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Towards the establishment of a relevant national tender price index for the South African building industry

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Abstract

There is currently only one published tender price index available in South Africa for use by built-environment practitioners. The purpose of this article is to report on an investigation into the nature of a more recent tender price index.

A literature study was conducted to examine the theory of indices in order to establish which type of index as well as which formula would be appropriate for use in South Africa. Thereafter, the priced bills of quantities of a selected number of projects were analysed in order to identify representative indicator items as well as the weighting thereof for an index. Thirty-two indicator items were identified that could be used for calculating an index. In addition, sourced priced bills of quantities for a number of projects over a six-and-a-half year period were analysed to calculate average rates for the 32 selected indicator items. These rates, together with the established weightings of items, were used to calculate an index.

The main finding that emerged from the research was that, by using the above methodology, an alternative tender price index could be determined for use by the South African building industry.

Keywords: Indices, bills of quantities, rates

Abstrak

Daar is tans slegs een gepubliseerde tenderprysindeks beskikbaar in Suid-Afrika vir gebruik deur bou-omgewing praktisyns. Die doel van hierdie artikel is om verslag te lewer oor 'n studie wat gedoen is oor hoe 'n meer onlangse tenderprysindeks daar sou uitsien.

'n Literatuurstudie is uitgevoer om die teorie van indekse te bestudeer. Dit is gedoen ten einde te bepaal watter tipe indeks asook watter formule die mees geskikte sou wees vir gebruik in Suid-Afrika. Daarna is die gepryste hoeveelheidslyste van geselekteerde projekte ontleed om verteenwoordigende aanwyseritems te bepaal asook die gewigte daarvan. Twee-en-dertig verteenwoordigende aanwyseritems wat gebruik kan word vir die berekening van die indeks is geïdentifiseer. Verdere ontleding van ingewinne gepryste hoeveelheidslyste van 'n aantal projekte oor 'n ses-en-'n-halfjaar tydperk is gedoen om gemiddelde tariewe vir die gekose 32 aanwyseritems te bepaal.

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Hierdie tariewe, saam met die bepaalde gewigte van die items, is gebruik vir berekening van 'n indeks.

Die belangrikste bevinding van die studie is dat deur gebruik te maak van bostaande metodologie kan 'n tenderprysindeks daargestel word vir alternatiewe gebruik deur die Suid-Afrikaanse bou-industrie.

Sleutelwoorde: Indekse, hoeveelheidslyste, tariewe

1. Introduction

Construction-cost indices are used on a daily basis in the industry for cost planning (Kirkham, 2007); forecasting (Flemming & Tysoe, 1991: 18, 21; Yu & Ive, 2008: 694; Ashworth, 1991); updating cost estimates (Brook, 1974: 54; Ferry, Brandon & Ferry, 2003: 154); updating of tenders (Van der Walt, 1992: 1.1; Seeley, 1996: 224; Segalla, 1991: 44); monitoring price movements (Ferry et al., 2003: 176); replacement cost of buildings (Segalla, 1991: 47; Kilian, 1980; Akintoye, Bowen & Hardcastle, 1998: 161); monitoring the national economy (Statistics Norway, 2007), and negotiation of contracts (Brook, 1974: 55; Statistics Finland, 2001: 52).

According to Mohammadian & Seymour (1997: 1), a number of role players in the building industry, such as producers and purchasers of construction projects, suppliers and manufacturers of construction products, designers, quantity surveyors, cost estimators and budget managers, can use cost indices. As there is currently only one tender price index in use in South Africa (the index of the Bureau of Economic Research [BER] of the Stellenbosch University) which uses 22 representative indicator items (Marx, 2005: 8), the author identified the need to conduct a study on the use and compilation of cost indices which might lead to the construction of a possible new tender price index for the South African building industry.

In order to construct a possible new tender price index for the South African building industry, 32 representative indicator items were sourced from priced bills of quantities over a six-and-a-half year period to calculate average unit rates which, in conjunction with the established weightings of items were used to calculate a new index. If the BER index, which, as deemed by some, is outdated and, therefore, no longer accurate, it could have a negative influence on a number of activities of these industries. On the other hand, if the BER index is still accurate, a new index would still be useful, as quantity surveyors and other users of the index could then use it as a checking mechanism in conjunction with the BER index. A new index would, therefore, make an important contribution to the quantity-surveying profession in South Africa.

2. Index theory

2.1 Indices in general

Steyn, Smit, Du Toit & Strasheim (2007: 250) define an index as "[a] ratio that measures relative change", whereas Flemming & Tysoe (1991: 1) state that "[i]ndex numbers of cost and prices provide a convenient means of expressing changes over time in the cost or prices of a group of related products in a single measure". Another way of explaining an index is to state that index numbers are intended to show the average percentage changes in the value of certain products at a specific time, compared to another time. Furthermore, Marx (2005: 3) is of the opinion that indices only measure relative numbers and can, at best, only give an indication of the measure to which a variable, compared to an earlier period, has changed. Therefore, most index figures cannot be very accurate, being unable to reflect information regarding the actual level of a variable.

2.2 Types of indices

Steyn *et al.* (2007: 252) are of the opinion that one must distinguish between simple and composite indices, on the one hand, and un-weighted and weighted indices, on the other. A simple index is used to represent the price change of a single commodity, whereas a composite index represents the price changes of more than one commodity. In addition, when an un-weighted composite price index is calculated, the price changes of all commodities are regarded as equal, while in a weighted composite index, different weights are allocated to the different commodities.

All the important indices used in the construction industry are weighted composite indices. According to Yu & Ive (2008: 704-705), the two most popular indices used are the following:

The Laspeyres price index, for which the formula for calculating the index is:

$$PI = \frac{\Sigma\ pnqo}{\Sigma\ poqo} \times 100 \quad \frac{(\text{price in current period} \times \text{base weight})}{(\text{price in base period} \times \text{base weight})} \times 100$$

This formula thus calculates a base-weighted (or fixed basket) index, where the relative quantities of the base period provide the weighting.

The Paasche index has the following formula:

$$Pp = \frac{\Sigma\ pnqn}{\Sigma\ poqn} \times 100 \quad \frac{(\text{weight in current period} \times \text{price in current period})}{(\text{weight in current period} \times \text{price in base period})} \times 100$$

This formula calculates a current weighted price index, where current prices are compared with the base-year prices.

2.3 Indices in the construction industry

Flemming & Tysoe (1991: 41, 57, 133) and Eurostat (1980: 89-90) state that the following three main types of indices are used in the construction industry.

2.3.1 Input price index

The primary objective of such an index is to reflect local market prices and it can, therefore, be used to reimburse the contractor in respect of cost increases in labour and material. An example of such indices is the Construction Price Adjustment Provision indices published by Statistics South Africa on a quarterly basis.

2.3.2 Output/tender price index

Such indices attempt to measure the total cost of construction of a completed structure in each location, taking into account local conditions, changes in productivity, and contractors' profit margins. For these type of indices, both the Laspeyres index (example: BER building-cost index) as well as the Paasche index (example: Building Cost Information Services (BCIS) index in the UK) may be used.

2.3.3 Seller's price index

Such an index, according to Statistics Norway (2007), includes not only all the costs of the completed construction project, but also the cost of land, finance costs, professional fees, VAT, and the seller's profit. This type of index is not used a great deal in the South African building industry.

2.4 Factors influencing the composition of indices

The following factors influence the composition of indices and should be taken into account when constructing a new index.

2.4.1 Availability of data

Sufficient data in the correct format should be available on a continual basis for any index to succeed (Akintoye, 1991: 27). For a tender price index, priced bills of quantities can be used as a data source if there are a sufficient number of projects available on a long-term basis. Priced bills of quantities provide a valuable source

of information on unit rates of the various building elements. Van der Walt (1992: 3.3) is of the opinion that an index based on starting rates, as is found in tender documents, will be of greater value than using final account rates.

2.4.2 Selection of items

Selecting the items for inclusion can be difficult when constructing an index, especially if there are a number of possible items that can be included. Steyn *et al.* (2007: 261) suggest that a representative sample of items be selected from the survey population and that only these items be used in the index.

2.4.3 Base period/year

A number of authors (Akintoye, 1991: 27; Flemming & Tysoe, 1991: 33; Steyn *et al.*, 2007: 260) conclude that the period chosen as the base (or reference) period should be one of relative economic stability with no 'unusual' occurrences such as wars, abnormal climatic conditions, serious recessions, and so forth.

2.4.4 Choice of weights

As discussed earlier under "selection of items", it is possible to achieve a reliable index by significantly reducing the number of items that form part of the index. When these selected items are not of equal importance, the choice of weights for these items becomes very important. Akintoye (1991: 27) opines that the weights assigned to various items reflect their relative importance and should be carefully chosen in order to avoid biased and misleading results. This principle is commonly known as selecting a 'basket of goods'. When using bills of quantities to be used in an index, Seeley (1996: 228) concludes that the major items incorporating the largest price extension in each trade of the bills of quantities should be included in the index.

Marx (2005: 6) cites Mitchell (1971) who has shown that, by selecting various items which represent as little as a 25% sample of the total contract value, an accepted level of reliability may be achieved. However, Marx (2005: 7) cautions that, after a period of time, such weights will have to be revised in order to accommodate changes in the quality of materials, improved construction techniques, and so forth. Statistics Finland (2001: 18) as well as The Statistics Directorate, European Union (1997: 33) support this observation by mentioning that weights for construction indices should be revised every five to ten years.

2.4.5 Method of construction

As discussed earlier, the most frequently used indices in the building industry are the Laspeyres and the Paasche indices (Yu & Ive, 2008: 704-705).

2.5 Problems with indices

There are some inherent problems in the use of tender price indices. The following are some of the major problems as indicated in the literature:

2.5.1 Accuracy of the index

Van der Walt (1992: 4.72) mentions that an index is relative; in other words, it is not its absolute value that matters, but its tendency over time. It is, therefore, more of an economic model giving a general trend of change over time.

2.5.2 Sample size

To determine an adequate number of respondents is, to a large extent, a sampling question: the larger the number of respondents, the more detailed will the index be that is produced. Ferry *et al*. (2003: 193) mention that, in a tender-based index, a good sample of priced bills of quantities is required to avoid bias such as regional variations. Although the literature is vague about the actual number of priced bills of quantities that are required for an index, authors that comment on the BCIS's tender price index conclude that the BCIS aims at sampling 80 projects per quarter, although this requirement is seldom met.

2.5.3 Changes in quality

Building quality and specifications have changed over time because of advances in building technology. As a typical index will measure the trend of building costs of a typical building, these changes in quality may not be taken into account. One way of overcoming this problem is to review the basket of items on a regular basis so that the components and their weights reflect the changes in standards and technology (Marx, 2005: 7).

2.5.4 Unit rates

According to Marx (2005: 8), the unit rates in bills of quantities can differ markedly. The reasons for these are the different approaches by tenderers to determine such rates, allowances made for inflation, and so forth.

3. Indices in South Africa

Van der Walt (1992: 2.3) states that no officially published building cost-related indices existed in South Africa until the 1960s. Some local firms developed their own indices, mostly by re-pricing existing bills of quantities, but these were never officially published.

3.1 The building-cost index of Stellenbosch University's Bureau of Economic Research

During the early 1960s, a quantity surveyor responsible for research and development at the then Department of Public Works (DPW) in Pretoria, D. Brook, developed an index for use by the DPW (Brook, 1974). The Bureau of Economic Research (BER) of the Stellenbosch University was seeking a deflator for building prices in the mid-1960s and, according to Kilian (1980: 30), obtained permission from the DPW to take over this index.

Marx (2005: 5) reports that the index is based on a 100m^2, single-storey building to which a concrete slab was later added. From this building, 22 cost components were selected and expressed as quantities. Segalla (1991: 55) states that the reason for using these 22 components is that they are representative items from the original building and are weighted in proportion to the role they play in the total cost.

The index is obtained by multiplying each of the 22 weighted components with the current tariff of the items. The information on which the index is based is supplied by quantity surveyors and is submitted on a standard form supplied by the BER. The sum of the current market-related tariffs, multiplied by the base-period quantities, is then divided by the sum of the base-period tariffs multiplied by the base-period quantities. It is thus clear that the BER index is a Laspeyres index. Segalla (1991: 56) notes that, in order to ensure that correct comparisons are made, the index allows a 5% "P & G" amount (currently referred to as "preliminaries") per project. According to Segalla (1991: 56), the 5% was derived from norms established during previous analyses.

Quantity surveyors who submit information to the BER on completed projects are also required to indicate the amounts for electrical work, lifts, air conditioning, and rates for different types of sanitary fittings. In this regard, Segalla (1991: 48) mentions that the amounts for electrical work, lifts and air conditioning are calculated as percentages of the specific contract and, when the index is published, the average percentages for this work section in a specific quarter are given. These

percentages, as well as the published average rates per sanitary fitting, have no bearing on the index and are given as additional information.

3.2 The contract price index for buildings

Very little is known about this index, except that it was compiled by Van der Walt, a quantity surveyor in private practice in Pretoria. The research that was done in the compilation of the index was adapted and presented as part of a PhD thesis in 1992 at the University of Pretoria, but the study was already done in the early 1970s (Van der Walt, 1992: ii). The details of the index were made available to the then Central Statistical Services (CSS), currently known as Statistics South Africa, and published as Statistical Newsletter P0153 since 1980. Due to budget cuts in the CSS, this publication was discontinued in June 1998 (Klaas, 2011: personal communication).

The methodology used for this index was also based on a Laspeyres index with fixed base-year weights. The rates of approximately 270 items that appeared in bills of quantities were surveyed from quantity surveyors and used to publish a contract price index for buildings as well as the weighted average price indices according to region on a quarterly basis (Van der Walt, 1992: 5.2).

4. Constructing a new index

Based on the literature reviewed, the factors that should be considered before constructing an index include a selection of the constituent items as well as the choice of the weights. After determining these factors, the steps towards calculating the index can be followed. For purposes of this article, the following steps have been followed:

- Draw sample of bill of quantities; make adjustments.
- Detail analysis of trades using 5% value (for weights).
- Select indicator items from step 2.
- Request further bills of quantities.
- Analyse rates of indicator items per quarter.
- Average unit rates; smooth out (3-quarter moving average).
- Calculate index.

4.1 Constituent items

In the choice of formula, it was decided to steer the investigation in the direction of a fixed weight, short-list method with priced bills of quantities as basis (Laspeyres index). The main reason for not using

the Paasche index is because of the unavailability of a so-called 'price book' as in the United Kingdom. Such a price book is compiled annually and can be used to re-price bills of quantities with base rates, as has been done by the BCIS.

Preliminaries form an important part of any contract and can fluctuate between contracts and varying economic climates. The BER allows a 5% fixed amount per project. For this article, however, it was decided to spread the preliminaries as priced for each project as a percentage across all rates.

Neither the BER nor the BCIS makes any provision for provisional amounts/sums in their indices. As provisional amounts, as currently priced in contracts in South Africa, can be as high as 40% to 50% of the contract amount, it is considered to be an important item that should form part of a new index. The decision was, therefore, made to include the amounts for the main items such as electrical and mechanical installations on own merit in the index.

Influence of region and site – Although it is anticipated that there will be differences in the prices of labour and material across different regions, only the rates will be influenced by it. This problem can be overcome if a sufficient number of priced bills of quantities can be sourced and averaged rates used. Regarding differences in site conditions, this will be reflected in the rates for poor soil conditions and no other rates would be influenced by it.

4.2 Determination of a new basket of items and their weights

It was mainly decided that the calculation of a new index will be based on fixed weight, short-list method of indicator items, because priced bills of quantities are freely available, as it is still one of the preferred procurement methods in South Africa. In order to establish weights for such an index, it was decided to use the analysis of a variation of buildings to compose an 'average' representative building. This method is, in essence, using the analysis of a variation of different building types to compose an 'average' representative building. Using averages is an accepted method of calculating construction price indices, as indicated by Van der Walt (1992: 4.32) who states that a set of standard weights may be used for all buildings. In Finland the weights of the building-cost index are based on the estimated share of four different types of projects (flats, houses, offices and warehouses) (Statistics Finland, 2001: 8).

First, in order to determine these weights, a sample of buildings that could be regarded as representative of the South African building

industry were determined. The information used for this was that published by Statistics South Africa, viz. *Statistical release P5041.3, Selected building statistics of the private sector as reported by local government institutions, 2008* (Statistics South Africa, 2009). Table 1 shows the selected sample.

Table 1: Value of completed buildings by municipalities, 2008

Building type	*Total value (R'000)*	*% of total*
Office and banking space	4 805 301	35
Shopping space	3 636 047	27
Industrial and warehouse space	3 714 338	27
Schools, nursery schools, hospitals, and so on	145 406	1
Churches, sport and recreation clubs, and so on	282 209	2
All other non-residential spaces	137 826	1
Hotels, holiday chalets, tourism accommodation, and so on	892 815	7
Total	13 613 942	100

Source: Adapted from Statistics South Africa statistical release P5041.3

Secondly, the actual amount of priced bills of quantities needs to be analysed in order to have sufficient information to determine weights that could be regarded as representative of an average building in South Africa. As the literature does not indicate anything specific in this regard, it was decided, in conjunction with the Department of Statistics at the University of Pretoria, to first analyse 20 buildings, then another 10, and finally another 10. At this stage, it was found that the difference in the average percentages that were calculated for the various trades decreased as the number of projects increased. It was thus decided to analyse only 40 priced bills of quantities of different projects.

In terms of the sample of building types that were identified previously from data published by Statistics South Africa, a proportional allocation could be made for the 40 projects that were to be sourced. Table 2 shows the number of bills of quantities per project type; however, in comparison with the percentages as calculated in Table 1, it was decided to reduce the number of industrial buildings. At the same time, it was decided to increase the number of schools and hospitals and to include a block of flats in order to provide a better balance to the projects. Housing was deliberately excluded from the selection because of the different nature thereof (e.g., mostly single storeys with moderate levels of specification), compared with more sophisticated projects such as offices, shops, and so on. Provision was made in

the selection for single-storey buildings to include a single-storey primary school.

Table 2: Number of bills of quantities per project type

Building type	*Number*	*% of total*
Office space	12	30
Shopping space	10	25
Industrial space	8	20
Schools and hospitals	3	7,50
Churches	1	2,50
All other non-residential spaces	1	2,50
Hotels, holiday chalets	4	10
Flats	1	2,50
Total	40	100

4.3 Steps towards calculating the index

Step 1: Draw sample of bill of quantities and make adjustments

Purposive sampling was used to collect bills of quantities for the analysis. A number of well-known quantity-surveying firms throughout South Africa were contacted via e-mail with the request to submit priced bills of quantities for new or so-called 'green fields' projects that were executed between 2005 and 2008. A number of firms responded and a total of 183 priced bills from 27 different firms were received. From these projects another purposive sample was drawn to match the selection of 40 projects needed.

First, some adjustments were made, viz. by omitting allowances for contingencies and the External Works trades, and then adjusting the Preliminaries amounts *pro-rata*. Secondly, the arithmetic mean for each trade per project was calculated and this average was then expressed as a percentage of the arithmetic mean of all projects. It became evident from this analysis that not all trades, as indicated in the Standard System of Measuring Building Works (ASAQS, 1999), are always present in a project. As a result, the less represented trades such as Alterations, Lateral Support, Piling, Precast Concrete and Paperhanging, were omitted from inclusion in the index. Table 3 shows the chosen trades, expressed as percentages (or possible weights), of an 'average' building.

Table 3: Trades' percentages

Trade	*Percentage*
Earthworks	2.70
Concrete, formwork and reinforcement	20.00
Masonry	8.40
Waterproofing	1.10
Roof coverings	3.50
Carpentry and joinery	4.60
Ceilings, partitions and access flooring	3.40
Floor coverings, wall linings, and so on	1.10
Ironmongery	0.70
Structural steelwork	6.20
Metalwork	6.80
Plastering	3.40
Tiling	3.30
Plumbing and drainage	3.90
Glazing	0.20
Paintwork	1.80
Provisional sums	28.90
Total	100

The chosen projects were all measured according to the *Standard System of Measuring Building Works* (ASAQS, 1999) with no or little alteration works involved; it was sourced from the entire country (seven of the nine provinces were represented), and the value of the projects ranged between R2.78m and R568m.

Step 2: Detailed analysis of trades using 5% value (for weights)

Step 2 included a detailed analysis of all the trades in the various bills of quantities. In order to keep to the objective of identifying the minimum number of items to make up a short-list of items, each project's bills of quantities were analysed by selecting all the measured items with a monetary value of more than 5% of the total value of that particular trade. The 5% value is an arbitrary value, as the literature is not clear on this aspect. In this article, on a trial-and-error basis, 5% of the trade value was deemed to give an acceptable lower line of demarcation prior to items becoming insignificant in value. It was found that, with the 5% rule that was adopted, the average number of items selected amounted to 24.7% of the total. These items represented 75.6% of the total adjusted contract amount and, therefore, compares favourably with the BCIS index, where 25% of the items are considered to be adequate for evaluation. Table 4 gives an example of the trade analysis of one project.

Table 4: Extract for bills of quantities analysis

Trade	*Trade total*	*5% of trade*	*Item value*	*% of trade*	*% of adj. tender*
C, F & R	2 357 886	117 849			
25MPa r.conc. in strip footings			333 500	14.14	2.03
25MPa r conc. In surface bed			322 872	13.69	1.97
25MPa r conc. In slabs, beams			271 400	11.51	1.65
Rough formwork to soffits			167 485	7.1	1.02
193 fabric reinforcement			175 240	7.43	1.07
High tensile 20-32mm			141 450	6.00	0.86
High tensile 10-16mm			317 860	13.48	1.90
Total			1 729 810	73.36	10.53

As is clear from Table 4, the value for the trade Concrete, formwork and reinforcement of this project was R2 357 886, with 5% of this amounting to R117 894,30. Seven items were identified with amounts of over 5% of the trade value, as indicated. These seven items represent just over 73% of the trade value and 10.5% of the adjusted tender amount.

Step 3: Select indicator items from step 2

In step 3, all the identified items in step 2 were carried to a spreadsheet indicating all items for all trades to determine which could be selected as indicator items in terms of both the frequency of occurrence and the weight they represent. After some adjustments were made, especially in the Preliminaries trade, the provisional amounts allowed for measurable trades (such as structural steel, aluminium windows and doors, timber fittings, plumbing and drainage, floor and wall tiling, and so forth) were removed and allocated to the various trades where they belong. Of these items, those with the most frequent occurrence were identified. An example of this is the Concrete, Formwork and Reinforcement trade, where a total of 35 items were identified as having a value of over 5%. The most frequent items were the following:

- 25MPa reinforced concrete in strip footings (37 out of the 40 projects).
- 25/30MPa reinforced concrete in surface beds (39).
- 25/30MPa reinforced concrete in slabs and beams (34).
- Rough/smooth formwork to soffits of slabs 1.5 to 3.5m high (34).
- High tensile steel reinforcement 20 to 32mm in diameter (33).
- High tensile steel reinforcement 10 to 16mm in diameter (37).

Four clear groups can be identified from this trade, with the following distribution:

- Concrete: 8.80%
- Formwork: 3.46%
- Reinforcement: 7.22%
- Other: 0.52%
- Total percentage for trade: 20.00%

The same principles were followed with all other trades, some of which were more complex than others, with a large number and variety of items, e.g., Ironmongery, Plumbing and Drainage, and so forth. Resulting from this, 32 indicator items were identified that could be used for calculating an index. There is no indication in the literature on how many items should be necessary to calculate an index (a similar index in Finland consists of 60 items [Statistics Finland, 2001], while one in Ireland uses 40 [Farrely, 2010: personal communication]). From the methodology that was followed, however, the 32 items can be deemed to be adequate to satisfy the requirement of having enough representative items in terms of monetary value to calculate an index. The final weightings for the various groups and items are indicated in Table 5.

Table 5: Final weights according to groups and indicator items

Categories and indicator items	*% (items)*	*% (category)*
Earthworks		2.70
Excavate not exceeding 2m deep for trenches	2.00	
Extra over excavations for carting away surplus material from site	0.70	
Concrete, formwork & reinforcement		20.00
25/30MPa reinforced concrete in surface beds	3.40	
25/30MPa reinforced concrete in slabs, beams, inverted beams	5.60	
Rough/smooth formwork to soffits of slabs propped 1.5-3.5m high	3.60	
High tensile steel reinforcement 10-16mm diameter	7.40	
Masonry		8.40
One-brick walls	7.10	
Extra over ordinary brickwork for face brickwork	1.30	
Waterproofing		1.10
250-micron waterproof sheeting under surface beds	0.30	
4mm waterproofing system on concrete roofs	0.80	
Roof coverings		3.50
0.6mm galvanised steel sheet roof coverings with Chromadek finish	3.00	
Insulation with roof coverings	0.50	
Carpentry and joinery		4.60
Wrought hardwood skirting	2.20	

Categories and indicator items	*% (items)*	*% (category)*
Single semi-solid door with veneer both sides	2.40	
Ceilings, partitions and access flooring		3.40
600x600x12.5mm vinyl suspended ceilings below concrete slab	3.40	
Floor coverings, plastic linings, and so on		1.10
500x500mm carpet floor tiles to screeded floors	1.10	
Ironmongery		0.70
Two-lever mortise lockset	0.70	
Structural steelwork		6.20
Welded and bolted columns, beams, and so on	6.20	
Metalwork		6.80
Galvanised pressed steel single rebated frame for door 813x2032mm suitable for half-brick walls	0.40	
Aluminium windows and doors	6.40	
Plastering		3.40
25mm thick cement mortar screed on floors	0.90	
One coat 1:5 internal cement plaster on brick walls	2.50	
Tiling		3.30
300x300mm ceramic tiles fixed to walls with tile adhesive	1.00	
400x400mm ceramic tiles fixed to floors with tile adhesive	2.30	
Plumbing and drainage		3.90
110mm uPVC soil pipes in ground not exceeding 1m deep	1.10	
White vitreous china WC close coupled pan and matching 9-litre cistern and double flap seat	2.10	
150-litre 400kPa electric water heater complete with control valve, safety valve, vacuum breakers, and so on	0.70	
Glazing		0.20
6mm silvered float glass copper-backed mirror size 400x600mm high fixed with mirror screws	0.20	
Paintwork		1.80
One coat primer and two coats interior quality PVA emulsion paint on internal walls	1.40	
Three coats clear varnish on timber doors	0.40	
Provisional sums		28.90
Electrical installation	16.70	
Mechanical installation	12.20	
Total	100.00	100.00

In determining the unit rates, all the selected indicator items were transferred from the spreadsheet to another spreadsheet. This meant that, where more than one unit rate was selected from the priced bills of quantities, now only one would be selected (those that were closest to the original list of indicator items where there was no exact match). Only the rates inclusive of the respective preliminary percentages were used.

For purposes of this article, the base year to which the estimated weightings related was 2006, as it complied with most of the requirements for a "normal" year, as set out in the literature, e.g., no abnormalities in the levels of production and devoid of abnormal conditions such as war, droughts, floods, and so on (Akintoye, 1991: 27). It also complied with another requirement, namely that it should not be too far in the past (Steyn *et al.*, 2007: 260). Resulting from the above, 2006 was chosen as the base year with a value of 100.

Step 4: Request further bills of quantities

Once the weightings, unit rates and base year were established, further bills of quantities could be requested in order to calculate the index.

In order to obtain a representative sample, another purposive sample was done by requesting price bills of quantities from quantity-surveying firms. A request was e-mailed to firms across South Africa and, ultimately, the bills of quantities of 231 projects received from 37 firms were used. The projects covered the period January 2006 to June 2012 and represented 26 quarters in total. The distribution per year is indicated in Table 6.

Table 6: Number of projects used per year

Year	*Number of projects*
2006	29
2007	31
2008	39
2009	36
2010	48
2011	36
2012	12 (1st and 2nd quarters)
Total	231

Step 5: Analyse rates of indicator items per quarter

In step 5, all the projects from the bills of quantities were analysed, using an Excel spreadsheet, going through the bills of quantities of each project and listing the tariff of the various items that were selected as indicator items to make up the weighting, as discussed earlier. In the first phase of the analysis, more items were extracted from the bills of quantities than those listed. The reason for this was that, in some instances, the exact item as listed might not have been available, but a close substitute was. An example of such items could be found in the Formwork trade, where items with different propping height and/or

different slab thicknesses occurred similar to the original indicator item. As decided erlier, the amount for Preliminaries for each project was added proportionally to the rates of that project. Once the above process was concluded for all projects, the analysis was refined by drawing up another spreadsheet, containing only the rates for one indicator item (those that matched or the closest to the original).

Step 6: Average unit rates and smooth out (3-quarter moving average)

During step 6, when analysing the unit rates captured, it was found that there were substantial differences in the unit rates for the same item during the same time period. Various options were considered on how to deal with such outliers in the rates. One option was to set upper and lower limits (e.g., 30% above and 20% below) to the mean rate. If any rates exceeded these upper or lower limits, they were substituted with either the maximum or the minimum rate. Another option mentioned by Van der Walt (1992: 4.34) was to calculate the standard deviation from the mean rate and use this as a limit. However, Van der Walt (1992: 4.34) concluded that by using this method, too many rates would fall outside this limit and, therefore, change the distribution dramatically.

Both of these options were tested. However, after consultation with the Statistics Department at UP, it was decided to use a more simplistic method, where only the highest and lowest rates were discarded from a series of similar rates and the mean of the remaining rates calculated. These figures would then be used as the base rate for that quarter. The advantage of using this method is that the majority of the rates in a series are considered. This is beneficial where a low number of rates have been received in a particular series.

Once the above calculations were made, the averaged rates were transferred to another spreadsheet. Even though the rates had been averaged, it became apparent that there was still a large amount of fluctuation among the rates from one quarter to another. After further discussions with the Statistics Department at UP, it was decided to smooth the rates further by calculating a three-quarter moving average for each rate for the time period under investigation. According to Steyn *et al.* (2007: 227), the principle of using a moving average within a time series is to smooth out short-term fluctuations.

Step 7: Calculate the index

After completion of steps 1 to 6, the complete index for the time period under investigation could be calculated. This was achieved by following the principles of the Laspeyres index, as discussed earlier,

viz. by calculating the total of the base-year quantities at current rates, divided by the total of the base-year quantities at base-year rates, multiplied by 100. This was done for each quarter in the study period. The calculation, for example, for Quarter one, 2007, would be as follows:

$$\frac{273\,344{,}67}{243\,535{,}96} \times 100$$

$$= 112.24$$

Similarly, the calculation for Quarter Two, 2007, would be:

$$\frac{287\,057{,}59}{243\,535{,}96} \times 100$$

$$= 117.87$$

The calculation for the full time period, first quarter 2007 to end of second quarter 2012, analysed, is shown in Table 7.

Table 7: Calculation of price movement: 2006 to 2012 (2nd quarter)

2006	*100*
Q1 2007	112.24
Q2 2007	117.87
Q3 2007	117.22
Q4 2007	114.72
Q1 2008	113.44
Q2 2008	133.13
Q3 2008	153.80
Q4 2008	158.99
Q1 2009	157.90
Q2 2009	139.93
Q3 2009	131.25
Q4 2009	111.34
Q1 2010	106.94
Q2 2010	106.24
Q3 2010	110.18
Q4 2010	113.22
Q1 2011	114.28
Q2 2011	115.48
Q3 2011	115.87
Q4 2011	115.54
Q1 2012	112.68
Q2 2012	110.41

Figure 1 shows the above movement graphically.

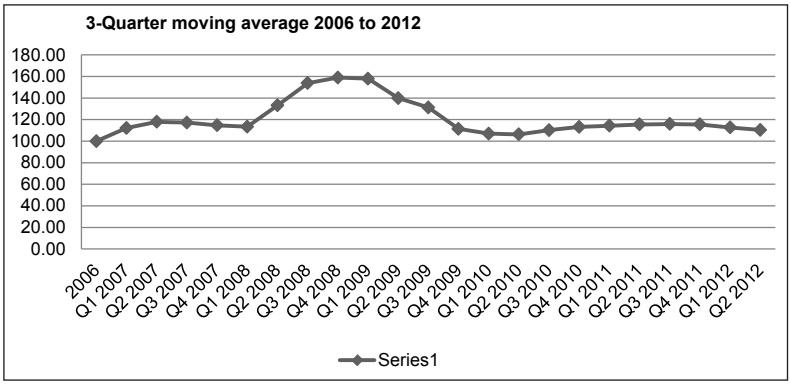

Figure 1: Three-quarter moving average 2006 to 2012 (2nd quarter)

5. Discussion

As indicated earlier, a tender price index is an indication of the movement of a basket of rates over a period of time. The new index under scrutiny should be examined in that context (for research purposes, the index can be referred to as the 'UP 2006' index). The index, as depicted in Figure 1, shows an upward curve from 2006 (UP 2006 = 100) to about the end of 2008, where the index peaked at 158.99. This represents an increase in prices of almost 60% over the two-year (or eight quarters) period or an average of approximately 7.5% per quarter. As indicated earlier, this was a period in the history of the South African building industry which overlapped with a worldwide boom in the construction activity, especially in the light of the then upcoming 2010 Soccer World Cup. Therefore, the general movement of this peak in the UP 2006 index seems to be defendable.

After the construction boom period, there was a sharp decline in construction activities. This could be attributed to the conclusion of the World Cup projects and to the worldwide economic recession, which also started to have an impact on the South African economy. The UP 2006 index shows a similar movement with the trend going down from the 158.99 figure in the fourth quarter of 2008 to a low of 106.24 in the second quarter of 2010.

This represents a decline of 33.18% over a six-quarter period, with an average of approximately 5.5% per quarter. After this, the UP 2006 index shows a relatively consistent movement over the following two years until the end of the research period, the second period of 2012. This movement seems consistent with what emerged from the

projects that were investigated over this period, viz. that tendered rates did not show a significant amount of increase during this two-year period.

6. Comparison of indices

In order to determine whether it is possible to construct a new tender price index based on accepted norms and standards regarding index theory, a comparison was made between the BER building cost index and the UP 2006 index. To compare the two indices over the same time period, it was necessary to extract information for the BER index from information published by Medium Term Forecasting Associates (2008 to 2013) for the same time period, and then to extrapolate the data.

Figure 2 shows that there is a reasonable degree of correlation between the two data sets. The biggest difference is shown from the second half of 2009, where the UP 2006 trend is sharply downwards, and the BER trend is more gradual.

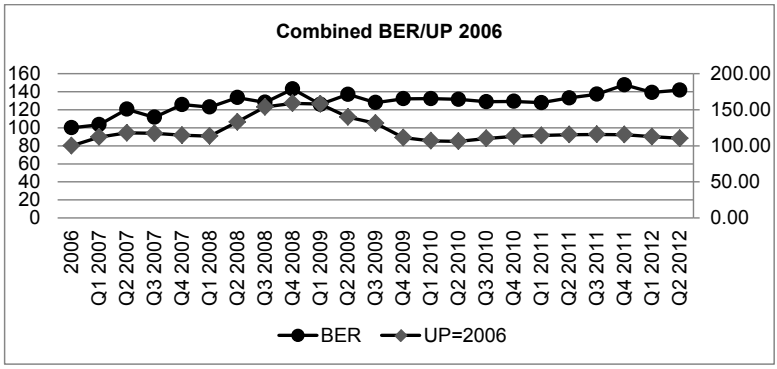

Figure 2: Combined BER/UP 2006 indices

7. Conclusion

Based on the reasonable degree of correlation between the BER and UP indices, it may be concluded that it is possible to construct a new tender price index based on accepted norms and standards regarding index theory as laid down in the literature and in studies conducted on other similar indices. In order to test the validity of the UP 2006 index, it is suggested that comparisons be made with the movement of the economy in general over a longer time period. It will also be beneficial if a larger sample of priced bills of quantities be

obtained to make it statistically more stable. To achieve this, a new method of collecting these projects will have to be considered, e.g., in collaboration with the ASAQS. The UP 2006 index can also be made available to the quantity-surveying community on a quarterly basis for comments and to test it in a commercial environment.

References list

Akintoye, A., Bowen, P. & Hardcastle, C. 1998. Macro-economic leading indicators of construction contract prices. *Construction Management and Economics*, 16(2), pp. 159-175.

Akintoye, S.A. 1991. *Construction tender price index: Modelling and forecasting trends.* PhD thesis. University of Salford, UK.

Ashworth, A. 1991. *Cost studies of buildings.* Essex, UK: Longman.

Association of South African Quantity Surveyors (ASAQS). 1999. *Standard system of measuring building works. 6th revised edition.* Midrand: ASAQS.

Brook, D.E. 1974. Building cost index. How it works and how to use it. *BER Building Survey*, 21, pp. 5-18.

Farrely, B. 2010. (The Society of Chartered Surveyors, Dublin, Ireland). Personal communication on tender price indices in Ireland. Date of communication: 5 January 2010.

Ferry, D.J., Brandon, P.S. & Ferry, J.D. 2003. *Cost planning of buildings.* 7th edition. Oxford: Blackwell Publishing.

Flemming, M.C. & Tysoe, B.A. 1991. *Spon's construction cost and price indices handbook.* London: E & FN Spon.

Kilian, W.F. 1980. *An assessment of the BER building cost index.* Building survey no. 44, January 1980. University of Stellenbosch, Stellenbosch, South Africa.

Kirkham, R. 2007. *Ferry and Brandon's cost planning of buildings.* 8th edition. Oxford: Blackwell Publishing.

Klaas, R. 2011. (Senior statistician, Statistics South Africa). Personal communication on Statistical newsletter P. 0153. Date of communication: 15 November 2011. Pretoria, South Africa.

Marx, H.J. 2005. *Correctness of the BER building cost index.* Research Report: Department of Quantity Surveying and Construction Management, University of the Free State, Bloemfontein. June 2005.

Mohammadian, R. & Seymour, S. 1997. *An analysis of some construction price methodologies.* Statistics Canada, price division. Catalogue no. 62, F0014, MPB, no. 2. April.

Seeley, I.H. 1996. *Building economics.* 4th edition. London: Macmillan Press.

Segalla, U. 1991. The BER building cost index – an overview. *Journal for Studies in Economics and Econometrics,* 15(1), pp. 43-57.

Statistics Directorate, European Union. 1997. *Sources and methods: Construction price indices.* Luxembourg: Statistical Office of the European Community.

Statistics Finland. 2001. *Building cost index 2000 = 100: User's handbook*. Helsinki: Hakapaino Oy.

Statistics Norway. 2007. *Construction price indices and house and property price indices 2006: Results and methods.* Oslo: Statistics Norway.

Statistics South Africa. 2009. *Selected building statistics of the private sector as reported by local government institutions, 2008.* Statistical release P5041.3. Embargoed: 29 June 2009.

Steyn, A.G.W., Smit, C.F., Du Toit, S.H. & Strasheim, C. 2007. *Modern statistics in practice.* 7th edition. Pretoria: Van Schaik Publishers.

Van der Walt, P. 1992. *'n Kontrakprysindeks vir geboue in die Republiek van Suid-Afrika*. PhD proefskrif. Universiteit van Pretoria, Pretoria.

Yu, M.K.W. & Ive, G. 2008. The compilation methods of building price indices in Britain: A critical survey. *Construction Management and Economics*, 26(7), pp. 693-705.