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THE USE OF BILLS OF QUANTITIES IN CONSTRUCTION PROJECTS - AN AUSTRALIAN SURVEY

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ABSTRACT

Bills of Quantities (BQs) have existed in one form or another for over 300 years. Debate over the use, benefits and problems of BQs has been long standing. A literature review on BQs is reported herein. The review found little empirical research into the use of BQs. Much of the literature is based on unsubstantiated opinion. The results of a survey of 86 Australian construction professionals, primarily consultant quantity surveyors, are reported to provide some empirical evidence of issues related to the use of BQs in construction projects. The key findings are that there is a strong desire to simplify the measurement process; there is a reluctance by building principals to formalise BQs as part of the contract; over the past five years there has been little change in the use of BQs by either clients or contractors; and BQs account for less than 25% of quantity surveyors' work load. The most useful aspect of BQs is its ability to provide a common basis for assessing change in a project.

Keywords: Bills of Quantities, quantity surveying

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INTRODUCTION

Bills of quantities (BQs) have existed in one form or another for over 300 years (Milliken, 1996). It is claimed that the use of BQs is perhaps the most misunderstood facet of building contracts today (AIQS, 2001). Debate over the relative advantages and disadvantages of BQs has been long standing and generates strongly held and conflicting views (NPWC/NBCC, 1990).

The BQ is a document that itemises the work in a construction project. It is usually prepared by professional quantity surveyors on behalf of the principal, based on detailed drawings and specifications (NSW Legislative Council, 1991; Marsden, 1998; Seeley, 1997). The BQ has two primary uses (Brook, 1998):

- Pre-Contract: the BQ assists contractors in the formulation of their tenders. The BQ breaks down the contract works in a formal, detailed, structured manner for tendering (AIQS, 1997).
- Post-Contract: the BQ assists contractors and quantity surveyors in the valuing of progress payments and variations. The BQ provides a financial structure for contract administration (AIQS, 1997).

Methods of Measurement

A BQ can be prepared using various alternative methods of measurement (AIQS, 1997):

Australian Standard Method of Measurement of Building Works (AIQS, 1990) – This is commonly used for fully measured 'guaranteed' BQs.

Abbreviated Method of Measurement - These are published by larger quantity surveying firms and state governments. They are used on simple buildings and place greater requirement on contractors to refer closely to drawings.

Builders' measurement – This measurement method is used by contractors preparing tenders where a BQ is not provided by the principal No specific form of measurement exists.

BQs – Contractual Status

The contractual status of the BQ can vary (AIQS, 1997):

- Form part of the contract and be guaranteed
- Form part of the contract and not guaranteed
- Not forming part of the contract and for information only

The term 'guaranteed' means that the principal and contractor have a guarantee that they will only pay for/be paid for work tendered under the contract. It does not mean that the QS guarantee the accuracy of the BQ (AIQS, 1997). Builders are skeptical of BQs provided for 'information only" because they present unreasonable risk (AIQS, 2001).

ISSUES

When to use of BQs

The AIQS recommends BQs for projects (AIQS, 1997):

- Where the anticipated reduction in tender price is calculated to be greater than the fee for producing the BQ

- For all projects of a complex nature or alterations work
- For less complex projects with an estimated cost of greater than $2M.

Declining Use of BQs

In 1984, the Royal Institution of Chartered Surveyors (RICS) stated that UK quantity surveyors earn their "bread and butter" from the production of BQs and settlement of final accounts, with tender documentation accounting for 35% of professional QSs workload (RICS, 1984). In 1991, the RICS declared that BQs were not about to disappear (RICS, 1991). Since then there has been a significant decline in professional quantity surveyors' workload associated with producing BQs. In the UK, the use of BQs had declined from 65% of building work by value in 1984 to 56% in 1989 (RICS, 1991). In Australia, twenty five years ago quantity surveying work almost entirely consisted of the production of BQs (Wood & Kenley, 1997). The AIQS (Victorian Chapter) survey indicates a sharp downward trend in the production of BQs. This may be seen with reference to Table 1.

Table 1 BQ production as percentage of office workloads (AIQS Victoria)

1993	1994	1995	1996	1997	1998	1999
27%	30%	22%	16%	15%	17%	11%

BQ: Claimed Benefits – Pre-Contract

Quality Management - The process of producing a BQ requires the QS to interrogate the design and specification. This provides a quality control review to identify inaccuracies and inconsistencies in drawings and specification prior to tender, and the subsequent reduction in post-contract problems (Milliken, 1996; AIQS, 1997; Mitchell Brandtman, 2001).

Tender Assessment – BQs, when available, are widely used by Australian building contractors for tendering (Slattery, 1993). The professionally prepared BQ provides a common basis for the comparison of tenders (AIQS, 1997). The structured format simplifies the assessment of tenders (AIQS, 1997). Where a BQ is not provided, each tenderer prepares its own quantities and the principal cannot be sure that tenders are being compared on the same basis (AIQS, 1997; Mitchell Brandtman, 2001). So, the absence of a BQ leads to greater variability, increased risk in estimating and consequently more disputes (Seeley, 1997).

Tendering Cost - If the principal does not arrange for a BQ to be prepared, the tenderers will incorporate the cost of measuring the work within their tender, thereby passing the cost onto the principal (Mitchell Brandtman, 2001). Cordell's (1979, in Mills, 1991) studies indicated that tendering costs for head contractors was approximately 0.15% of the tender value for projects with a BQ and 0.45% per tender for projects without a BQ.

Competitive tenders – Tenderers can rely on the quantities within a guaranteed BQ, resulting in lower tender prices from more competitive tendering (AIQS, 1997). Research into this factor includes:

- Slattery (1993) - 74% of Australian contractors stated that guaranteed BQs increase the competitiveness of tenders whilst non-guaranteed BQs increased tender prices by 4.6% due to increased risk. BQs reduce tender prices from

between 2.3% for simple projects to less than $5m to 4.2% for complex projects greater than $5m. Where the principal provides a BQ, more subcontractors are likely to tender for a subcontracted package, resulting in lower prices in the range of 5% to 12%, than when there is no BQ.

- Hind (1993) estimated that on a project of moderate complexity with total contract value of $10m, if professional BQs were prepared at a cost of approximately $60,000, net savings on tender costs would be in the vicinity of $140,000.
- The Economic Development Committee (1994) found that the use of BQs reduced tendering costs and resulted in savings on project costs.

Completeness and Builder's Risk - BQs reduce contractors risk in tendering by 95% (Slattery, 1993). A BQ prepared by a professional quantity surveyor, given appropriate time and design information, should ensure that all items of work have been included in tenders. Without a BQ, there is the risk that the successful tenderer may underestimate the quantities and then be unable to complete the work, and/or cut corners in an attempt to recover the consequent loss (Ramus & Birchall, 1996).

Time – BQ preparation, and the level of associated design, requires time (Ramus & Birchall, 1996; Turner, 1983). This time must be adequate to provided for a quality BQ (NPWC/NBCC, 1990). The amount of additional time to prepare a BQ can be offset by a reduction in tendering time, thereby allowing the reduction of the tender period, particularly on larger projects (AIQS, 1997; Mitchell Brandtman, 2001). In contrast, if there is no BQ it is recommended that sufficient time should be allowed to enable tenderers to provide their own BQ (NPWC/NBCC, 1990). Interestingly, Uher (1996) found that contractors consider the main benefits of BQs to be speeding up the tendering process and simplify obtaining and analysing bids from subcontractors.

BQ: Claimed Disadvantages – Pre-Contract

Cost & Time - The preparation of a BQ tends to increase the cost of documentation and documentation period (NSW Legislative Council, 1991).

Estimating Practice - Tenderers may ignore the specification (e.g. workmanship requirements), pricing only according to the BQ. This may lead to under pricing and the consequent risk of unsatisfactory performance as contractors try to avoid losing money (NSW Legislative Council, 1991).

Procurement – The use of a detailed design and associated BQ discourages contractors from submitting alternative design solutions, as alternatives will amend quantities (Turner, 1983). The BQ is only suitable (if at all) to the traditional procurement system and non-traditional methods are increasing, allowing contractors greater opportunities for innovation, individual expertise and buildability (NSWPWD, 1992).

BQ: Claimed Benefits - Post-Contract

Certainty of progress payments – The BQ provides a post-contract administration tool and becomes a basis for the evaluation of progress payments. The calculation of these progress claims is straightforward and reliable (AIQS, 1997). This offers contractor, principal and financiers peace of mind in the knowledge that all work is being carried out at prices fair and reasonable to all involved (AIQS, 1997; Mitchell Brandtman, 2001).

Variations Management - The BQ provides a sound, common basis for the valuation of variations (NSW Legislative Council, 1991; Ramus & Birchall, 1996*)*. Also, the prices for variation work are reduced by the use of BQ unit rates (AIQS, 1997). The Economic Development Committee (1994) found that where BQs are provided, there was less scope for variations in contract tendering prices to occur and where such variations did occur they are more easily identified. Without a BQ, the pricing of variations will lead to more protracted negotiations (Ramus & Birchall, 1996).

Risk management - The prices in the BQ can be used as a basis for comparing a builder's price with current trends in the market place. This provides an basis for management to determine the likely manifestation of risk factors (AIQS, 1997).

BQ Errors - Errors are not a major cause of variations (AIQS, 2001). Choy (1991) researched 32 projects across four Australian states and found an average level of variations of 7.7% of firm base contract sums. BQ errors represented 4.5% of total variations, or 0.3% of firm base contract sum.

BQ: Claimed Disadvantages – Post-Contract

BQ Errors - Because of the amount of detail required in a BQ, there is a significant chance of finding errors, omissions and discrepancies between drawings and the BQ, with consequent disputation (NSW Legislative Council, 1991). This risk of disputation arising from misinterpretation and error outweighs the advantages of BQs (NSW Legislative Council (1991*)*. The NSW Public Works Department (1992) found discrepancies between BQs and the rest of the contract documents to be common, and subject to substantial claims from contractors, in three areas – under measures, omitted items and misdescribed items.

Australian Standard Method of Measurement [ASMM] - The ASMM is over complex and creates ambiguities (NSWPWD, 1992). It leaves avenues for different interpretation, and these may lead to disputes (NSW Legislative Council, 1991*)*.

Unit rates - The cost data obtained from contactor-priced BQs is often used by QSs for cost management, such as valuing progress payments. This data can be suspect for reasons such as: contractors increase rates on early trades above their real cost, and reduce the cost of later trades, to improve cash flows; some contactors may load later trades to gain benefits from rise and fall provisions (NSWPWD, 1993; Yizhe & Youjie, 1992). In fact some contractors detect errors in principal-provided BQs and subjectively adjust the associated rates accordingly (Green, 1986).

Builder's BQ - Where a BQ does not exist, contractors often seek a "Builder's Bill". Therefore, "if full scale Bills provide the economic benefits espoused by the QS industry, then surely Builders would be prepared to pay upfront cost in order to save them the claimed additional construction costs they supposedly encounter due to the so called lack of precise detail" (NSWPWD, 1992).

Responsibilities – BQs involve a shift in, or 'risk blurring' of, the contractor's responsibility that results in claims and disputes (NPWC/NBCC, 1990).

BQ: Claimed Benefits – Others

Database - The pricing details within the BQ provides a cost database for future estimating (NSW Legislative Council, 1991*)*.

Fee Calculation - The BQ provides an absolute basis for the calculation of consultants' fees (AIQS, 1997).

Asset Management - The BQ provided readily available data for asset management of the completed building, life cycle costing studies, maintenance schedules, general insurance and insurance replacement costs (AIQS, 1997).

Taxation – BQs provide a basis for quick and accurate preparation of depreciation schedules as part of a complete asset management plan for the project. (Mitchell Brandtman, 2001; AIQS, 1997).

Accuracy of QS Estimates - Mills (1991) found the accuracy of forecasting the value of the lowest tender received for new building work was good when a BQ was prepared, although the additional accuracy was quite small.

METHODOLOGY

The literature review found that there has been little empirical research into the use of BQs. Several important issues came to light from the literature. These were investigated using a survey instrument containing a number of closed questions. The Australian Institute of Quantity Surveyors (AIQS) and the Australian Institute of Building (AIB) posted the survey instrument on their respective websites. Each web site was established with directions to the survey's location, instructions on its use and method of return to the research team. The sample in essence was AIQS and AIB members with access to their particular member's pages. The response flow rate was initially high with over 50 replies received in the first two weeks of the instrument being available. The final response to the instrument prior to its removal from the web site was 86. The instrument was analysed using SPSS with the following discussion arising from an in depth analysis.

RESULTS

Demographics

The backgrounds of the 86 respondents in the research sample are shown in Table 2. Key attributes are:

- Majority are professional quantity surveyors (54%) or building contractors (31%)
- Main source of work is a combination of private and public sector (48%), or solely private sector (43%)
- Majority have over 20 years experience in the construction industry (63%)

This indicates that the respondents have a wealth of experience in working in the private and public sector and are a good sample to respond to questions on BQs.

Table 2 Demographics of the sample

Role	Project Manager	Building Contractor	Quantity Surveyor	Other	Total
Frequency	7	27	45	7	86

Source of Work	Public	Private	Combination	No reply	Total
Frequency	7	37	41	1	86

Construction Experience (years)	0-10	11-20	21-30	<31	No reply	Total

Frequency	10	21	23	31	1	86

BQ Measurement –Principal

There are various methods for measuring work for BQs sponsored by a building principal. Respondents were asked which measurement method – abbreviated, Australian Standard Method of Measurement (ASMM) or builder's quantities – is most frequently used. Table 3 shows builder's quantities (mean 3.16) as the favoured measurement method for BQs sponsored by principals. This may be considered unexpected because building principals have traditionally sponsored the production of ASMM-based BQs. It could be that the ASMM approach is considered overly complex and there is a desire for a more efficient approach to measuring work that still achieves the objective of facilitating the pricing of building work, such as builder's quantities. Furthermore, because BQs are typically not part of a contract and provided for information only (see later results in this paper), it might be considered suffice to provide builder's quantities rather than more detailed ASMM-based measurement.

Table 3 BQ Measurement – Principal

Principal BQ	Never 1	Seldom 2	Sometimes 3	Mostly 4	Always 5	No reply	Mean	Mode	Total
Abbreviated	14	30	18	13	1	10	2.43	2	86
ASMM	19	26	16	12	3	10	2.39	2	86
Builder's Quantities	6	15	26	17	11	11	3.16	3	86

BQ Measurement – Contractor

There are various methods for measuring work for BQs sponsored by a building contractor. Respondents were asked which measurement method – abbreviated, Australian Standard Method of Measurement (ASMM) or builder's quantities – is most frequently used. Table 4 shows the most commonly used measurement method is builder's quantities (mean 3.75). This is perhaps not surprising because this method of measurement has been instigated by contracting organisations to provide a quick but effective means of generating quantities to sufficient detail to facilitate the tendering process.

Table 4 BQ Measurement – Contractor

Contractor BQ	Never 1	Seldom 2	Sometimes 3	Mostly 4	Always 5	No reply	Mean	Mode	Total
Abbreviated	19	25	24	7	0	11	2.25	2	86
ASMM	42	18	13	3	0	10	1.70	1	86
Builder's Quantities	5	7	13	34	22	5	3.75	4	86

Contractual Status

The contractual status of BQs sponsored by the building principal can vary. It can be part of the contract and guaranteed; part of the contract and not guaranteed; or, not part of the contract and provided for information only. Respondents were asked which contractor status is most frequently used for principal-sponsored BQs. Table 5 shows the most common contractual status is for BQs to not be part of the contract and provided for information only (mean 3.05). This seems to represent a risk adverse

attitude by building principals to avoid any possible claims from contractors for errors in the BQs by placing responsibility on the contractor to determine the appropriateness of a BQ for the basis of formulating a tender.

Table 5 BQ Contractual Status

Contractual Status	Never 1	Seldom 2	Sometimes 3	Mostly 4	Always 5	No reply	Mean	Mode	Total
Contract, guaranteed	26	23	10	15	6	6	2.40	2	86
Contract/ not guaranteed	13	22	34	10	1	6	2.55	2	86
Information only	8	14	26	26	4	8	3.05	3	86

Criteria for producing BQs

There are various reasons for deciding to produce a BQ for a building project. Respondents were asked how often particular project criteria are used to determine the use of a BQ. Table 6 shows that both project complexity (mean 3.24) and monetary value (mean 3.04) are common criteria for deciding to produce a BQ. This suggests that BQs are produced as a means of facilitate quality assurance and greater understanding in complex and/or large projects.

Table 6 BQ Selection Criteria

Project criteria	Never 1	Seldom 2	Sometimes 3	Mostly 4	Always 5	No reply	Mean	Mode	Total
Complexity	7	11	24	32	6	6	3.24	3	86
Alteration work	11	22	29	13	4	7	2.71	3	86
Value ($)	11	11	25	28	4	7	3.04	3	86

Increased use of BQs – Client sponsored

The respondents were asked if over the past 5 years the use of principal sponsored BQs had increased, decreased or remained unchanged. The results may be seen with reference to Table 7. The majority of respondents saw an unchanged demand or a reduction for principal sponsored BQs in the last 5 year period. Although there was a minority (n=10) that perceived a small (<25%) increase in the use of principal sponsored BQs. Reference to the table highlights a respondent error in answering this question. It may be seen that 6 respondents reported both an unchanged demand as well as either an increase or decrease.

Table 7 Use of principal sponsored Bills of Quantities

Use of principal BQ	1-25%	26-50%	51-75%	76-100%	No reply	Total
increase	10	0	1	2	73	86

decreased	13	13	9	3	48	86
unchanged				29	57	86

Increased use of BQs – Contractor sponsored

The respondents were asked if over the past 5 years the use of building contractors sponsored BQs had increased, decreased or remained unchanged. The results may be seen with reference to Table 8. Nearly 40% of respondents saw no change in the use of building contractor sponsored BQs in the last 5 year period. Although there were a few (n=14) that perceive there was an increase in the use of principal sponsored BQs. Several (n=6) of the respondents saw a decrease of between 26-50%. Reference to the table highlights a respondent error in answering this question. It may be seen that 5 respondents reported both an unchanged demand as well as either an increase or decrease.

Table 8 Use of contractor sponsored Bills of Quantities

Use of contractor BQs	1-25%	26-50%	51-75%	76-100%	No reply	Total
increase	11	6	14	2	53	86
decreased	5	6	2	1	72	86
unchanged				34	52	86

Work load attributed to BQs

The respondents were asked to report on the percentage of work load, by income for creating BQs. Of those that responded to this question 62.8% indicated that it accounted for between 0-25percent of their work load. This may be seen with reference to Table 9. Accordingly it seems that BQ creation does not account for a lot of the respondent's activity. This concurs with the research undertaken by the Construction Economics Committee, Victorian Chapter of the AIQS who reported a decline in office work load associated with BQs from a high of 30% in 1994 reducing to 11% in 1999. It seems this decline in the mid to late 90's has reached status and remained in the same relative position to date.

Table 9 Percentage of work load, by income for creating BQs

	0-25 %	26-50%	51-75 %	76-100%	No reply	Total
Income - creating BQs	54	15	6	1	10	86

Important use of BQs

The respondents were asked to consider many characteristics/ uses arising from the literature associated with BQs. The respondents were asked to identify using a likert scale the effectiveness of the identified variables where: *1=not important, 2=little importance, 3=undecided, 4= quite important, 5=very important*. The results may be seen with reference to Table 10.

Table 10 Important uses of Bills of Quantities

Key	Characteristic/ use	1	2	3	4	5	Mean	Rank
pos	Facilitates variation cost management	3	8	33	40	8	4.27	1
pos	Facilitates evaluation of progress payments	1	3	6	43	3	4.19	2

pre	Results in risk reduction to tenderers	2	4	9	33	3	4.15	3
pre	Obtains more competitive tender prices	2	5	13	24	4	4.13	4
pre	Facilitates tender comparison	8	15	21	40	8	4.11	5
pre	Provides cost database	1	4	11	40	2	4.07	6
pre	Provides tendering cost certainty	1	6	14	32	3	4.02	7
pre	Efficient use of industry resources	4	7	21	36	1	3.63	8
pre	Provides a reduction in tender duration	4	13	18	29	2	3.57	9
pre	Facilitates design interrogation/ quality	11	12	13	24	2	3.41	10
pos	BQ errors causing variations	5	21	20	28	1	3.20	11
oth	Facilitates accurate depreciation schedule	7	18	21	29	8	3.16	12
oth	Provides data for insurance purposes	8	23	18	25	1	3.07	13
pos	BQ fails to suit building contractors needs	9	20	29	16	1	2.98	14
pos	Complexity due to ASMM measurement	11	17	28	17	9	2.95	15
pre	Strategic loading of selected sections of the	11	14	36	16	7	2.93	16
oth	Basis for fee calculation	18	21	21	20	4	2.65	17
pre	Ignore documents aside from BQ	16	20	34	9	2	2.52	18
pre	Increases overall project time	18	31	25	7	2	2.33	19
pre	Increases overall project cost	21	33	20	6	3	2.24	20

Key: pre = pre-contract activities
pos = post-contract activities
oth = other activities

The top five characteristics or uses of a BQ were found to be:

1. Facilitates variation cost management
2. Facilitates evaluation of progress payments
3. Results in risk reduction to tenderers
4. Obtains more competitive tender prices
5. Facilitates tender comparison

The least important two were found to be:

1. Increases overall project cost
2. Increases overall project time

Following Table 10 it may be seen that in the top 10 the most important 2 uses are post contract activities. The balance of activities is represented by pre-contract activities. The least important use/ characteristics are all pre-contract activities. Variation cost management ranked as the highest mean score indicating its level of importance as a tool available for the use of a building developer to manage cost associated with changes to the scope of works. It seems that the respondents concur with the sentiments in the literature that a BQ provides a sound common basis for the valuation of variations; reducing the ensuing protracted negotiations. Evaluation of progress payments was ranked as the second highest mean following the literature that indicates that the calculations of progress claims is straight forward when using a BQ. Risk reduction to tenderers was third in the table and related to pre-contract activities undertaken by QS. The writers reviewed indicated that a BQ reduced tendering risk by 95%; mainly by reducing general errors in tendering and ensuring that all the work has been priced. More competitive tender prices are assured with a BQ according to the

literature reviewed. The sample respondents agreed and ranked this item as four in the survey instrument. Tender comparison was ranked five in the survey. It appears that the argument that a developer cannot be sure that tenders are being compared on the same basis without one is valid in the view of the respondents. The two least important variables: increased overall cost of the preparation of the tender documentation and increased overall project time in preparing the BQ appear to have little importance to the QS despite the conjecture and level of importance seemingly referred to by the authors cited in the literature.

CONCLUSIONS

There are clear arguments for and against BQs, but very limited research to support them. Many of the arguments are based on anecdote, intuition or common sense. In 1991, the NSW Legislative Council (1991) identified an obvious need for continuing research and debate and advocated further research to establish whether BQs remain an essential part of contract documentation prepared by the building principal.

This paper reports the results of a survey of 86 construction professions within the Australian building industry on issues related to the use of BQs. The key conclusions are:

- Where BQs are sponsored, either by the principal or contractor, measurement is based on builder's quantities. This indicates a strong desire to simplify the measurement process whilst providing appropriate information fro tendering purposes.
- There is a reluctance to make BQs formally part of building contracts. This suggests that principals are more sensitive to the claimed disadvantages, rather than advantages of BQs.
- The majority of respondents saw an unchanged demand or a reduction for principal sponsored BQs in the last 5 years. Nearly 40% of respondents saw no change in the use of building contractor sponsored BQs in the same period. Respondents indicated that BQs accounted for no more than 25% of their work load.
- Respondents considered the important uses of BQs to be the provision of a common basis for valuing variation and a reduction in the need for negotiations.

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