

DEVELOPING A BASKET OF RESOURCES AS A TOOL FOR COLLECTING CONSTRUCTION COST DATA INTERNATIONALLY

Rick Best¹

*Centre for Comparative Construction Research, Institute of Sustainable Development and Architecture,
Bond University QLD 4229 Australia.*

Comparing construction costs between countries, even when the countries share a common currency, is recognised as a difficult problem. Construction cost data has been included in the World Bank's International Comparison Program for many years and that data has been collected using a variety of methods. Currently several different methods are in use within the ICP and these include several types of baskets of inputs of various types and combinations. These methods have been constantly under review and as part of the latest review a new approach is being developed based around a basket of resources (BoR). The new basket has been developed based on analysis of pricing instruments used in a number of earlier studies and several ongoing pricing exercises conducted regularly by commercial concerns such as large international quantity surveying organisations. The materials/components section of the new BoR, its development and some early observations of its use in practice are presented. Further development and refinement of the basket is outlined.

Keywords: construction cost, construction inputs, international comparison, purchasing power parity.

INTRODUCTION

The International Comparison Program (ICP) conducted by the World Bank routinely involves the collection of cost data across many sectors of the economies of around 180 countries (ICP 2011a). Construction and civil engineering costs are a significant component of the ICP. To date these costs have been collected using two general methods, i.e. standard projects and several variations on a basket of inputs (materials and other resources) (ICP 2011b). Recently a revised approach based on a basket of resources (BoR) has been developed and it is expected to be used in the next ICP pricing round. The choice of this method was based largely on previous studies by Meikle (2003a; 2003b) and Best (2008). The basket comprises physical inputs (materials, components), labour, plant and equipment and allowances for overheads, profit and other items that contribute to the final cost of construction that is paid to industry by clients. The discussion here is limited to the initial study which was focused on the identification and selection of the physical inputs (including construction plant/equipment) that would be included in the new BoR; the other components of the basket, including labour, will be the subject of future publications.

¹ ribest@bond.edu.au

RESEARCH AIMS

The aim of the exercise described in this paper was to analyse previous studies/exercises to inform the process undertaken to develop a new basket of resources for pricing purposes as part of the ICP. While the people engaged in the latest study possess considerable experience in construction generally and in the collection of cost data particularly simply populating a basket of resources on a purely ad hoc basis was not considered to be sufficiently rigorous given the importance of satisfying a number of possibly conflicting requirements if the whole exercise was to produce improved outcomes for the ICP. Thus a detailed examination of other efforts was carried out and where possible the level of success achieved in those earlier efforts was considered.

BASKET PARAMETERS

The aim of the ICP is to compare GDP in real terms between different countries. This requires a method that does not use market currency exchange rates and eliminates differences in price levels between countries. Construction cost data feeds into the ICP and leads to the production of purchasing power parities (PPPs) for whole economies and for sectors such as construction. Ideally for this to be done successfully costs should be actual prices paid for goods and services. In the case of construction this might be out-turn costs paid by clients to the industry for completed projects. In practice such data for comparable projects is extremely difficult to obtain. The OECD-Eurostat standard project method aims to do this but it is not considered to be particularly successful as costs are estimates rather than actual project data and the complexity and costliness of the method means that only one price observation is obtained in each country (Dubner and McKenzie 2002; Stapel 2002; Ward 2003). The alternative is some form of input cost method with mechanisms that adjust input costs to give out-turn prices. Such methods have been trialled and two have been used previously by some sectors in the ICP. These are outlined briefly later.

The new basket will be used to gather input costs for a variety of items that are primary inputs into the construction process:

- basic materials, such as sand and cement
- manufactured goods such as ceramics and paint that are incorporated into buildings in a similar fashion to basic materials
- complex items, such as windows and electrical components, that are installed as units
- labour required to fabricate and fix materials onsite
- supervisory labour
- plant and equipment required in the construction process.

The items selected for the BoR should be:

- in common use in many locations
- be able to be specified in clear terms so that very similar items will be priced in all locations
- typically used in quantities that make them significant factors in total construction cost of projects
- reasonably representative, as a basket, of all elements of typical construction including engineering/building services

POPULATING THE BASKET - MATERIALS

For practical reasons the basket, while needing to be comprehensive enough to represent the industry, must be such that in-country pricing can be done reasonably quickly and cheaply. The more cheaply the data collection can be done the more opportunity there is for obtaining more than one set of price observations in each country. It is also important that as many product groups as possible are represented so that the spread of items includes as many as possible of the Standard Industrial Classification (SIC) product groups that feed into construction. This provides the added benefit of feeding construction materials data into national accounting processes in countries that do not have well developed systems and/or that may not have the wherewithal to support a wide-ranging national statistics office.

Once it was determined that a BoR approach would be adopted (how this decision was made is a separate topic) and the parameters above in mind a number of existing basket-based exercises were analysed to determine the items most commonly included. Those exercises are briefly described below.

Analysis of previous studies

Eight baskets used in both one-off studies and some regular pricing exercises carried out by firms were examined. Commonly occurring items were identified and these form the basis of an initial basket. Each of the baskets examined had its own characteristics:

The BLOC (Basket of Locally Obtained Commodities)

The basket used in this exercise was derived from analysis of a priced bill of quantities for a completed hotel project located in suburban Sydney (Best 2008). Cost significant items in each trade were identified and a weighted basket of goods was derived. The basket was representative of a particular building type in Australia. It included 24 materials items and included a number of items related to building services. It was not intended to be representative of any other type of construction (such as engineering construction or residential building)

The BoG (Basket of Goods)

This basket was produced by Davis Langdon Consultancy (DLC 2003) and tested across a number of European countries. Material selection was based on the researchers' personal experience. It included 35 materials items of which 20% related to building services. It was intended for use in the European context and the choice of materials does to some extent reflect that, e.g. concrete and clay roof tiles as the only roof covering materials.

The BOCC (Basket of Construction Components)

This basket was devised by Walsh and Sawhney (2002; 2005) and was used in the 2005 ICP pricing round. It contains both simple/basic materials and as well as composite/complex items. In this analysis only the basic items were considered although it should be noted that many of the composite included basic materials that were also part of the basket. Selection of items was based on extensive research in a number of countries where the designers of the basket looked at various materials and components or assemblies of materials (e.g. concrete footings and columns). The basket contained only one item related to services and that was difficult to price with any certainty.

Table 1: Most common materials items identified in previous studies

Materials	Frequency	Notes
Sawn timber	4	Also part of formwork
Aggregate	8	Varying specifications
Sand	5	Generic item
Paint	6	Spec ranges from generic "paint" to particular types (e.g. "emulsion")
Windows	6	Includes frames only, fully glazed, single and double glazed
Vinyl floor coverings	3	Tiles and sheet
Plastic pipe	4	Varying specifications
Plywood	6	Various types: internal, external, formply
Timber door	6	Various types, inc/exc frame and hardware
Cement	7	In some cases as a component of concrete not as a discrete item
Concrete	7	Varying strengths
Bricks	5	Mostly commons (4)
Ceramic tiles	5	Wall and floor - clay tiles not included
Plasterboard	5	Also plaster (tonnes) occurs twice
Concrete blocks	10	Mostly hollow (n=8)
Glass	7	Mostly 6mm clear float (n=6)
Reinforcing steel	7	Mostly high tensile (n=6)
Structural steel	8	
Roof coverings	3	Various types - no clear choice
Cast iron/steel pipe	7	4/3 split
Copper pipe	4	Small diameter
Electrical cable	5	
Basin	3	Hand basin/vanity basin
WC suite/pan	4	

The ICEC Location Factor Model

This initiative by the International Cost Engineering Council (ICEC n.d.) was intended to collect a relatively small set of costs for a model project comprising a process plant and a small building. The survey form included composite and basic items and was weighted towards engineering construction of a certain type. It was included in this analysis as it did contain some of the commonly occurring items such as concrete, gravel and sand. It includes four services items.

Gardiner and Theobald

Gardiner and Theobald is an international firm of construction consultants. They publish the results of a regular cost survey of international construction (GandT 2010). Their list of key materials is quite short, comprising only 11 items of which none are related to services. Although the list is short it contains key materials and it is the choice of these items that is of interest here. It is not a basket as such but more a set of indicative prices that appear to be published as much as a public relations exercise as for any other purpose.

CIS – The Resource Technological Models

This method is based on a list of 66 items that includes basic and composite items plus three energy items (CIS 2005). Only items that roughly correspond to those in other baskets in the analysis were included, e.g. concrete and cement are included while "foundations" and "external wall panels for residential buildings" were not. The significance here is in the key items that are included that reflect similar choices in other baskets. Some 16 of the 63 materials items are services related.

Building Cost Information Service (BCIS) - Asia Building Construction Survey

This study included input costs for 15 materials (BCIS 2006). Materials costs were not the primary focus of the study and were included to allow indicative comparisons of relative construction costs in a number of Asian countries. Once again the significance is in the choice of items that the BCIS considered to be the key items. The list did not include any services items.

Faithful+Gould – International Construction Intelligence

This is a regular survey carried out in 32 countries (Faithful+Gould 2010). It includes a list of 25 material/component inputs of which 11 are services related.

Summary

Several key factors emerge from the foregoing analysis.

- There are a number of materials that appear in many of the lists with some that are more or less ubiquitous, e.g. concrete/cement, structural and reinforcing steel.
- Some of the lists are produced for purposes other than the population of a basket to be used for comparative purposes and of these lists some are quite short, being intended as simple indicators of comparative costs between locations.
- Although in practice building services typically represent between 20% and 50% of building costs, services related items are often poorly represented or even ignored completely in these pricing studies.

Table 1 lists the items that were identified as those most commonly occurring in the analysis. In some cases similar items have been combined, e.g. aggregate was described differently in some studies (i.e. coarse aggregate, fine aggregate, aggregate for concrete). Table 2 shows the items arranged by SIC groups.

Selecting materials for the basket

The analysis was carried out in order to provide a sounder basis for the selection of items in the BoR than just relying on the experience of one or two people. In the entire cost comparison arena there are no "correct" answers and the question of what should or should not be included in such a basket is no exception; in this exercise, however, the opinions of a number of experts have been sought, indirectly, through analysis of the items included in other baskets.

The items cover eight SIC groups; to maximise the utility of the data gathered in a national accounts context coverage of more SIC groups is useful. The wider coverage also increases the representativeness of the basket thus several additional items were considered for inclusion in the BoR:

- Carpet (SIC 17 - Manufacture of textiles)
- Petrol (gasoline) and diesel fuel (SIC 23 - Petroleum products)
- Pumps and fans (SIC 29 - Manufacture of machinery and equipment)

Inclusion of these items increases the coverage from eight SIC groups to eleven. Carpet, although appearing only once in the analysis, is in common use and in the study based on the BLOC was priced consistently with just a single outlier from a dataset of 50 observations across six locations (Best 2008). The fuel items appear only in the CIS list but are included here as the data may be useful as a proxy for

construction equipment. Electrical equipment constitutes a significant cost component in mechanical and hydraulic services thus the fan and pump items fill a gap in the basket as well as adding another SIC group to the mix.

ASSEMBLING THE SURVEY INSTRUMENT

Once the items have been identified it is necessary to define and specify the actual items to be priced.

Table 2: Materials items in summary arranged by SIC code

Sic code	Industry group	Selected materials and products
14	Other mining and quarrying	Aggregates and sand for concrete
20	Wood and wood products	Sawn timber, plywood, timber door, timber window (†)
24	Chemicals	Paint
25	Rubber and plastic products	Vinyl floor coverings, plastic pipe
26	Glass, ceramic, clay and cement products	Cement, ready mix concrete, plasterboard, bricks, concrete blocks, float/sheet glass, window glass (†), ceramic tiles, basin, wc, roof coverings (†)
27/28	Metal products	Reinforcing steel, structural steel, cast iron drain pipe, copper pipe, roof coverings (†)
31	Electrical machinery	Pvc insulated cable

(†) means the product may be part of more than one code as it is a composite product such as a timber framed window with glass infill, or it depends on the item specified (e.g. roof coverings might be clay tiles or metal sheet).

Where there are options for pricing (e.g. aggregate may be priced by the tonne or per m³, bricks and blocks may be priced per unit/each or per m²) respondents may be asked to supply some additional data to allow others to convert prices to common units. A glossary of terms may be required to provide clear definitions of terms where it is expected that there may be differences in regional terminology.

Table 3 Basket of resources (materials and fuel only)

Sic	Item	Specification	Unit	Notes
14	Aggregate	Coarse aggregate (crushed rock, gravel) for use in concrete	Tonne	If pricing in m ³ please give indication of density (kg/m ³) of typical aggregate in your location
14	Sand	Sand suitable for use in concrete and render	Tonne	If pricing in m ³ please give indication of density (kg/m ³) of typical aggregate in your location
17	Carpet	80/20 wool blend carpet, average commercial quality	M ²	Typical for use in mid-range hotel or residential
20	Sawn timber	Softwood sections for use in general carpentry (wall framing, roof framing and similar)	M ³	Typical sections such as 100mm x 50mm
20/26	Timber window	Approx. 500mm x 500mm, timber frame, glazed with one fixed	Each	Average cost for domestic or commercial use - fixed pane

		pane of 6mm plain glass		hence no hardware included
20	Plywood	15-18mm thick plywood for basic interior use	M2	Do not price for water resistance, decorative finish or exterior grade
20	Timber door	Timber door, interior use, nominal overall size 2000 x 800 x 35mm, flush panel for paint	Each	Excluding hardware, frame and all other accessories
23	Petrol/gasoline	Standard grade unleaded petrol/gasoline	Litre	
23	Diesel fuel	Standard grade diesel fuel	Litre	
24	Paint	Low sheen emulsion (water based) paint suitable for interior plaster and render	Litre	Commercial quality and quantity
25	Vinyl sheet	2mm thick vinyl sheet - average quality	M2	Commercial quality and quantity
25	Plastic pipe	150mm diameter plastic drain pipe	M	Straight lengths of plain pipe suitable for stormwater (rainwater) in ground
26	Cement	Ordinary portland cement for general building work	Tonne	Contractor quantity
26	Concrete	25mpa (25n/mm ²) readymixed concrete delivered to site	M3	Medium size project quantities
26	Bricks	Common bricks suitable for rendering or painting	M2	If pricing in other units please specify dimensions of bricks
26	Ceramic tiles	300mm x 300mm (approx.) Ceramic floor tiles - average quality	M2	Commercial quality and quantity
26	Plasterboard	13mm thick paper faced gypsum board	M2	Also known as sheetrock - suitable quality for basic interior use (wall and ceiling linings)
26	Concrete blocks	Plain hollow blocks - basic quality	M2	If pricing in other units please specify dimensions of blocks - no reinforcement or core filling
26	Glass	6mm thick plain float glass	M2	Suitable for basic glazing in frames
26	Wash basin	White fired clay hand basin - wall or bench mounted	Each	Commercial quality and quantity - no tapware or plumbing
26/28	Metal window	Approx. 500mm x 500mm, aluminium frame, glazed with one fixed pane of 6mm plain glass	Each	Average cost for domestic or commercial use - fixed pane hence no hardware included
27	Iron/steel pipe	100mm diameter steel or cast iron drainage pipe	M	Average quality, interior use
28	Rebar	High strength steel bar reinforcement 12-24mm diameter	Tonne	Medium size project quantities
28	Structural steel	Standard steel sections 150-300mm max cross sectional dimension	Tonne	Including fabrication and delivery
28	Metal roofing	Simple profile galvanised steel roof sheeting	M2	No colour treatment
28	Copper pipe	Small diameter (15-20mm) pipe suitable for hot and cold water reticulation	M	Straight lengths of plain pipe in medium size project quantities
29	Electric pump	Electric pump, flow rate 10 litres/second, head pressure 150kpa	Each	For pumping water, temperature range 5-800c
29	Fan	Electric exhaust fan, flow rate 1000 litres/second, head pressure	Each	For interior installation

		250pa		
31	Electrical cable	Pvc sheathed and pvc insulated cable suitable for domestic circuits	M	Medium size project quantities

The survey instrument must also include instructions regarding pricing parameters such as the exclusion of VAT/GST, inclusion of delivery to site, pricing “supply only” not “supply and fix” and so on. Best (2008) gathered costs for a basket of materials in only four countries but still experienced difficulties with differences in the way some items were priced and often identified prices that were supply and fix rather than the supply only prices that were requested. Table 3 lists 29 materials and products (including two fuel items) covering eleven SIC groups with brief specifications, units of measurement and brief explanatory notes.

Brief specifications for the fan and pump items were devised in consultation with a specialist services quantity surveyor (Nowak 2010). Specifications for the rest of the items were developed in consultation with Meikle (2010; 2011) who has many years of experience in international construction cost data collection (e.g. Meikle 2003).

CONSTRUCTION PLANT AND EQUIPMENT

While materials generally account for a large proportion of total construction costs plant and equipment used onsite can also be a significant cost in building work and are generally more significant in engineering construction. Plant and equipment are costed in different ways according to country and the manner in which items are sourced (i.e. owned by contractors or hired as needed). For example, in Australian it is common practice for large items of plant that are used by more than one trade (e.g. a tower crane that hoists all manner of materials off trucks and to storage areas or to working levels for installation) to be costed as part of a Preliminaries package (Rawlinsons 2010). Preliminaries also includes other site/job specific costs that the contractor incurs in the course of building a project apart from costs (e.g. labour and materials) that are incurred; such costs include insurances, site amenities and site water and electricity supply. In the USA, however, craneage is usually treated as a separate cost centre. If a crane is hired then daily/weekly/monthly costs are incurred; if the contractor owns the item then a time-related cost of ownership is charged against the job which includes depreciation, maintenance, fuel, operator and so on.

Table 4 Preliminary list of plant items for inclusion in the draft BoR

Item	Unit	Notes
Backhoe	Day	Suitable for excavating trenches for pipework and footings/foundations, including operator
Plate compactor	Day	Suitable for compaction of base materials under concrete slabs, excluding operator
Mobile crane	Day	10--15 tonne capacity, diesel or petrol fuel, including operator(s)

The analysis of previous baskets revealed that plant and equipment are seldom addressed. The BOCC includes just two items, the ICEC model included crane hire, two include energy (fuels and electricity) in some way while the rest do not include plant directly at all. The BOCC also included plant costs in composite rates for components, however, there are no details available to verify how well that worked in practice. Given the lack of information available in regard to plant and equipment and how it might be priced the short list of items shown in Table 4 was selected for

inclusion in the draft BoR with a view to testing the suitability of the items in a pilot study. The result of the pilot will be published when data validation is complete.

CONCLUSIONS

The foregoing analysis and discussion covers only a small portion of the effort that is required to develop a new pricing mechanism for gathering construction data for the ICP. The adoption of the BoR approach has led to many issues that must be resolved. Identifying materials and products that can be priced in many places and that are representative and comparable between locations is, however, a significant part of the overall process. Development and refinement of the BoR and the survey instrument that will be used to gather data for the BoR exercise is ongoing and will be reported in later publications. Similarly the performance of the BoR exercise will be reported when field tests are complete and eventually when the main pricing round is complete.

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