

# CDW QUANTIFICATION IN THE SEVERAL STAGES OF LIFE OF A BUILDING: IDENTIFICATION AND CHARACTERIZATION OF THE MAIN METHODS

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## ABSTRACT

Construction and demolition waste (CDW) represent, in mass, the largest fraction of the waste generated in many Brazilian cities. Quantifying this type of waste is an expensive task that still has to overcome some obstacles. Lack of management and irregular disposal are some of the main limiting factors. Thus, this work aims to identify CDW quantification methods as a basis for further studies of adaptation and/or development of specific methods for the quantification of the Brazilian CDW in the different life stages of a building. Publications were identified in scientific journals and events from the set of keywords: "estimate generation", "quantification method", "construction and demolition waste", "construction waste" e "demolition waste". The articles were classified in general criteria, type of residue evaluated, scale and public interest. At the end, 22 articles presenting methods of quantification of construction and demolition residues were identified. Methods for quantification of construction waste (CW) and CDW predominate among those identified, representing 41% each. Half of the studies adopt design data and 41% use regional data. Some of the methods identified cover both the interest of the builders and the public agencies, reaching 50%, however only 18% are specific of interest to the public management agencies. Related to the Brazilian CDW, only 2 publications were identified. Therefore, it is possible to verify that there is a gap in the development of Brazilian CDW quantification methods in the various phases, which could help construction companies and public agencies to improve the management of this type of waste.

**KEY WORDS:** CDW; Quantification methods; National Policy on Solid Waste.



## 1. INTRODUCTION

Construction and demolition waste (CDW) are generated in high volumes around the world. Estimating the quantities and composition characteristics of these wastes have been one of the challenges in the CDW management. Private and public construction works, beyond CDW generated by the population, are the sources of generation in Brazil, and in most countries around the world. Private and public civil works are responsible for all stages of waste management (segregation, storage and final destination) and CDW generated by the population are managed for the municipalities.

There are few CDW database in Brazil, restricted to surveys such as those conducted by the Brazilian Association of Public Cleaning and Special Waste Companies (ABRELPE, 2017) and the National Information System on Water, Sanitation and Solid Waste (SNIS), this one corresponds to a national information database fed by Brazilian recycling/waste disposal plants, however known to be incomplete.

45 million tons of CDW were collected, in Brazil, by the municipalities (ABRELPE, 2017) in the 2016, allowing to infer a minimum average generation of 123,421 tons of CDW/day and 0.6 kg/person/day. These data, however, consider only the CDW collected by the municipalities, that is, generated by local population.

In Brazil, there are disposal places, called Voluntary Delivery Points, that receive waste generated by the population in quantities below 1 m<sup>3</sup>. It is necessary, however, to consider the occurrence of known irregular disposals, called "Vicious Point of Disposal" (OLIVEIRA et al., 2011; MMA, 2012), some points are informally mapped by the municipalities that collect the arranged materials, others however are dynamic or inaccessible.

CDW from private or public civil works needs to be managed by it is companies, which in Brazil in 2017 were over 126,000 (IBGE, 2017). Quantitative database of this CDW are scarce, being limited the declaration of these values to the local environmental agencies that do not always have online systems of treatment of these data.

The CDW composition characteristics are related to the type of work (building, highway, excavation), generation stage (construction, demolition or renovation), construction method (precast building system, engineered masonry, pillar and beam construction, steel/wood frame), building age, waste management practices (source segregation or not) (Esa et al., 2017; Gálvez-Martos et al., 2018) and others.

Waskow et al. (2019) perform statistical treatments to consolidate Brazilian CDW composition (Figure 1). These authors suggest a Brazilian average CDW composition

composed basically of mortar (39%), concrete (14%) and ceramic (47%). However, according to the characteristics of the construction and/or building source of waste, as described in the previous paragraph, it is still possible to find divergent CDW compositions within a Brazilian state, such as Scoot Hood (2006) and Bernardes et al. (2008), or municipality, such as Oliveira et al. (2011) and Lima & Cabral (2013).

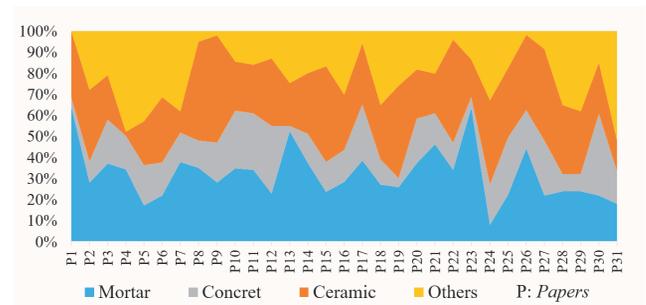


Figure 1 – Brazilian CDW Composition  
Source: adapted from Waskow et al. (2019).

Thus, it is necessary to know which CDW estimation methods are available in the scientific literature, whether there are proposed methods for Brazil, whether these methods are replicable in the Brazil regions or identify necessary adaptations. Thus, this paper aims to conduct a systematic survey of CDW generation estimation methods in the world and in Brazil, discuss them, identify potential input data sources for the identified models, evaluate their applicability and propose adaptations for the Brazilian case.

## 2. METHODOLOGY

To achieve the objective of this paper was necessary identify quantification methods of the residue's generation adopting as way of identifying scientific papers the scientific portal Science Direct and internet search. The procedure for selecting articles of interest followed criteria, described below:

- Search in the abstract of articles by set of keywords: "estimate generation", "quantification method", "construction and demolition waste", "construction waste" and "demolition waste";
- Selection of articles published in journals, congresses, symposia, events among others of which were the target of evaluation;
- Discard of articles that presented only the characterization of the CDW or the determination of the generation rate;
- Identification of the main characteristics of the developed method;
- Classification of articles that meet the characteristics and objective of the work.

The classification of the selected articles followed criteria, such as: general data, type of residue evaluated, scale and public of interest. The criteria adopted in the mapping stage of the articles included in this study are presented in Table 1.

Criteria	Scope
General data	Author, year, country target of study.
Type of waste	- Construction waste; - Demolition waste; - Construction and demolition waste (CDW).
Scale	- Project; - Regional.
Target audience	- Construction company; - Government or state agency.

**Table 1** – Articles classification criteria  
**Source:** Authors.

### 3. RESULTS AND DISCUSSION

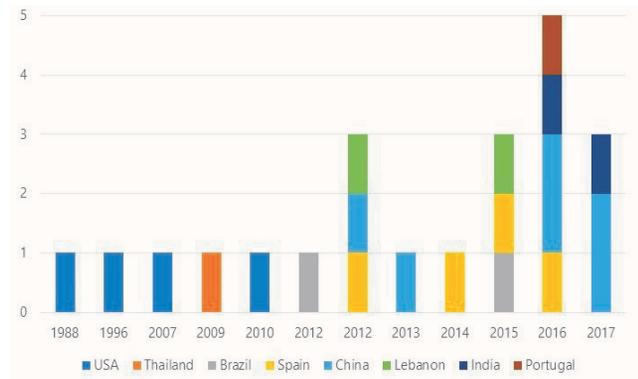
The highest fraction of the identified studies adopts as a quantification method the constructed/demolished area multiplied by an average generation rate per area, corresponding to 59%. However, some of the authors complement this method with the insertion of other variables, such as Saez et al. (2014), which consider the life span of the building, in addition to density population, density of buildings by area, coverage of built and green area (BERNARDO et al., 2016; ZHENG et al., 2017).

The relationship between the amount of material acquired and the average generation rate is considered by 23% of the authors (NAGALLI, 2012; JINGKUANG et al., 2012; LI et al., 2016; LLATAS & OSMANI, 2016; GHOSH et al., 2016).

The other methods adopted are based on the generation rate multiplied by the population (RHYNER & GREEN, 1988), multiple equations for several phases of building (COCHRAN et al., 2007), lifetime of the applied material and its exchange (COCHRAN & TOWNSEND (2010)) and Grey Model (GM) in conjunction with a Support Regression Vector (SONG et al., 2017).

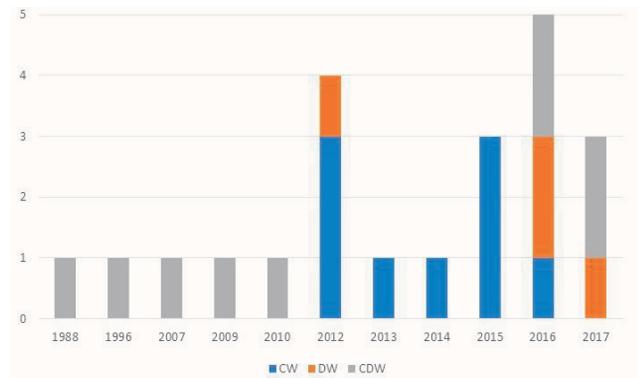
More details about the methods adopted by the identified studies in the research are presented in final.

The first research results reveal the studies growth of construction and demolition waste (CDW) quantification methods from 2015 (Figure 2). The results obtained also suggest that the United States were the pioneers in the search for quantification methods, being responsible for 4 of the first 5 studies identified.



**Figure 2** - Available papers by year and country.  
**Source:** Authors.

Initial results suggest that the first studies of quantification methods development aimed to quantify construction and demolition residues, that is, the generated residues in building construction and its demolition (Figure 3). Construction phase residues (construction waste, CW) were the target of subsequent studies, in chronological order, however both CDW and CW represent 41% of all identified studies.



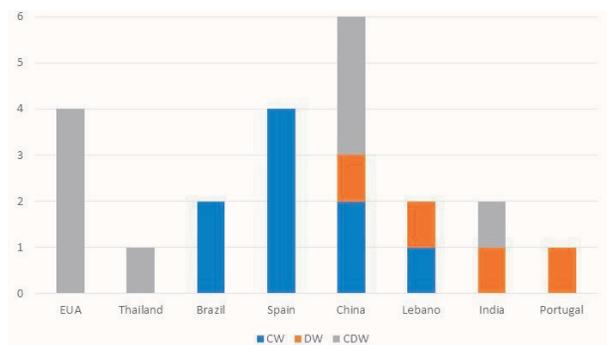
**Figure 3** - Number of papers per year by waste evaluated type.  
**Source:** Authors.

Project scale studies predominate among those identified, representing 50%. The quantification methods on a regional scale represents 41%, followed by methods that meet both scales (9%). Corroborating these data, the evaluation of the target audience of the study shows that construction companies may be the largest beneficiaries of most identified studies (82%), including the methods where both target audiences are met. Figure 4 presents more details about the results obtained.



**Figure 4** - Papers by scale and target audience of waste quantification equations.  
**Source:** Authors.

Although the United States was the pioneers in the quantification methods development, China was the target of largest studies identified (Figure 5). While China presents studies aimed at CW, DW and CDW, the United States and Spain, which have the same number of studies (4), only focused on CDW and DW, respectively.



**Figure 5** - Papers by country classified by waste evaluated type.  
**Source:** Authors.

Brazil, Lebanon and India are other studied countries that have more than one study. Studies focused on Brazilian waste focused only on construction waste, however those developed in Lebanon and India focused on CW/DW and DW/CDW, respectively.

Table 2 summarizes the main information from the works that suggest CDW quantification methods. The information is classified into the following categories:

Author	Country	Origin	Equation Scale	Input Data Source	Period	Method Description
Rhyner & Green (1988)	USA	CDW	State	- Wisconsin Department of Natural Resources.	Early 1970s	Aimed at the CDW, the method is based on the multiplication between the generation rate estimated by different authors and the total population of the region.
Yost & Halstead (1996)	USA	CW	National	- U.S. Census Bureau.	Not Specified	Method focused on estimating generation from the relationship between the average generation of one of the wastes that makes up the CDW per square meter of built area and the average cost per built area of buildings in the region (of the same type or an average of the total).

**Author:** Description of the authors and publication year, according to scientific citation.

**Country:** Description of the country where the study is applied or where the CDW quantification method is developed.

**Origin:** Describes the origin of the waste considered in the study and method of quantification, which can be the stages of construction, renovation and demolition individually or independently.

**Equation Scale:** Describes the scale of application of the proposed quantification method. The work (construction, demolition or renovation) classifications as municipal, state, national are adopted.

**Input data source:** Describes the source of information that feeds the CDW quantification methodologies proposed by the authors.

**Period:** Describes the applied period and/or the expected for proposed applicability CDW quantification methodology.

**Method Description:** Describes information that complementary previous classifications and supported the analysis of methods applicability to Brazilian scenario. Likewise, the information in this topic helps identify useful information the discussions about methods to be used in Brazil.

As can be seen, some authors converge on their quantification methods. Rhyner & Green (1988) and Yost & Halstead (1996) adopt the average generation rate or estimated population quantity.

Other authors adopted data on measures of expansion and/or built/demolished area, such as Cochran et al. (2007), Saez et al. (2012), Bernardo et al. (2016), Zheng et al. (2017) and Ram & Kalidindi. Cochran & Townsend (2010), Saez et al. (2014) and Saez et al. (2015) went further in forecasting waste demolition, considering, in addition to demolition data, the expected generation according to local buildings to compose forecasts waste generation.

Kofoworola & Gheewala (2009), Jingkuang et al. (2012), Li et al. (2013) and Ghosh et al. (2016) estimate the generation of waste by the building materials consumption and their previously defined generation rates.

Cochran et al. (2007)	USA	CDW	State	- Florida Department of Environmental Protection (FDEP).	1999-2000	Aimed at CDW, the study presents equations of divided waste quantification estimation into construction, demolition and renovations, the latter divided into expansion, changes and roof changes.
Kofoworola & Gheewala (2009)	Thailand	CW	National	- National Statistics Organization of Thailand.	2002-2005	Aimed at construction waste, supporting the subsequent evaluation of the amount energy saved by recycling the CDW, the work considers in calculation of generation construction area multiplied by the average generation rate and the percentage of material type that is evaluating itself.
Cochran & Townsend (2010)	USA	CDW		- Portland Cement Association; - US Geological Survey; - USDA Forest Service; - US Geological Service; - Brick Industry Association.	2002	Considers in the calculation of generation of the demolition CDW (already encompassing the construction residue and renovations) the life of the material, where for example, a construction material applied in 2010 and which has an estimated shelf life of 10 years will be generated in 2020.
Nagalli (2012)	Brazil	CW	National	- On-Site Data Collection.	2009-2012	Aimed at construction waste, the author uses process factors, execution schedule and experience and management of the team associated with the amount of materials purchased and loss rate, estimated, by material type.
Saez et al. (2012)	Spain	CW	Municipal	- II National Plan of C&D waste; - Interviews; - On-Site Data Collection.	2008-2015	Aimed at construction waste, the developed method by the authors adopts as input criteria of the equation quantification data of volume ratio of waste generated by built wall area multiplied by the building area (to be) built.
Jingkuang et al. (2012)	China	CW	National	- On-Site Data Collection.	Not Specified	Aimed at construction residues, the authors developed quantification equation considering consumption criteria and estimated coefficients of conversion into residue by material type. Packaging residues of building materials are also considered and equations allow them to be quantified individually.
Tamraz et al. (2012)	Lebanon	DW	State	- Interviews; - On-Site Data Collection.	2009-2010	Aimed at demolition residues the method developed by the authors starts from other authors equations and adopt criteria such as number of buildings being demolished, an average constructed area of a demolished buildings sample, residue volumes by area and residue cementitious cluster density.
Li et al. (2013)	China	CW	State	- On-Site Data Collection.	2009	Focused on construction waste. The method is based on the values of: Quantity of materials (by type) for the construction of the work; Residue generation rate (by material type); and Total building area.
Saez et al. (2014)	Spain		Municipal	- On-Site Data Collection.	Not Specified	Aimed at the construction waste. Evaluating and simulate the CW generation in new condominiums constructions in Spain. The development of the method is based on the CDW generated amount, an area covered by the constructions and the expected duration/time of the work. Thus, the authors obtained final result of generating CDW according to the duration of a work with those characteristics.
Kern et al. (2015)	Brazil	CW	Municipal	- On-Site Data Collection.	2008-2013	Aiming at quantifying construction waste, the method considered the amount of waste generated in the construction of 20 buildings in Brazil. At the end uses the variables the number of apartments per floor, apartment area, area per floor, construction system and waste reuse.
Bakshan et al. (2015)	Lebanon	CW	Municipal	- On-Site Data Collection.	Not Specified	Aiming at construction waste, it estimates the amount of generated waste by material type in kilograms per square meter from data from other authors.

Saez et al. (2015)	Spain	CW	Municipal/ State/ National	- Spanish Government; - National Institute of Statistics.	Not Specified	Aiming the construction waste, the method was based on condominiums built in Spain. The input parameters were the number of residential units per condominium, the area of each unit and the quantified waste generation per unit and per area. Thus, the authors established factors for calculation of mass generation and volume.
Lu et al. (2016)	China	CW		- Chinese Statistics Yearbooks; - China Statistical Yearbook on Construction.	Estimated for 2014	Aiming at the CDW, the authors adjusted the equation cited by other authors based on individual building area, renovation and demolition criteria, and the waste generation rates for each of these steps.
Li et al. (2016)	China	CDW	National	- Uniformat II classifying building specifications, cost estimating, and cost analysis in the U.S. and Canada.	Not Specified	Aiming at demolition residues, the estimate was based on a mathematical modeling and has as a return which residues of the work are the most significant, quantitatively. This method considers the CDW composition, including the corresponding fraction of other types of waste, such as packaging.
Llatas & Osmani (2016)	Spain	CW	National	- On-Site Data Collection.	2009-2012	The modeling carried out aims to evaluate the effectiveness of design actions and the minimization of waste generation in the construction of the building. Data such as the waste expected and generated are related.
Ghosh et al. (2016)	India	CW	Municipal	- European Waste Catalogue; - National Methodology.	2015	Aiming at the CDW, the authors objective was developing a series of mathematical functions focused on the analysis and potential of waste management cost maximization, mainly regarding the minimization of landfill destination and transportation cost. The input data for the equation are number of bricks, iron, lime, concrete, other CDW, soil and transportation cost.
Bernardo et al. (2016)	Portugal	CDW	Municipal	- Statistical Information, from Lisbon Metropolitan Area (LMA).	2008-2012	Considered the quantification of building demolition residues, correlating these values with population density, building density per square kilometer and the percentage of urban area in relation to the total region area.
Song et al. (2017)	China	DW	National	- Estimates the Annual Total Area of Construction (ATAC), in China.	2015-2018	The methodology developed by the authors considers the quantities generated in various regions of the country and the CDW composition in each of these locations. Using a Gray Model (GM) in conjunction with a Regression Support Vector, the authors obtained generation results with the error associated for each year.
Zheng et al. (2017)	China	CDW	Municipal	- China Statistical Yearbook; - China Statistical Yearbook on Construction.	2003-2013	The method is not restricted only to quantifying CDW generated over a period of time, but also to quantifying the area required for CDW management such as construction, recycling and disposal. The authors used input data such as built-up area, urban area covered by road system, urban area with green coverage, increase of buildings over a year, average of floors per building and other related data.
Ram & Kalidindi (2017)	India	CDW	National	- Technology Information, Forecasting; - Assessment Council (TIFAC), India Government.	2013	Aiming demolition residue quantification, the adopted method is based on other authors works introducing some changes in the quantification equation. The authors adopted as calculation criteria the total area of demolitions in a given region, generation rate per area and the proportion of the type of building to be demolished in under study region

**Table 2** – List of articles with proposed methods of quantification of construction, demolition and/or renovation waste. The main information of each article is described in columns, allowing to establish relations and further discussions.

Source: Authors.

More simplified methods are adopted by Bakshan et al. (2015) and Tamraz et al. (2012), who use the built-up area as a reference for their estimates. Lu et al. (2016) presents estimates in more detail, predicting generation by

stage (construction, renovation and demolition).

Studies conducted in Brazil are restricted to estimates based on quantifications of previous project generations, as presented by Nagalli (2012) and Kern et al. (2015).

Li et al. (2016), Llatas & Osmani (2016) and Song et al. (2017) adopted modeling systems. Llatas & Osmani (2016), evaluated different design possibilities, correlating them to waste generation estimates. Song et al. (2017) estimated the generation from regression of quantities and compositions from various regions of China.

#### 4. CONCLUSION

The constructed/demolished area ratio and the generation rate per square meter can be considered most widespread method, however it is difficult to infer about its greater accuracy.

It is concluded that the development of segregated quantification methods for the construction and demolition phases separately could improve the management of the CDW either in project management or in public management.

The evolution of CDW quantification methods occurs slowly, given the year of the first study.

There is a development gap in quantification methods of CDW in numerous countries, including Brazil.

A few sources national data may support the use of methods used for country (population x average generation rate) or regional (urban expansion x average generation rate) scale. Local scales, however, lack the development of methods that allow the estimation of quantities and characteristics of the Brazilian CDW, which still does not exist.

#### REFERENCES

- ABRELPE Brazilian Association of Public Cleaning and Special Waste Companies (2018). **Overview of Solid Waste in Brazil 2017**. Special edition of 15 years. Brasil (in Portuguese)
- Oliveira, M. E. D.; Sales, R. J. M.; Oliveira, L. A. S.; Cabral, A. E. B., 2011. Diagnóstico da geração e da composição dos RCD de Fortaleza/CE. **Revista de Engenharia Sanitária e Ambiental**, 16, 219-224, 2011.
- MINISTÉRIO DO MEIO AMBIENTE – MMA. **Planos de Gestão de Resíduos Sólidos: manual de orientação**. Brasília – DF, 2012.
- INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, IBGE. **Pesquisa Anual da Indústria da Construção – PAIC**, 2017.
- Esa, M.R., Halog, A., Rigamonti, L. Developing strategies for managing construction and demolition wastes in Malaysia based on the concept of circular economy. **Journal of Material Cycles and Waste Management**. 19 (3), 2017. p. 1144-1154.
- Gálvez-Martos, J.L.; Styles, D.; Schoenberger, H.; Zeschmar-Lahl, B. Construction and demolition waste best management practice in Europe. **Resources, Conservation and Recycling**. 136, 2018. p. 166-178
- Waskow, R.P., dos Santos, V. L. G., Kanno, R., Tubino, R.M.C. Cost Assessment of the Brazilian Construction and Demolition Waste Recycling Plant: A Case Study of Porto Alegre. **Revista Asociación Interamericana de Ingeniería Sanitaria y Ambiental (AIDIS)**. 2019. No prelo.
- Scott Hood, R. S. **Análise da viabilidade técnica da utilização de resíduos de construção e demolição como agregado miúdo reciclado na confecção de blocos de concreto para pavimentação** (in portuguese). Dissertação (Mestrado) – Escola de Engenharia. Universidade Federal do Rio Grande do Sul – UFRGS. Porto Alegre, 2006.
- Bernardes, A.; Thomé, A.; Prietto, P. D. M.; Abreu, Á. G. Quantificação e classificação dos resíduos da construção e demolição coletados no município de Passo Fundo, RS. **Revista Ambiente Construído**. 3, 2008. p. 65-76.
- Lima, A. S.; Cabral, A. E. B., 2013. Caracterização e classificação dos resíduos de construção civil da cidade de Fortaleza (CE). **Revista de Engenharia Sanitária e Ambiental**, Rio de Janeiro, 18, 169-176.
- Saez, P.V. et al. Assessing the accumulation of construction waste generation during residential building construction works. **Resources, Conservation and Recycling**, n. 93, 2014. p. 67-74.
- Bernardo, M. et al. Demolition waste generation for development of a regional management chain model. **Waste Management**. n. 49, 2016. p. 156-169.
- Zheng, L. et al. Characterizing the generation and flows of construction and demolition waste in China. **Construction and Building Materials**, n. 136, 2017. p. 405-413.
- Nagalli, A. Quantitative Method for Estimating Construction Waste Generation. **The Electronic Journal of Geotechnical Engineering**, 2012.
- Jingkuang, L. et al. A Model for Quantification of Construction Waste in New Residential Buildings in Pearl River Delta of China. **The Open Construction and Building Technology Journal**, n. 6, 2012. p. 398-403.
- Li, Y. et al. Developing a quantitative construction waste estimation model for building construction projects. **Resources, Conservation and Recycling**, n. 106, 2016. p. 9-20.
- Llatas, C.; Osmani, M. Development and validation of a building design waste reduction model. **Waste**

**Management**, n. 56, 2016. p. 318–336.

Ghosh, S.K. et al. An Optimization Model on Construction and Demolition Waste Quantification from Building. **Procedia Environmental Sciences**, n. 35, 2016. p. 279 – 288.

Rhyner, C.R.; Green, B.D. The Predictive Accuracy of Published Solid Waste Generation Factors. *Waste Management & Research*, n. 6, 1988. p. 329-338.

Cochran, K. M.; Townsend, T.G. Estimating construction and demolition debris generation using a materials flow analysis approach. **Waste Management**, n. 30, 2010, p. 2247–2254.

Song, Y. et al. Development of a hybrid model to predict construction and demolition waste: China as a case study. **Waste Management**, n. 59, 2017. p. 350–361.

Yost, P.A.; Halstead, J.M. A Methodology for Quantifying the Volume of Construction Waste. **Waste Management & Research**. 14, 1996. p. 453–461.

Cochran, K. et al. Estimation of regional building-related C&D debris generation and composition: Case study for Florida, US. **Waste Management**, n. 27, 2007. p. 921–931.

Kofoworola, O.F.; Gheewala, S.H. Estimation of construction waste generation and management in Thailand. **Waste Management**, n. 29, 2009. p. 731–738.

Saez, P.V. et al. Estimation of construction and demolition waste volume generation in new residential buildings in Spain. **Waste Management & Research**, n. 30(2), 2012. p. 137–146.

Tamraz, S.N. et al. Construction **Demolition Waste Management in Lebanon. Integrating Sustainability Practices in the Construction Industry - ICSDC**. ASCE Library, 2011. ISBN (print): 9780784412046.

Li, J. et al. A model for estimating construction waste generation index for building project in China. **Resources, Conservation and Recycling**, n. 74, 2013. p. 20– 26.

Kern, A.P. et al. Waste generated in high-rise buildings construction: A quantification model based on statistical multiple regression. **Waste Management**, n. 39, 2015. p. 35–44.

Bakshan, A. et al. A field-based methodology for estimating waste generation rates at various stages of construction projects. **Resources, Conservation and Recycling**. n.100, 2015. p. 70–80.

Saez, P.V. et al. New quantification proposal for construction waste generation in new residential

constructions. **Journal of Cleaner Production**, n. 102, 2015. p. 58 – 65.

Lu, W. et al. Estimating and calibrating the amount of building-related construction and demolition waste in urban China. **International Journal of Construction Management**, 2016.

Ram, V.G.; Kalidindi, S.N. Estimation of construction and demolition waste using waste generation rates in Chennai, India. **Waste Management & Research**, 2017.

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