Technical Guide for the Building Construction Price Index

by Anahita Azam

Release date: July 28, 2022
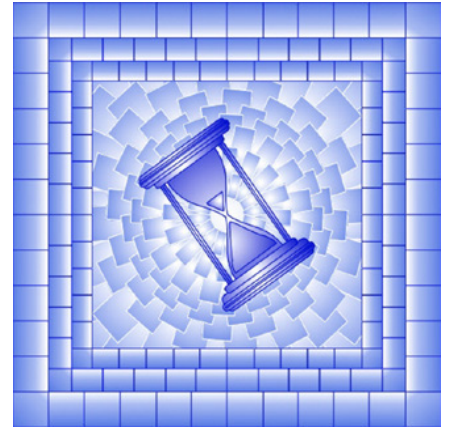
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Technical Guide for the Building Construction Price Index

1. Introduction

This technical guide describes the estimation of the Building Construction Price Index. It explains the component cost methodology, the aggregation structure, and the data sources used to derive price relatives that are appropriately aggregated to estimate the index.

The Building Construction Price Index (BCPI) measures the quarterly change over time in the prices that contractors charge to construct a range of new residential and non-residential buildings. It is composed of two separate indexes: the Residential Building Construction Price Index (RBCPI) and the Non-Residential Building Construction Price Index (NRBCPI). The index is available for 11 Census Metropolitan Areas (CMAs) – St. John's, Moncton, Halifax, Montréal, Ottawa, Toronto, Winnipeg, Saskatoon, Calgary, Edmonton, and Vancouver – as well as for a Canada-wide composite.

The BCPI is used by government agencies undertaking economic analysis and other users that are interested in evaluating the impact of price changes on capital expenditures. Statistics Canada, for example, uses the BCPI in preparing estimates of the construction industry's contribution to national expenditure, real output and capital stock. Other uses include the revaluation of expenditure and output for construction work, making adjustments to project costs for escalation, as well as forecasting financial requirements for proposed projects and real rates of return on investment.

Table 1
Key concepts and definitions used for constructing the BCPI

Concept	Definition
Price	The value of all materials, labour, equipment, overhead and profit represented by the construction contractor's bid price for a new building project. It excludes value added taxes and any costs for land, land assembly, building design, land development and real estate fees.
Target population	All cost components used to construct new residential and non-residential buildings in Canada. These cost components cover construction activities associated with the architectural, structural, mechanical and electrical trade groups, as well as general contractors' overhead and profit.
Composite	The aggregated index for the 11 CMAs for residential and non-residential building construction; a composite is available by each structure type and building type.
Index base period	The period for which the BCPI equals 100.
Weight reference period	The period when cost component weights were determined for each building; for non-residential buildings and high-rise apartments, it is 2015; for all other residential buildings, it is 2017
Collection period	Collection of prices and price movements occurs over the second and third months of each quarter, i.e. February and March, May and June, August and September, November and December.
Structure type	Multi-family dwellings, single-family dwellings, commercial buildings, industrial buildings, institutional buildings.
Building type	High-rise apartment building (five storeys or more), low-rise apartment building (fewer than five storeys), single-detached house, townhouse, office building, warehouse, shopping centre, factory, bus depot with maintenance and repair facilities, school.

2. Component Cost Methodology

The component cost approach uses the price change of sets of standardised homogenous components representing typical operations in the construction of a representative building construction project.

It begins with identifying representative building projects and all the cost components required for these building projects. Of all the cost components required for a building project, a sample of representative cost components are selected with a target coverage of components that together account for about 80% of the total expenditure of the project. The price movements of these representative components are tracked over time.

Price movements of the cost components are aggregated by building type, structure type, CMA, and across CMAs to derive an 11-city composite price index for residential and for non-residential building construction.

Additional details about the representative construction project and representative cost component selection processes are provided in the appendix.

3. Aggregation Structure

The BCPI aggregation structure is presented in Figure 1. It illustrates the various levels of aggregation from the elementary aggregates at the representative cost component level, to higher level indexes at the building and structure level, up to the total residential building construction and non-residential building construction index. Furthermore, the index is classified by geography at the structure and building type levels for each CMA surveyed and also calculated as an 11-CMA composite.

The index at each of these levels is compiled as a weighted aggregation of the representative cost components associated with a particular building type. The representative cost components are selected from all the major trade groups – general requirements, architectural and structural, mechanical and electrical. The index at the building, structure and aggregated residential or non-residential level is available for each of the 11 CMAs and as an 11-CMA composite.

Figure 1
BCPI aggregation structure
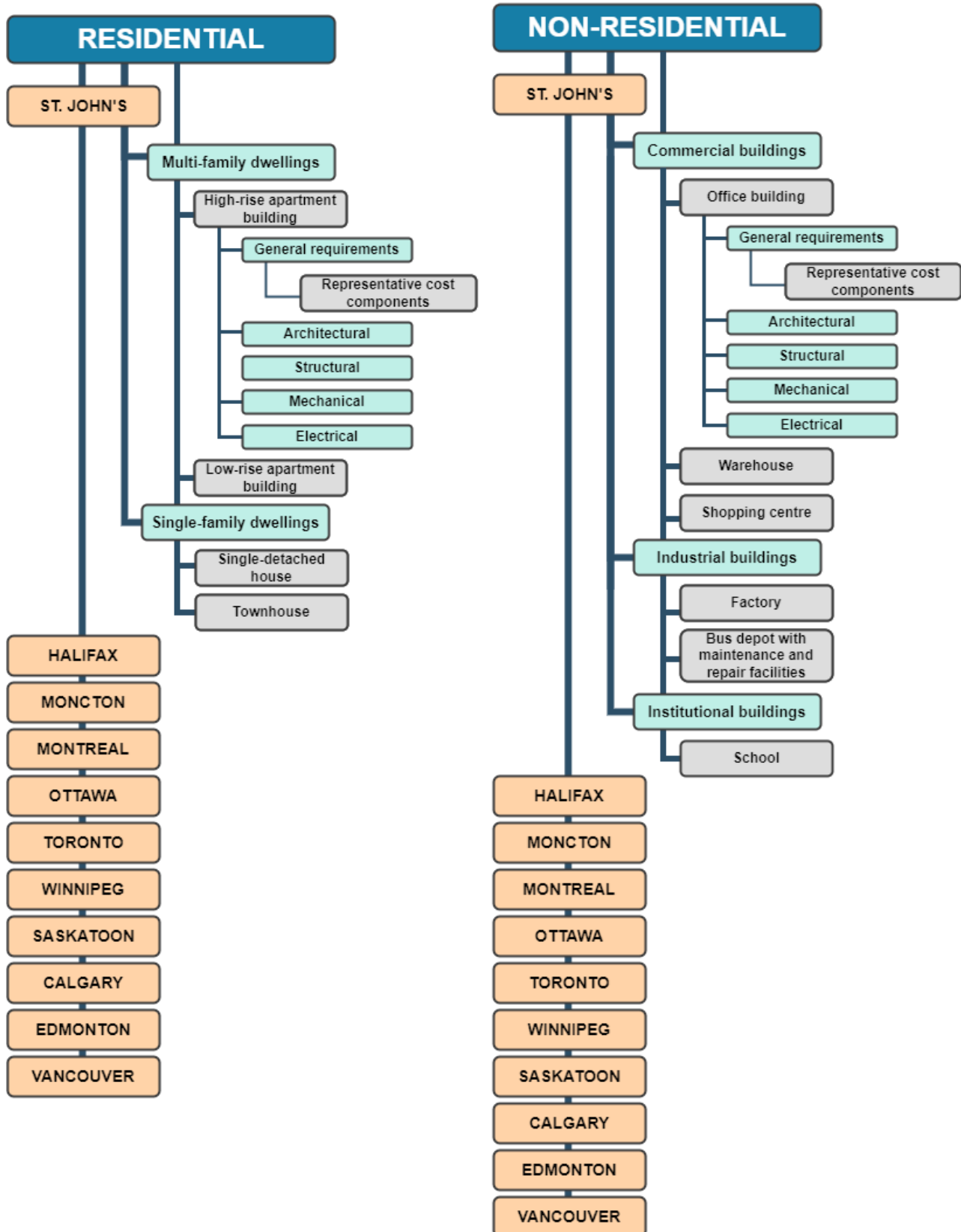
4. Data Sources

4.1. Sampling process

The BCPI uses a multi-stage sample design. The selection of representative cost components is detailed in the appendix. To collect information on changes in the prices of representative cost components under the architectural and structural trades as well as under the general requirements categories, a sample of active general contractors is selected for each CMA. The contractors must be actively bidding and winning a share of the residential and/or non-residential construction jobs and are usually members of local construction associations who are knowledgeable and capable in their pricing. Their reported price movements are considered to be representative of market conditions in their CMA.

Many of these contractors are reporting intended building construction projects to Statistics Canada's Building Permits Survey. Other sources include the companies listed on Statistics Canada's Business Register (BR) that are classified as NAICS code 2361 (Residential Building Construction) and 2362 (Non-residential Building Construction) as well as external online research by Statistics Canada.

Over time, contractors enter and exit the construction market. To ensure that the BCPI continues to measure change in the prices that contractors charge to construct residential and non-residential buildings, the sample of contractors must be monitored and refreshed on a quarterly basis. Statistics Canada subject matter staff continuously review the contractor sample size and composition to remove those that are no longer in business or determine when new units need to be added.

4.2. Prices

The index is calculated based on estimated prices in the real market for the representative cost components. The current price for each representative cost component is estimated by adjusting the previous quarter's price for quarterly changes in the per unit value of its material, labour rate, overhead and profit components. Information on price changes is collected from respondents or derived from administrative data or other Statistics Canada survey sources as described below. These current quarterly output prices are then used in the quarterly calculation of the BCPI.

4.2.1. Electronic questionnaire – Construction Contractors Survey

For representative cost components categorized under the general requirements, architectural and structural trade groups, price information is collected using an electronic questionnaire called the Construction Contractors Survey (CCS). The electronic questionnaire was originally designed, tested and refined in consultation with the Questionnaire Design Resource Centre and with residential and non-residential general contractors operating in the Vancouver, Toronto, Ottawa and Montréal CMAs. The electronic questionnaire is sent out quarterly to a sample of building contractors that work on building project types covered by the BCPI and their response to the survey is mandatory.

The electronic questionnaire collects information on price movements in the representative cost components included in building projects in their respective CMA, the reasons for those movements and local construction market conditions. With reference to a project built or bid-on in the previous quarter, respondents are asked to report how much the estimated costs for each representative cost component would have changed if they repeated the build or bid in the current quarter. Respondents are asked to compare the price on the 15th day of the middle month of the previous quarter to the price on the 15th day of the middle month of the current quarter (i.e. February 15th compared to May 15th) or to the nearest business day prior to the 15th.

An arithmetic mean is calculated for all of the price movement quotes that are reported by respondents for a representative cost component within a CMA. This average price movement is applied to the output price of the previous quarter to obtain the output price for the current quarter. These steps are repeated for each representative cost component in a particular building. Since the price movements reported by contractors include labour, overhead and profit margins, no further manipulations are necessary.

As an example, assume that the arithmetic mean of all movements reported by the electronic questionnaires amounts to 3% for a particular representative cost component. If the unit output price in the previous quarter for that cost component was $5.00, with a 3% price increase, the unit output price in the current quarter would be ($5.00 x 1.03) = $5.15.

Table 2
031000 Perimeter foundation wall, 8" thick framework

Q1 Initial output price (previous quarter)	$5.00
Average reported formwork output price movement - Toronto	**3%**
Q2 Output price (current quarter)	$5.15

4.2.2 Administrative and alternative data sources

For representative cost components under the mechanical and electrical trade groups, administrative data is used to collect prices. In addition, prices for certain materials, labour rates, rental of equipment and municipal charges are obtained from a variety of secondary sources. These sources include construction industry online publications and in-house data such as the Industrial Product Price Index and the Machinery and Equipment Price Index. Additionally, labour rates are obtained from the Construction Union Wage Rate Indexes (CUWRI).

Unit prices are obtained for the labour and material factors of each representative cost component by mapping to similar components from the various administrative and alternative data sources. Quantity information for each product is gathered from the initial building model specifications. Since the administrative and alternative data sources do not provide prices that are inclusive of labour, and overhead and profit, these are added to calculate the output price of each representative cost component.

As an example, assume that the previous quarter unit input price is determined to be $3.33 for a certain amount of PEX piping material and $2.22 an hour for the plumber needed to install the piping, respectively. This unit output price is determined from the contractor's initial specifications for the building model. Then, administrative or alternative data sources are searched to find appropriately similar products and their corresponding prices for both the previous and current quarters.

In this case, a previous quarter material price of $350.80 and a current quarter material price of $361.30 may be available for a different amount of the same type of PEX piping material. Similarly, a previous quarter wage rate index of 130.20 and current quarter wage rate index of 134.10 may be available from the Toronto Plumber construction union wage rate index. From the latter sources, a price movement can be calculated between the relevant quarters as 3% for both the material price and labour wage rate. This price movement can then be applied to the previous quarter unit input price to determine the current quarter unit input price for the material and labour costs being $3.43 and $2.29, respectively. Finally, an overhead and profit rate of 11% is added to calculate the total current quarter output price for the relevant cost component: ($3.43 + $2.29) x 1.11 = $6.34.

Table 3
¾" PEX piping

Admin data material price change		CUWRI labour wage rate change	
Q1 ¾" 100' PEX piping material price	$350.83	Q1 Toronto plumber wage rate index	130.2
Q2 ¾" 100' PEX piping material price	$361.36	Q2 Toronto plumber wage rate index	134.1
Material price change	**3%**	**Labour wage rate change**	**3%**
Q1 initial material price	$3.33	Q1 initial labour hourly wage rate for plumber	$2.22
Quarterly price movement	**3%**	**Quarterly labour wage rate movement**	**3%**
Q2 material price	$3.43	Q2 hourly labour wage rate for plumber	$2.29
Overhead and profit rate			11%
Q2 Output price = (Q2 material price + Q2 hourly labour wage rate) x overhead and profit ($3.43 + $2.29) x 1.11			$6.34

4.3 Weights

The BCPI utilizes two sets of weights. Cost component weights are used for representative cost components and building permit weights are used to aggregate by building type, structure type and geography.

Cost component weights are derived from the detailed costs originally provided by consultants when the building construction project was chosen. For non-residential buildings and high-rise apartments, this was in 2015; for all other residential buildings, it was 2017. The weight assigned to each representative cost component reflects the share in the total project cost that was attributable to the sampled component and the other components that it represents. The weight for the same representative cost component will vary by building type and by city. For example, since more lumber is necessary on average in residential construction projects relative to non-residential construction projects, a relatively higher weight will be attributed to lumber in the various residential buildings (except for high-rise apartment buildings). As cost component weights are price updated quarter to quarter and these price movements can differ between CMAs, each city will have differences in the weight distribution of the cost components across a particular building type.

Building permit weights are used to reflect the relative importance of particular buildings in the higher level indexes and within a CMA. The unadjusted annual estimates of the value of building permits by CMA and building type are provided by Statistics Canada's Investment, Science and Technology Division. The building permit weights are based on a three-year moving average of building permit values for residential and non-residential building construction approved in each CMA. New CMA weights are updated on an annual basis as part of the second quarter release.

4.4. Revision and seasonal adjustment

The BCPI series are subject to a one quarter revision period after publication of a given quarter's data. The indexes are not seasonally adjusted.

5. Index Estimation and Aggregation

The BCPI is based on a fixed sample, where quarterly price changes for building construction are measured over time by using a fixed set of representative cost components that are used in the construction of a building. The BCPI is calculated for the current period and compared to the previous period to measure price movement. Estimates are calculated using a weighted average of price relatives by representative cost components which are chained together to form an index series. Two separate indexes are produced: the Residential Building Construction Price Index (RBCPI) and the Non-residential Building Construction Price Index (NRBCPI). The RBCPI and NRBCPI are fixed-weight Laspeyres indexes available at the CMA and the 11-CMA composite levels.

The BCPI encompasses both elementary aggregates and higher level aggregate indexes. Elementary aggregates measure the price movements at the building level by CMA using price-updated cost component weights for representative cost components. For higher level indexes, building permit weights are applied to each building under a structure or the aggregate residential and non-residential levels by CMA. To calculate the 11-CMA composite indexes at any level, the building permit weights are adjusted to reflect the relative importance of each building type across CMAs.

5.1. Price relatives

The starting point in the estimation of the index is to determine the initial output price and the current output price in unit terms. This calculation differs between the architectural and structural trade groups, and the mechanical and electrical trade groups.

5.1.1. Architectural and structural trade groups

For the architectural and structural trade group representative cost components, the price movements are derived from the responses of building construction contractors in the electronic questionnaire. These reported price movements are aggregated using an arithmetic mean for each CMA and representative cost component and then multiplied by the initial output price to arrive at the current output price as follows:

$$p^t_{mc} = (p^{t-1}_{mc}) \frac{1}{N} \sum_n \Delta^t_{mc}$$

p^t_{mc} : The current output price for the representative cost component m for CMA c at time t.

p^{t-1}_{mc} : The output price for the representative cost component m for CMA c at time $t-1$.

Δ^t_{mc} : The price movement for representative cost component m as reported by contractor n for CMA c at time t.

5.1.2. Mechanical and electrical trade groups

For the mechanical and electrical trade group cost components, the output prices are calculated using the contractor's original detailed specifications for each building construction project. Each representative cost component that was priced in the original building specification is mapped to similar items from administrative and secondary data sources. The previous quarter and current quarter prices are obtained for this similar item and a price movement is then calculated for the representative cost component.

The representative cost components in these trade groups are split up into material, k, and labour factors, l, and price movements for the factors are determined. The labour wage rates and the material prices from the previous quarter are then multiplied by the price movement for each factor, respectively, and aggregated. Since the administrative data sources do not include overhead and profit margins, these are added to arrive at a complete initial output price:

$$p^t_{mc} = [(kp^{t-1}_{mc})\,k\Delta^t_{mc} + (lp^{t-1}_{mc})\,l\Delta^t_{mc}]\,(1+o)$$

p^t_{mc} : The current output price.

kp^{t-1}_{mc} : The initial material price which equals the material price for the previous quarter.

$k\Delta^t_{mc}$: The material price movement for representative cost component m for CMA c at time t.

lp^{t-1}_{mc} : The initial labour wage rate which equals the labour wage rate for the previous quarter.

$l\Delta^t_{mc}$: The labour wage rate movement for representative cost component m for CMA c at time t.

o : The overhead and profit rate.

5.1.3. Representative cost component price relative

The initial and current output prices are then used to calculate price relatives at the representative cost component level:

$$PR^t_{mc} = \frac{p^t_{mc}}{p^{t-1}_{mc}},$$

Representative cost components are priced at the CMA level. Consequently, the price relatives for each representative cost component correspond to a particular CMA.

5.2 Elementary aggregate

The estimation of elementary aggregates is the first step in index aggregation. An elementary aggregate combines weighted price relatives of all representative cost components at the building level.

The price relatives for each representative cost component are aggregated across building type by CMA using a fixed-weight Laspeyres index formula. The various price relatives are aggregated using the cost component weights to reflect the relative importance of each representative cost component in a particular building.

$$EA_{bc}^t = \sum_m [(PR_{mc}^t) \, w_{mbc}^t]$$

EA_{bc}^t : The elemental price index of the building type b in for CMA c at time t.

PR_{mc}^t : The price relative of each representative cost component m for CMA c at time t.

w_{mbc}^t : The component-item weight given to representative cost component m at time t for building type b in CMA c.

5.3. Higher level indexes

The elementary aggregate is then chained with the previous period index to arrive at the current period index at the lowest level – by building type and CMA:

$$I_{bc}^t = I_{bc}^{t-1} \, EA_{bc}^t$$

I_{bc}^t : The current quarter index by building type b and CMA c.

I_{bc}^{t-1} : The previous quarter index by building type b and CMA c.

Since the Laspeyres index is consistent in aggregation, at all aggregation levels higher than the elementary aggregate, the elementary aggregate can be weighted and aggregated as necessary to compile higher level indexes.

At higher levels, the building permits weights are used to reflect the relative importance of building types within and between CMAs. The indexes by CMA for the structure, residential aggregate or non-residential aggregate levels are calculated as follows:

$$I_{xc}^t = I_{xc}^{t-1} \sum_b [(EA_{bc}^t) \, pw_{xbc}^t]$$

I_{xc}^t : The index at level $x = (building, \; structure, \; residential \; aggregate, \; non-residential \; aggregate)$ for CMA c at time t.

I_{xc}^{t-1} : The previous quarter index.

pw_{xbc}^t : The building permit weight for each building b being aggregated to level x in CMA c at time t.

Similarly, the composite indexes at all levels can be calculated by applying the appropriate building permit weights to reflect the relative importance of each building in each CMA.

$$I_x^t = I_x^{t-1} \sum_c [I_{xc}^t \, pw_{xc}^t]$$

I_x^t : The index at level $x = (building, \; structure, \; residential \; aggregate, \; non-residential \; aggregate)$ at time t.

I_x^{t-1} : The previous quarter index.

I_{xc}^t : The index at level $x = (building, \; structure, \; residential \; aggregate, \; non-residential \; aggregate)$ for CMA c at time t.

pw_{xc}^t : The building permit weight for each building construction project being aggregated at level x in CMA c at time t.

5.4. Linking of indexes

With the introduction of a new basket, historical estimates are linked to the new basket by maintaining the same historical period-to-period changes. This is done by calculating a link factor for each index series as the ratio of the new index series (2017=100) in the overlap period to the old index series (2002=100). This link factor is then applied to the old index series to bring it up or down to the level of the new index series. The historical continuity of the building construction price indexes are maintained wherever possible by linking the new building construction price indexes with comparable historical indexes when they exist.

Appendix

A.1. Representative construction projects

The first step for the component cost approach is to determine which structures and buildings require a price index to be developed. Users of the BCPI, like the Canadian System of Macroeconomic Accounts, are consulted during the process for information about which type of buildings are required for their intended use. For each type of building under the residential and non-residential structures, representative building projects are identified.

The selling price of these representative building projects are estimated by external construction consultants by accounting for the appropriate composition of materials and labour used in the construction project. The project chosen must be for a residential or non-residential project that might be built in any of the geographies surveyed. It must represent the median for its class with respect to price, size, design and construction techniques employed. Buildings with a contemporary design are preferred and those with an unusual shape, size or materials are avoided.

Once a construction project is selected, it must be validated to ensure all required specifications are met. These specifications include: being sufficiently detailed to align with the requirements of the BCPI users, being representative of a typical building construction project in the respective region, the building construction project processes and materials used comply with the latest National Building Code of Canada and/or provincial codes, and the availability of prices for all construction cost components within each representative building projects over time in a given CMA. Representative residential and non-residential building construction projects are replaced every 10 to 15 years. The frequency of replacement is dependent on the pace of structural and technological change taking place in the construction industry, as these will impact the relevance of the weights used in the building construction projects.

A.2. Representative cost components

Once the general specifications are agreed to and finalized, the construction consultants provide a list of detailed technical specifications of every cost component for each representative building construction project.

These cost components represent all expenditures, including labour, materials, overhead and profit. They are organized using the MasterFormat classification system, an industry classification used for construction projects in Canada and the United States. These are then aggregated into trade groups classifications.

These trade group classifications include general requirements, architectural, structural, mechanical, and electrical trade groups.

General requirements include office site, building permits, and insurance.

The architectural trade group includes cost components for:

- masonry,
- metal fabrications,
- wood,
- plastics and composites,
- thermal and moisture protection,
- openings, finishes,

- specialities,
- equipment,
- conveying equipment,
- earthwork, and
- exterior improvements.

The structural trade group includes cost components for:

- general site conditions (including demolition),
- concrete,
- masonry, and
- structural steel.

The mechanical trade group includes cost components for:

- plumbing,
- heating,
- ventilation,
- air conditioning,
- integrated automation,
- utilities, and
- fire suppression.

The electrical trade group includes cost components for:

- electrical costs,
- electronic safety and security, and
- communications.

For each cost component in a representative building, the description, quantity, material cost, labour and equipment cost, as well as the sum of costs represented by the unit rate are included. The unit rate is multiplied by the quantity for each item to determine the total expenditure. Each building project's specifications include hundreds of cost components, thus to track them all over time would be impractical and cost-prohibitive. Therefore, a sample of representative cost components is selected which targets coverage of components that together account for about 80% of the total expenditure of the building project.

In addition to their importance by initial dollar value in the total project expenditure, representative cost components have a higher likelihood of selection if they meet the following criteria: they are standard to all residential and non-residential buildings across geography and across time; or they are included in some of the projects used to compile other building construction price indexes.

After selection, the representative cost components are assigned the total dollar value of all work put in place components for the cost component category they represent. These become the starting component item weights for each building type. Once the representative cost components are selected, they do not change throughout the lifespan of the respective building type.