but deferred to the dispute resolution phase’*. The Report concedes that this outcome *‘is often the opposite of that intended’* in respect of cost certainty. The Report’s first recommendation is to reduce *‘the level of risk currently being transferred by making the bill of quantities the primary reference document for tender purposes on employer-designed contracts’*. This recommendation will return the quantities risk to the employer, which should have an immediate beneficial effect in improving the reliability and quality of the Pricing Document. The Report’s authors justify this recommendation on the basis that, as they engage consultants to prepare bills, the State should retain the quantities risk (p.11).

Bills result in Lower / Cheaper Tenders

Regardless of its other uses, building employers should be of the opinion that taking the quantities risk and providing bills is worthwhile and will add value to the project and/or save money. Bills are entirely justified where the anticipated savings outweigh the fee charged to produce them.

The effect of bills in reducing the contractor’s estimating and tendering overhead costs has been commented on in the ‘Tender Document’ section above. Of more importance, however is the potential reduction in the risk premium charged by contractors where ‘with quantities’ arrangements are used. Hughes *et al.* (2015) comment that where a contractor is required to bear a risk that a corresponding premium must be charged to cover it. The quantities risk is one principal commercial risks borne by contractor, and where a contract does not include quantities the premium charged may be substantial.

While the previous discussion might suggest that occasionally contracts may be won due to under-measuring the work, these occurrences may be the exception rather than the rule and tend to be more common during the depressed stages of the economic cycle. More normally, contractors are required to measure the quantities within pressurized time scales and measurement is usually based on ‘builder’s quantities’, which typically takes a more commercial or broad brush approach. Simplifying the measurement process typically focuses on a limited

range of the most cost-significant design items (the Pareto principle or ‘20:80’ rule) onto which allowances for minor items and un-measured sundries are added. This process often measures gross in the first instance without deducting openings or boundary details and consequently may generate excess quantities. Secondly, the allowances for unmeasured sundries under this approach is often intuitive and may not be particularly reliable and, in the absence of (numerous) analyses of similar projects, becomes somewhat speculative, a guesstimate. Similarly, building contracts often contain substantial uncertain elements, in particular, groundworks and alterations in existing buildings. Where time permits, further investigation of these uncertain areas by the contractor may improve the degree of accuracy, nevertheless, the contractor will risk a worst-case scenarios and may adopt a more conservative approach to these areas than would be taken by a consultant QS in (provisionally) measuring a bill. It should be noted that where the quantities are over-measured or where contingencies are over-provided for, that the contractor retains such ‘premiums’. Critics may describe these as ‘windfall’ profits. In general and in times when work is plentiful it is probable that these premiums would more than justify the QS’s fee for producing a full bill.

The *2014 GCCC Report* provides an interesting insight into the question of transferring risk to the contractor. The Report states that it was expected that costs would rise by an average of 10% on the introduction of the Public Works fixed price lump sum contracts. It is suggested here that an important contributor to this 10% rise would be the contractor’s assumption of the quantities risk².

Bills Provide an Effective Means for Valuing Interim Payments and Variations.

The discussion above argued that bills provide an effective basis for valuing work in progress on site. This assessment may be debated on the basis that bills prepared in accordance with ARM4 are more detailed than contract sum analyses or tender breakdowns typically produced by contractors and consequently produce more accurate valuations. In the normal course of events where a contract is successfully completed the benefit of this increased accuracy is of little effect. However, in cases of contractor default, accurate valuation of the completed work takes on more importance and may prevent irrecoverable overpayment by the employer.

² Other risks might include inflation risks, the need for variations, the impact of additional contract mechanisms etc.

Likewise where variations arise during the course of the works, these will generally be measured in accordance with ARM and valued at bill, fair, or local rates as appropriate. This valuation procedure is relatively transparent and traceable. However contract sum analyses / tender breakdowns for projects where bills are not provided are usually **not** prepared in accordance with the ARM and a ‘builder’s quantities’ approach is often used to measure the work. These quantities are far less precise in their definition and may roll up several measurable items into a single composite description. In these instances the basis of the build-up of the various components in the rates are not obvious. Consequently valuations are more likely to become matters of negotiation and wily contractors may exploit this lack of clarity to maximise the opportunity to gain additional reimbursement.

Disadvantages of Bills of Quantities

Bills are an Added Expense for Employers

Hackett *et al.* (2007) note that even with the more or less universally adopted use of computers, the cost of producing bills of quantities is high and consequently their use as tender procurement and contract documents is often questioned. The use of bills adds to the overhead to be paid by the employer. This expense must, however, be balanced with the additional measurement costs which would otherwise be incurred by the successful contractor (and unsuccessful contractors) and passed on in their tender to the employer (see Page One). The previous discussion relating to ‘lower and cheaper tenders’ above should also be borne in mind in this regard. In addition the move to fee negotiation and away from scale fees has resulted in more competitive professional service provision. Quantity surveyors often argue that producing bills actually saves the employer money.

Bills Delay the Commencement of the Project

One of the main drawbacks associated with bills is the extra time required to complete the design and production information stage in advance of tendering. Bill preparation is one of the final task in this process and has become linked with the criticism that bills (needlessly) delay the tendering process. Attempts to ‘freeze’ the design might improve this situation, but this, of course, will have knock-on effects during the post tender and construction phases if the design information is incomplete. Time is money and the employer will have to finance this additional period. Again, this drawback must be viewed in the context of allowing the contractor additional tendering time in order to measure the works requirements where bills are not provided.

The Cost Certainty of Bills is Questionable

The objective of a bill of quantities is to fully describe and accurately quantify the works content of the project. As noted above, under ideal conditions this should provide employers, *all other things being equal* with a high degree of cost certainty. This ideal, however, is rarely achieved in practice as ‘all other things’ are almost never ‘equal’. In the absence of complete design, claims that bills provide cost certainty may be seriously misleading leaving clients with a false sense of security regarding outturn costs.

Bills represent the nature of the project at a given point in time - when tenders are sought - and this is expressed as the Contract Sum. The design process, nevertheless, continues to evolve and design decisions continue to be made until practical completion of the project is achieved. Design changes and improvements clearly have cost implications over and above the basis on which contract was initially let.

Bills, particularly on private sector developments, often include a number of cost variables such as prime cost (PC) sums to cover the appointment of specialist sub-contractors and suppliers, and provisional sums to cover areas where the extent of the work cannot be (or is not) established in at the time tenders are submitted. Likewise, building contracts invariably experience variations and the standard form contracts also contain various events which may give the contractor an entitlement to recover for delay or disruption to the programme. In addition, the contract may provide for cost increases in labour and materials resources.

All human activity is prone to mistakes: and errors, omissions and inaccuracies often occur in producing bills. When a contract is let on a ‘with quantities’ basis, incorrect quantities are rectified, and the final account is adjusted. A bill of approximate quantities may be used where the extent of the works is unknown or cannot be established at tender stage and the quantities are subject to remeasurement on completion. All these variables may result in substantial cost overruns in final accounts, particularly where contracts are let on incomplete information.

Public works contracts are subject to robust cost control procedures aimed at delivering a comprehensively designed scheme at tender stage. Despite this the *GCCC Review* (2014 p.41) reported that cost overruns on the public sector building projects during the period 2008-10 averaged

at 4.8%. Cost overruns on State civil engineering projects during this period were 8.4%. The GCCC considers that this is ‘*still above the target of a maximum of 1 – 2% increase on the contract sum*³’

Bills of Quantities are not Suited to Complex Projects

Hughes *et al.* (2015) comment that traditional general contracting using bills of quantities is not suitable where PC sums and provisional sums (see below) constitute the majority of the buildings cost. These sums are used to appoint employer-selected specialist sub-contractors and/or suppliers to provide budgets for contingencies, both of which lend themselves to valuation by cost reimbursement rather than ‘pro rata’ payment approaches. Hughes *et al.* add that if PC and provisional sums make up a large proportion of the works that this reduces the main contractor’s role to a co-ordinator and accountant rather than a builder and that traditional contracts do not reflect this role.

The measurement of specialised design requires a detailed knowledge of the particular technology and an understanding of how this is to be incorporated into the overall scheme design. The employer’s requirements regarding specialist areas of design may occasionally be expressed as performance specifications whereby the appointed specialist contractor proposes and finalises the detailed design, subject to the approval of the design consultants. The detailed design interface between the specialist work, the general fabric of the building and the connections to the other (specialist) systems may need further exploration and ‘fine tuning’ on site to avoid clashes and to successfully integrate the specialist technology. The QS, consequently is often not well positioned to measure such work in advance and may have little or no previous experience of the proposed particulars, technology and/or systems. Attempts to specify and quantify such work, therefore, may be problematic.

Regarding complexity, Odeyinka, Kelly and Perera (2009) found that the budgetary reliability of bills in procuring buildings in Northern Ireland deteriorated as the projects became more uncertain and complex. They reported a -3 to 4% deviation on five housing projects; a 4 to 17% deviation on five educational projects; -20 to 20% deviation on five commercial projects and -11

³ It should however, also be noted that given the severely troubled state of the Irish economy and construction industry during this period, that these results were achieved in the context of ‘cut throat’ and abnormally low tendering and the widespread resorting to recovering a margin through hard bargaining and dispute resolution procedures.

to 37% deviations on five refurbishment projects. They suggest that the more complex the project is the less reliable it is to use the BQ to achieve cost certainty.

Bills are of Limited Use to the Contractor

Kirkham (2015) comments that bills remain primarily documents for obtaining tenders efficiently rather than a document for managing site production processes. One of the chief criticisms of bills of quantities is that despite the level of detail involved in the measurement process, the potential usefulness of bills for contractors is rarely considered or exploited. Much useful information is generated by the QS in the production of the bill (the take-off) but this is not made available to the contractor. For example the QS who measures a pitched roof structure calculates the numbers and lengths of rafters required, but this information is presented in elemental bills as a simple aggregated quantity without further annotation (see below). Contractors therefore must duplicate this process in order to estimate waste factors and resource requirements. Alternatively contractors may choose to re-work the bill to reflect planned site operations where an operational estimating approach is adopted.

Content of Bills of Quantities

Preliminaries

Preliminaries are work and other expenditure that is necessary but forms no part of the finished fabric of the building. The preliminaries describe the contractor's general obligations covering the contract in its entirety. The preliminaries section provides the contractor with the opportunity to price all matters in connection with the conditions of contract, special requirements of the employer and for all temporary works necessary in carrying out the contract. The contractor has the opportunity to price these individually rather than having to include them in the rates for specific items of work.

It could be said that the preliminaries form the framework around which the contract is organised. The preliminaries should enable the contractor to form an appreciation of the location, size and complexity of the project both in terms of its construction and management. This will enable contractors to plan the carrying out of the work in terms of plant, equipment, and management resources. The information contained in the preliminaries section falls into four general categories:-

1. *Preliminary Particulars*: this section sets out general project details including a general description of the project and site, the names of the employer and consultants and a list of drawings from which the bill has been prepared.
2. *Contract*: this section describes the form, type and conditions of contract to be used identifying any amendments to the standard conditions. The contract appendix/schedule insertions are stipulated; these identify the individual requirements of the contract (as distinct from the standard conditions) such as contract period, level of liquidated damages etc. In addition the insurance arrangements for the contract are detailed in this section. The section also sets out the obligations and restrictions imposed by the employer in relation to among other things: access; working space; working hours; materials discovered on site; hoardings and the like; maintaining existing services; sequence of work or phasing requirements; temperature or humidity requirements; temporary facilities and accommodation for the use of the employer; temporary telephones for the use of the employer; provision of a Project Supervisor Construction Stage under the Safety Health & Welfare Construction Regulations 2013; and any other obligation or restriction.
3. *Work by Nominated Subcontractors, Goods and Materials from Nominated Suppliers and Work by Public Bodies*: this sections covers requirements relating to nominated subcontractors and suppliers and work by utility providers and work by others engaged directly by the employer.
4. *General facilities and obligations*: this section covers the contractor's general cost items: The section often contains a large amount of information, despite this however it is usual for no more than a dozen items to be priced by tendering contractors. The following items, containing the most important site establishment costs are often referred to as "contractors preliminaries": site staff (all personnel whose cost has not been included in the unit rates); mechanical plant and hoisting (all items not included in the unit rates); scaffolding; site accommodation; insurances; site power and water supply; site cleaning and clearance; telecommunications; temporary roads; security; watching and lighting; hoardings and welfare, first aid and safety.

Preliminaries are general in nature and are related to the project as a whole rather than any specific trade or element (for example site accommodation and water for the works). They are not quantified. The cost of many of the preliminaries items are time-related, with their cost being

determined by the length of time they are required on site. It is common to refer to the preliminaries section as the 'project overheads', however it should be noted that preliminaries are direct costs specific to the particular site. They are not intended to cover head office costs but should include a contribution to cover head-office overheads and profit similar to that applied to the measured-work rates in the bill.

Preambles

Preambles are specification clauses of a general nature intended as concise definitions of the materials required and of the standard of workmanship to be employed in working or assembling the items contained in the measured work sections of the bills.

Preambles are not priced but they must be brought to the contractor's attention as they affect the rates tendered for the billed items of measured work. They are usually included as a separate section of the bill of quantities, but in certain instances may be inserted at the head of each work section of the bill.

Preambles by keeping general specification information separate, enable the descriptions in the measured work sections to be kept brief and to be easily priced by contractors. The contractor must however be aware that all information and instructions in the preamble clauses will be deemed to have been taken into consideration in pricing the corresponding measured items in the bill. For example a bill description might read:

Blockwork as described

Walls

100mm thick m²

This indicates that detailed information regarding the exact nature of the blockwork is described elsewhere in the preambles section. When pricing the bill the contractor reads the blockwork section of the preambles, which describes in full detail the related material, workmanship and construction standards to be achieved.

Measured Work

Measured works form the main part of the bills. This content fully describes and accurately represents the quality and quantity of work to be carried out on a project. This section comprises a list of quantified work descriptions which can be readily priced by the contractor. Measured

work in Irish bills is typically measured in accordance with ARM4 which avoids ambiguity over the meaning and interpretation of descriptions and quantities. The measured work sections typically correspond closely with the traditional trades, for example: demolition and alterations; excavation and earthwork; concrete work; brickwork and blockwork; roofing; woodwork; structural steelwork; finishings, glazing and painting.

Work which cannot be measured is given as a provisional sum. Work, the extent of which is not known is described as provisional or is given as approximate quantities. Prime cost sums are included for work by specialists.

Prime Cost Sums

“a sum provided for work or services to be executed by a nominated sub-contractor or for materials or goods to be obtained from a nominated supplier.” (ARM4).

Prime cost sums (PC sums) are sums included in bills for private sector projects to cover works by specialist sub-contractors and/or to procure materials from specialist suppliers. Such specialists are chosen (nominated) by the architect but are employed by the main contractor. PC sums have been widely used to appoint sub-contractors to carry out mechanical and electrical work, windows and curtain walling, and specialist finishes. They are also used to obtain goods, such as ironmongery and sanitary fittings from nominated suppliers.

The PC Sums are the amount of money the employer pays the main contractor who in turn pays the nominated subcontractor / supplier. The contractor is provided the opportunity of pricing items for profit and special attendance on nominated subcontract work.

Provisional Sums

“a sum provided for work or for costs which cannot be entirely foreseen, defined or detailed at the time the tendering documents are issued.” (ARM4).

Provisional sums are budgets covering the cost of particular aspects of the design that remain to be finalised at the time the bills are sent out to the tendering contractors. They are also used to provide contingency sums to cover situations where additional unforeseen work may be required. Provisional sums are adjustable in final accounts, and if the cost of the work exceeds the amount provided, the excess will be added to the contract sum. Provisional sums, therefore, should be sufficient to cover the likely cost of such work if cost over-runs are to be avoided.

Provisional sums are often used to cover the cost of remedial work, such as removing and replacing decayed timber where the extent of work cannot be accurately established before it is opened up. Ideally such work should be measured provisionally (see below).

Work executed by a Statutory Authority, Public Undertaking or Public or Private Utility Providers shall be so described and given as a provisional sum. An item shall be given for any profit required by the contractor. An item shall be given for other charges required by the contractor associated with the employment of each utility provider.

Provisional sums may be appropriate where clients prioritise rapid, fast-track design programmes over cost certainty thereby allowing design teams to finalise non critical details during the construction phase. They may also be appropriate on developments where the identity of the end user is not known, or where their requirements have not been fully formulated. Likewise they may be used cover various contingency events.

It should be noted that the public works contracts are intended to be used without prime cost or provisional sums.

Provisionally Measured Works

These are a variant on the provisional sum where the kind of work is known but the amount is not. Provisional quantities are widely used as an effective alternative to provisional sums. They are, in effect, quantified provisional sums. They are widely used in substructure and repair work for example breaking out a provisional volume of rock, or hacking off and re-plastering areas of defective plaster. They are measured on completion and valued at the rates tendered by the contractor.

Miscellaneous Content in Bills

Bills occasionally contain a 'dayworks' section which provides for the reimbursement of works on the basis of costs incurred rather than valuation by tendered rates. This section sets out provisional amounts to be included for various categories of labour and allows for percentage additions to be tendered by contractors on labour, materials and plant accounts to cover on-costs, overheads and profit.

Bills may also contain 'bill diagrams' which detail work which would otherwise require lengthy bill descriptions. Examples of works for which bill diagrams may be appropriate include items of joinery, and/or where complicated profiles are required, for example to describe the formwork to

a complex concrete beam design. These diagrams are more effective in communicating the designer's intentions, are less ambiguous than written descriptions and assist in enabling the drawn content of the tender documentation to be limited to the general arrangement drawings.

Bills of quantities typically conclude with a General Summary where the various sections of the bill are totalled and transferred to the Form of Tender which represents the contractor's offer to carry out the work.

Format of Bills of Quantities

Bills may be presented in a variety of formats. Towey (2012) explains that choice of format should take account of who the measurement is for, the time available to prepare the bills and the amount of design and documentation available. Hackett *et al.* (2007) comment that the objective should be to maximise the benefit to all concerned and that the effective management of documentation aids efficient working on site and that can be of cost benefit to the employer.

Elemental Bills

This is the most common bill format used by Irish quantity surveying practices. The elemental format produces a bill which is organised in terms of building design elements or constituent parts. In Ireland the measurement of new building work is typically organised in accordance with the National Standard Building Elements (NSBE)⁴. (ERU, 1993). Elements are defined as '*that part of the building, which always performs the same function irrespective of design or specification*'. The objective of the NSBE is to enable design teams to adopt, on a national basis, a common approach to the building process. The NSBE stipulate what is included and excluded from each element, which helps design teams coordinate their work and allows the measurement of the work to be divided up among teams, while ensuring that all aspects of the building works are fully covered in the bills. Elemental bills are favoured by quantity surveying practices as they simplify the cost analysis of the project, which may then be used as the basis for forecasting the costs of buildings of a similar nature. Each element forms a separate section of the bill and the work sequence generally follows that laid out in ARM. Lee *et al.* (2011) note that this approach should assist in generating accurate tenders as the items are related to a particular part of the building. They note, however, that elemental bills require contractors to sort the various items by

⁴ In the UK the Building Cost Information Service (BCIS) elements are standard.

trade or work section, into appropriate trade packages in order to obtain subcontractor quotes. Computer software, has, however, significantly simplified and speeded-up this process.

Traditional or Trade Bills

The traditional trade-by-trade format is the most common format used in the UK and produces bills which are arranged according to trade or work sections rather than elements. Standard methods of measurement such as SMM7 and ARM4 are divided into work sections, many of which correspond closely to the traditional trades and specialist subcontracts areas operating in the construction sector. Trade bills are organised according to these works section. This approach is considered to be more ‘contractor friendly’ than elemental bills as the sorting of the works into trade packages simplifies the contractor’s task of obtaining quotations from sub-contractors.

Trade Section Bills

Trade section bills may be viewed as a cross between elemental and trade bills. The work is arranged by trade but is further categorised according to elements. This format is designed to have the advantages of both traditional and elemental formats.

Operational Bills

Cartlidge (2013) comments that over the years various other formats such as operational bills have been developed, but they have not been adopted on a widespread basis. Towey (2012) explains that operational bills describe works in terms of the amount of labour plant and materials required for each operation. Operations are scheduled as labour requirements in gang(s) plus materials and items of plant required to carry out the specified work (or an operation). He argues that operational bills benefit builders in that the division of work items into components makes each work operation easier to recognise and price; thereby facilitating more effective cost control of the construction works. He adds that this format is suitable for small projects as it provides detailed information simplifying the ordering of materials. On large projects, however, this may result in bulky documentation which is costly to produce. The Author of this study is not aware of this format being used to any great extent to obtain tenders in Ireland as it requires the QS to further analyse and apply labour and plant production standards to the various work items. These are matters which the contractor has traditionally managed.

Activity Bills

The activity format modifies an operational bill, which is measured normally in accordance with a standard method of measurement, but in which the items are arranged in order of site activities instead of operations. Towey (2012) explains that these bills take into account activities as a network and programme each activity with a coded location reference. He notes that they have similar benefits to a builder as an operational bill as they provide the framework for the effective management of works and allocation of materials, labour and plant and show activities in identified locations of a project. He adds that activity bills are suitable for small, simple projects, but are not normally used on large projects. Again, this bill format does not appear to be widely used in Ireland.

Annotated Bills

Bills may be annotated in a various ways in order to provide location information (Locational Bills – Hackett *et al.* (2007)) and/or to provide a breakdown of the billed quantities identifying the various physical locations of, and particular quantities, giving rise to the overall aggregate billed quantity. Hackett *et al.* (2007) explain that annotations are most useful when presented alongside the relevant bill description, but they may also be provided in a separate document, or in a separate section of the bill. Again, these bills are not widely used in Ireland.

Computer Applications

Hore *et al.* (2009) note that bills may be produced in various formats using computer technology. Software and technology are developing rapidly in this area and their use has become standard practice. Telecommunications and electronic data interchange technology are also advancing in order to make the electronic communication of documents between parties, such as bills of quantities, standard practise.

Summary

This study has investigated the function and format of bills of quantities. It has explained the nature of bills and how they are compiled and identified the situations in which they may be used. The primary functions of the bill as a means of obtaining tenders and its status as a contract document have been explored. The study also addressed particular aspects of the bill which may aid the effective management of construction projects for the employer, design team and contractor. It examined the perceived advantages of producing bills and reviewed various

criticisms directed at their use. The study set out the contents of bills and described the most common formats in which they are presented in the Republic of Ireland.

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