TRANSFORMING WASTE INTO RESOURCES: QUANTIFICATION OF CONSTRUCTION AND DEMOLITION IN BUENOS AIRES

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ABSTRACT

In recent years, intense construction activity worldwide has led to massive environmental degradation, enormous CO^2 emissions and abuse of our natural resources. The lack of legislation to regulate the negative impact of the construction process in Argentina has allowed for unsustainable practices to take place.

There is no standardized classification of materials in the construction area. Land is mixed with ceramic materials in the demolition stage which makes it more difficult to isolate the reusable materials. All the waste is dumped into the same dumpster. Some elements that could be recycled are contaminated and damaged. The lack of awareness by the construction workers and industry professionals as to what material is recyclable translates into a less efficient, more expensive and more profligate process.

The first objective of this research is to promote a selective classification and quantification of CDW supported by our own data sheet, applied as a pilot for residential buildings based on the material resources used in their construction in Vicente Lopez, Buenos Aires Province, Argentina. Vicente Lopez is a town that limits with Buenos Aires, with similar construction characteristics to the city of Buenos Aires. However, Vicente Lopez has a smaller and less bureaucratic structure, which assures us better access to information that helps us to identify and quantify CDW generated in the buildings, a clear waste origin determination (in terms of construction materials) to enable the transformation of waste into resources.

The research is focused on four types of residential buildings that are commonly found in Buenos Aires. The hypothesis is that the larger apartment buildings will carry a greater environmental and ecological footprint per m², considering the consumption of raw materials, fuel consumption for material transport and CDW generation.

The final aim of this project is to establish the foundations of waste materials which come from the area of cuts and surplus, residues derived from the work force, and their packaging. Firstly, after identifying and disseminating good building practices to minimize waste and secondly, after a deep analysis to determine what would be directly reusable without requiring industrial recycling, suitable for reutilization in the development of new products. It is also intended that these new products comply with applicable laws and / or regulations in process about the building´s envelope reducing the current energy consumption without affecting comfort for its inhabitants. It is ensured that this will be the result of conscious design and an accurate material selection.

Keywords: CDW management, recycling materials, residential buildings, environmental impact, selective classification and quantification.

1.- Introduction

According to Reed [1] there are 3 dimensions to sustainability: environmental, economic and social. The main theme of this study is the environmental issue. The social and economic aspects will be taken into consideration on a complementary manner, through the enhancement of CDW, and the generation of employment for the production of new materials with local development. The environmental dimension will cover the global climate problem, the local context, waste generation and its links.

1.1.- The global climate problem, the need for adaptability

Sustainable system enables growth and transformation with flexible structures. Currently, there are advances in the technical knowledge that is used to understand how human actions affect the environment. We need to investigate adaptability; this is one of the fundamental concepts of this research: Specifically the ability to create constructive models that are adaptable for different construction methods and demolition waste byproducts (CDW).

Construction impacts climate change differently at each stage:

- The non-renewable energies used to manufacture and transport components, materials and machinery to the construction site, the energy used by the machines on site, and finally, energy that the building needs to operate once it has been completed, taking into consideration comfort standards for its occupants.
- The waste produced at each stage ranging from packaging, to the debris generated by inefficient use of materials and building waste. In the first stage of the construction process, waste is known as CDW. During occupancy, it is called USW (urban solid waste). USW is also generated during the construction process by the health, cleaning and hygiene of the workers.

1.2.- Local context

1.2.1- Environmental context

Climate change: Buenos Aires has witnessed climate change in recent years. Temperatures have risen and subtropical storms have appeared with greater frequency. There have been two instances of hurricanes taking place in the region during the last four years.[2] The climate has changed so dramatically that professionals now have to account for the rising temperatures when deciding how much roofing insulation to install. The latest updates of rising temperatures data were taken into account by the authorities to establish the calculation of roofing insulation. The same regulations reduced winter calculation temperatures for the calculation of heat transmission coefficients and interstitial and surface condensation, thus requiring a better envelope study in the building industry.

The Buenos Aires provincial law 13059/03 attempts to regulate thermal conditioning based on a number of IRAM / ISO standards. According to this law, the building's envelope must show K values of thermal transmittance (U in Europe) lower than those established in category B of the IRAM No. 11601. The envelope also must not generate surface or interstitial condensation according to IRAM N ° 11625 / 11630. The coefficient of volume heat loss (G) and cooling (GR) must be controlled according to IRAM No. 11604 and IRAM No. 11659-2. Professionals can verify this law using the software developed by Isover Gobain-Saint. The lack of regulation means that construction companies, architectural firms and investor groups have to take on the responsibility of building energy-efficient buildings. These organizations then must decide if they should invest in the additional costs of making sure that a building is energy-efficient, even if these alterations cut into the overall profit of their respective companies. The problem is not the lack of regulations. Rather, the real problem is the lack of qualified employees in the municipalities, consequences for those who fail to follow energy-efficient regulations and benefits for those companies that do.

1.2.2.- Urban solid waste USW

In Argentina there has been considerable progress in the management of USW since the economic crisis in 2001. The “cartoneros”[3] began a process of evaluating the so-called waste and transforming it into usable resources by collecting it and recycling it. This phenomenon affected the entire society. It especially mobilized the younger generation who started a large number of NGOs, civil associations and small specialized enterprises. These new organizations participated in activities such as teaching about environmental awareness, optimizing waste collection and processing systems and transforming waste into products with the help of professionals and college students through outreach programs.

- NGOs and associations that develop teaching and dissemination tasks in the management of waste, including qualifying campaigns and differentiated collection: Uba Verde y Fadu Verde; Geo Fans; Arca group; Red de puntos verdes; Manos verdes; Padua Recicla; Dona tu basura, Fundación Equidad;
- Collectors USW: Cooperative Creando Conciencia; Recuperadores del Sur; Recuperadores by neighborhoods’ communities.
- Organizations and companies that use waste to produce new products: Fundación Garraham; Modesta; Dos puntos, Bop bolsos reciclados; Not off; Sirplast; Cooperative El Ceibo, Abuela Naturaleza among others.

1.2.3.- Waste CDW

The metropolitan area of Buenos Aires generates a considerable amount of Waste from construction per month (CABA and the 3 rings conurbations) according to the Yajnes-Sutelman report and all [4]. The real local initiative for the classification and recycling of USW has not yet massively transferred to the management of the CDW. The prime objective of managing USW and CDW should be reduction. If that is not possible, it is essential to pursue a selective classification of the waste generated. To achieve satisfactory economic and environmental results, it is necessary to develop an organized and efficient recycling process of CDW. It is convenient to apply the same classification criteria that have been succeeding for the efficient management of USW.

If contaminants or sharp materials are mixed during the process many materials capable of being reused will be lost in the process. According to Mercante [5] " Waste is not part of the culture of the construction area, it is important for the Construction Chamber to get involved in waste management, it must create a database that contains generation rates for each type of work to manage the intro-edificial plan, taking into account the responsibilities and actions that are set for each work agent: designer, director, foreman and operator."

In the introduction of the Life Programme 98/351 report, the program of technical actions that are used to encourage the recovery, minimization and selection of construction and demolition waste [6], the consensus on the subject is reflected when they said in 2000 "... there is not a widespread mentality about environmental protection, the local legal and administrative requirements necessary to achieve this state have not been met yet, and codes of good practice to improve this situation and raise awareness industry players have not been developed." We hold that these concepts are still valid in Argentina.

The UOCRA foundation that belongs to the Union of Construction Workers of Argentina has developed strategies for handling CDW [7]. A training program on site to manage USW generated was started 2 years ago, as a first stage. They planned a 2nd stage through agreements with FADU, UBA to pass CDW by implementing its "Best Practices in Construction" and classification. It is estimated that the process will be slow, given the conservative characteristics of both teams, professionals and people implementing the project who are opposed to altering traditional cycles because of the potential increases in time expenditures on qualifying stockpiles. In 2010, the congress of Good Environmental Practice for the Construction in Rosario, Argentina presented a manual prepared by interdisciplinary team that had been distinguished for its Annex II, final spreadsheets on Waste Management [8] This group collected data by consulting construction and design professionals, as well as potential clients, about CDW management. According to the Alpha-Cronbach method this survey counts with a high liability, 0,76 [9].The responses to the surveys suggest the following:

- Most firms only reuse waste as aggregates in concrete sub flooring and wood from formwork as defenses and railings.
- The results indicate that the main difficulties in the classification of RCDs are lack of interest from the companies in charge, the lack of education of professionals and workers, the lack of technical tools and handling coupled with the lack of physical space in the sites.
- The firms propose to classify CDW by metal / wood / rubble,if they are not contaminated by other materials, especially hazardous waste since it cannot be re-used or recycled. It is intended to recover the rich recycling tradition that characterized the Italian immigrant builders who came to Argentina during the early twentieth century.

2.- Hypothesis

It is possible to generate new productive life cycles in the construction sites for materials and its packaging, reducing CDW, sorting and guiding recycling, and by turning waste into raw materials that could then be reused to generate products that would improve the quality of the buildings' envelope.

It is possible to modify established behaviors, only through qualitative and quantitative depth knowledge of the waste generated in different types of buildings and the understanding of the social environment, would allow to the creation of comprehensive and economically viable solutions.

3.-Objectives

State the current state of local waste treatment.

Reduce CDW sorting and guiding its recycling to generate new productive work life cycles for materials and packaging, converting waste into raw materials for construction, generating products that improve the quality of the building's envelope.

Modify established behaviors; develop a methodology for further qualitative and quantitative knowledge of the waste generated in different buildings and in the social environment for the arrival of comprehensive and economically viable solutions linking potentialities and local demands**.**

4.-Methodology

Draw from the analysis of the problem by: defining and characterizing the building typology, the actors involved, the study of material deposited in dumps and the generation stages in RCD.

4.1.-Definition of spatial-physical framework

The city of Vicente Lopez, located in Buenos Aires Province, bordering the Autonomous City of Buenos Aires (CABA) was the place chosen to conduct the analysis.(see table 1 and figure1) Reasons for this decision:

- After performing a comparative analysis between the province of Buenos Aires and the Autonomous City of Buenos Aires, it was concluded that Vicente López was the one with greater similarities in density and constructive typologies to CABA.
- The Provincial Law 13059/03 – Thermal Conditioning exists in the province of Buenos Aires. It was hypothesized that buildings in this province would be better adapted to climate change in order to respect the Law 13059/03 and would have well designed envelopes.

	Housing	CABA	V Lopez
1	Number of dwellings per 1000 inhabitants	504	429
2	Occupied dwellings per 1000 inhabitants	383	355
3	Houses with flat roofs and asphalt membrane	89.9%	80%
4	Housing with ceramic flooring, tile, wood, carpet	91.3%	88%
5	Houses with brick walls, stone or concrete with fine mortar	94.8%	94%

Table 1 “INDEC national census data 2010” [10]

Fig. 1 “Vicente Lopez map”

4.2.- Stakeholders

For subsequent decisions about the content and the developing of spreadsheets, the actors involved in the production cycle of a building were analyzed.

- Individual clients (single or family groups) or group (investors) are those that provide economic capital for the completion of the work.
- Design and Construction professionals (architects, engineers, construction foreman / surveyors) are in charge of designing the buildings, floor plans, volumes, bearing construction systems and envelopes.
- Construction: technical employees: Persons, who direct employees work, organize tasks, procurement of materials and tools.
- Construction: employees work: persons who carry out productive technical tasks to pass from project to finished work.
- End Users: are the people who inhabit the houses and will handle both building maintenance expenses and energy consumption bills of non-renewable energy.

- Regulators and government entities: institutions that set standards, municipal, provincial and legislative dictate laws.

4.3.- Dumpsters

A visual inspection in the construction areas of Vicente Lopez city was conducted. A total amount of 40 dumpers in a 20 square blocks area were recorded and the dumpsters were surveyed weekly during the month of December 2014. We found that construction waste was dumped with the urban solid waste (USW) from city neighbors. Different amounts of USW were found. In minor constructions, dumpsters remained outside the building for longer periods and bystanders and neighbors deposited their waste inside the dumpster. In intermediate scale constructions, tippers are sloughed every other day causing the dumpsters to fill faster. Neighbors hardly used these dumpsters. In the larger scale construction cases, large storage sites were a vailable, which allowed dumpsters to be kept inside the building site, which deterred waste input from others. (fig. 3).

Fig 3 “Pictures of dumpsters - Vicente Lopez City. Construction Works 2014”

There were found 13 categories of CDW-USW in dumpsters, isolated and/or combined:
TI: soil, from excavation and movement**, AR**: debris, loose aggregate, remains of cement mixtures and ceramic cuts**, PC**: paper and paperboard from ceramic packaging and other coatings, bags of binders such as cement, plaster, adhesives for tiles, etc.**, MA**: wood, parts from form work, pallets from packaging, remnants of floor and wall tiles**, PL**: lightweight plastic packaging films, plastic bags. Paint additives and, adhesives containers, cuts from electricity ducts and water pipes/drain. EPS packaging and EPS insulation leftovers**, ME**: metals light elements such as gutters clippings shapes of structural systems and enclosures, pipes leftovers, wires and irons bars from reinforce concrete**, YE**: plaster drywall remnants and scrapes of enclosures and cladding
In most cases we also found irregularities such as CDW in contact with elements belonging to the so-called USW and hazardous waste (RP):USW **C**: remains of suitable food for compost and unfit for compost. USW **G**: other household remains related to hygiene of workers. USW **BT**: beverage bottles**, VE**: vegetation and pruning**, HE**: discarded tools and accessories**, RP**: dangerous by its toxic nature (plastic containers with solvent - based paint residues, adhesives and metal with asphalt emulsions). Other dangerous objects, for example: pieces of sharp glass, broken mirrors and fiberglass fragments.

4.4.- Work stages

- Preliminaries: demolition work, excavation and connectors, - Thick Work: structure, enclosure and facilities, - Terminations: coatings, paints, fixed equipment, - Moving: electronic equipment, furniture, decoration.

4.5.- Conclusion of the analysis

- No systemic classification in the construction areas in any stage; elements like soil are mixed with ceramic materials during the demolition phase which effects the quality of the waste. The remains are then flushed in the same tipper.
- Elements that could be recycled get polluted and damaged, the lack of awareness and knowledge about recycling from professionals and workers results in a low efficiency waste management, profitability, and wasted resources.
- There are not action protocols for each residue.

4.6.- Definition of Conventional Constructive Model (CCM)

To determine the most common CDW in the study area, the conventional construction model (CCM) of Buenos Aires has to be researched. We have used the Spanish model [11] to apply in CDW classification and quantification worksheets, based on the material resources consumed in the construction and renovation of residential buildings. The system was chosen under the existing agreement between universities: UBA and U.Sevilla. To determine this CCM we take a sample of four types of buildings that meet local constructive traditions in the area of Vicente López. We based our selection on data obtained from the database of the INDEC (see Table 3). Census 2010, data provided by the Municipality of Vicente Lopez on construction in 2010-2014. (Table 2)

CCM	Typology (# of floors)	% fact CMVL	M² estimated average
1	1 to 2	75.4%	200
2	3 to 5	13.2%	1300
3	6 to 9	6.9%	3500
4	10 or more	4.5%	4500 or +

Year	Number of buildings	M² built
2010	709	339.107
2011	687	339.107
2012	620	259.781
2013	440	144.559
2014	136 (1st sem)	68.499

Table 2 “Housing or mixed buildings (housing and commercial)” [12]
Table 3 “Buildings for housing INDEC”. [13]

We decided to use the four groups determined by INDEC [13] including many materials with different scales of distribution and application. The four CCMs have common characteristics: Reinforced concrete structures, reinforced concrete or masonry, masonry exterior walls (bricks/ blocks), and aluminum windows. The major variables are found in the structure of foundation, which differed depending on the proximity to the river, ground stability or the need for greater resistance, and the other important variable was the roofing, the smaller buildings had a sloped roofing sheet and larger buildings had a flat roof. The buildings are mentioned as CCM 1-4 in order to preserve firms data and locations.
CCM 1: Single family building 2 stories. 200 m² covered, 20 m² semi-covered galleria. Kitchen, living room, two bathrooms, toillete, laundry room and three bedrooms. Structure: ceramic structural/supporting blocks in walls 12 cm, reinforced corners. Double envelope: ceramic structural bricks+ EPS insulation block+ layer of ceramic brick 8 cm. Roof: galvanized color steel pitched on wooden structure. Windows and doors: aluminum and wood.
CCM 2: Apartment building, 4 stories+ ground floor. 1100 m² covered. Basic unit: kitchen, living /dining room, bedroom and bathroom. Biggest unit: kitchen, living /dinner room, bathroom, toilet and three bedrooms. The surfaces of the units vary between 40 m² and 125 m² . Concrete structure (H°A°). Double envelope: lightweight concrete+ EPS insulation blocks + and ceramic bricks thickness 8 cm. Roof: flat areas covered with green roof. Aluminum joinery.

CCM 3: Apartment building, 6 stories + ground floor + basement. The building has 3940m² covered + 1030m² semi-covered. It has 10 units every floor with kitchen, living / dining room, 1 -2 bathrooms and 1-2 toilet rooms. The units' surfaces range from 55m² to 100m². Reinforced concrete was employed for vertical structure and bases. Has horizontal structure slabs without beams of H°A° lightened with plastic discs 22 cm thick used. For exterior walls: red brick + insulation+ hollow brick, for interior walls: red brick 15 cm, hollow brick 8cm and 12 cm , and drywall.
CCM 4: Apartment building, 11 floors+ ground floor + 2 basements. 9040 m² covered + 760 m² semi-covered, 4 units for each floor. Basic unit: kitchen, living/ dining room, bathroom, and two bedrooms. The units range from 80 m² to 130 m². Structure: reinforced concrete Ceramic brick exterior walls, thickness 18 cm, ceramic brick and dry-wall interior walls,(8cm/12cm). flat roof and aluminum windows.

5.- Proposal

5.1.- Approach to the characterization of building typologies CCM according to the analyzed subject: Construction and Demolition Waste

In the local practice there is distrust in delivering information about buildings so Table 4 was developed as a first approach to characterization of each CCM. The data collected will be useful for both the identification and quantification of packaging used and adaptation of models to quantify generation outages remains and materials.

	DESCRIPTIVE CONSTRUCTIVE STATEMENT	CCM1	CCM2	CCM3	CCM4
	UNDERGROUND LEVELS	0	0	1	2
	FLOORS + Groundfloor	2	5	7	12
	Living units	1	9	57	44
1	SOIL EXCAVATION				
a	standard excavation		■	■	■
b	black soil dismantlement	■			
2	PREVIOUS DEMOLITION				
a	No demolition	■			
b	Manual demolition				■
c	Machine		■	■	
3	FOUNDATIONS				
a	Foundation slab	■			■
b	Isolated bases + chained beams			■	
c	Tubbing + chained beams		■		
4	Main independent STRUCTURE				
a	In situ reinforced concrete		Found		
b	Elaborated reinforced concrete	Foun	■	■	■
c	Reinforcement bars: cutting+bending in situ	■	■	■	■
5	CONCRETE FORMWORK				
a	Wooden planks	■			
b	Wooden boards		■	■	■
c	Wooden supports	■	■		
d	Metallic supports			■	■
6	MAIN STRUCTURE slabs+beams				
a	Slabs+floor joists+bricks	■			
b	Reinforced concrete slabs with beams		■		■
c	Reinforced concrete slabs without beams			■	
7	EXTERIOR WALLS				
a	Comp walls red brick+hollow brick			■	■
b	Comp walls ceramic bearing brick+hollow brick	■			
d	Comp walls concrete blocks+hollow bricks		■		
8	WALLS THERMAL INSULATION				
a	EPS panels	■	■	■	
b	Fiberglass panels				■
7	ROOF				
a	Classic Rib Steel Roof Panel w wood structure	■			
b	Walkable+ceramic tiles		■		
c	Non-walkable+waterproof membrane		■	■	■
d	Green		■		
8	ROOF THERMAL INSULATION				
a	Expanded polystyrene panels EPS		■		
b	Fiberglass panels	■			■
c	Polyurethane confined in situ			■	
9	INTERIOR WALLS				
a	Drywall			■	■
b	Hollow brick walls 8cm+fine plaster	■	■	■	■
c	Red brick+fine plaster			■	
10	CEILINGS				
a	Wooden	■			
b	Plaster board w/expanded metal	■			
c	Suspended Plaster board		■	■	■
d	No ceiling/concrete in sight			■	
11	MASONRY PURCHASE				
a	By pallet	■	■	■	■
12	CONCRETE PURCHASE				
a	By truck				■
b	By pallet		■	■	■
c	By sole bag	■			

	DESCRIPTIVE CONSTRUCTIVE STATEMENT	CCM1	CCM2	CCM3	CCM4
13	FLOORS				
a	Solid Hardwood Flooring	■			
b	Ceramic tiles		■	■	
c	Porcelanain tiles	■		■	■
d	Smooth finish mortar		■	■	
e	Thermal pavers	■			
f	Garden tiles	■		■	
g	Grass	■		■	
14	EXTERIOR CARPENTRIES				
a	Lacquered aluminium without subframes			■	
d	Lacquered aluminium with subframes	■	■		■
c	Wooden	■			
15	INTERIOR CARPENTRIES				
a	Metal frames w/wooden sheets		■	■	■
d	Wooden frames and sheets	■			
16	GLASS				
a	Double glazed airtight windows	■	■	■	■
17	PAINTS				
a	Varnishes	■			
b	Water-based/latex	■	■	■	■
18	ELECTRIC INSTALATION				
a	Rigid plastic pipeline		■	■	■
b	Flexible plastic pipeline		■		■
19	GAS INSTALATION				
a	Metallic epoxi pipeline				■
b	Thermo fusion pipeline	■		■	
20	SEWER / PLUVIAL INSTALATION				
a	Thermo fusion pipeline	■		■	
b	PVC pipeline		■		■
21	HOT/COLD WATER INSTALATION				
a	PP pipeline or similar		■	■	■
b	Hidrobronz pipeline	■			
22	INSTALATION EQUIPMENT				
a	Tank water heaters (Electric)		■	■	■
b	Tank water heaters (Gas)	■			
c	Gas stove+oven (Domiciliary use)	■			■
d	Electric stove+oven (Domiciliary use)		■	■	
f	Electricity generating system	■			
g	Swimming pool	■	■	■	■
h	Solar collector	■	■	■	
23	HEATING AND AIR CONDITIONING EQUIPMENT				
a	Air conditioning simple splits	■		■	■
b	Air conditioning multisplits		■	■	
c	Central air conditioning	■			
d	Fans	■			
e	Central heating system (boilers+radiators)	■		■	
24	ELEVATORS				
a	Standard		■		
b	Counterbalanced			■	■
25	EQUIPMENT				
a	Marble countertops / granite for bathrooms	■	■	■	■
b	Toilets	■	■	■	■
c	Bidet	■	■	■	■
d	Vanities	■	■	■	■
e	Refrigerator	■	■	■	■
f	Freezer	■	■	■	■
g	Dishwasher	■	■	■	
h	Washing machine	■		■	

Table 4 “Characterization of building typologies”

5.3.- Status of building data collection and processing

Data collection stage is currently in progress: information from architectural firms is being processed. In CCM 4 there is an advancement on material data processing with a specific data disaggregation by item to study volumes, weights and quantification from different materials and there packaging. Architectural firms provided graphic documentation, initial calculations and technical description.

5.4.- Material entries model according to constructive analysis by CCM

Models used were developed by one of the authors of Introduction to Constructive Types [14] in architecture career degree. The model calculates inputs for one typical m² of each building subsystem. [15]

5.5.- Development of specific awareness campaigns

As a result of surveys analysis both professionals and clients, mentioned in section 1.2.3 and the definition of intervening actors according to Section 4.2, we conclude that: it is neccessary to design campaigns that focus on the one hand, to promote actions as a quality life improval, economic performance and social responsibility and the other hand, to facilitate everyday actions, demonstrating that these objectives can be achieved with simple actions if they are properly guided. Each group requires different strategies. Social (employment and health) and Economic: dimensions of sustainability are incorporated. It will work with interdisciplinary teams: Interns of Graphics, Image and Sound design, Occupational Hazards specialists and nutritionists. In Table 5 below a series of actions is proposed to include awareness campaigns:

	Campañas propuestas	Equipo Diseño	Constru Equipo Técnico	Constr Equipo Obra	Cliente inversión	Usuario final	Entes regulación gobiernos
		1	2	3	4	5	6
A	Asemejar manejo RCD a RSU ver casos exitosos	X	X	X	X	X	X
B	Mostrar cooperativas, ONGs, asociaciones, grupos trabajando en transformación de residuos en nuevos productos, generacion empleos	X	X	X	X	X	X
B	Mostrar fichas técnicas productos construcción con mejoras en indices relacionados con la envolvente por aislación y ahorro de energía final	X			X	X	X
D	Mostrar productos de construcción con fichas técnicas y simplifación etapas de construcción	X	X	X	X		
E	Plantear ejercicios cálculo de ahorro en consumo volquetes, horas carga al clasificar y reusar RCD		X		X		
F	Beneficios gestion responsable RCD Certifica ción Edificios: BREAM, CFSH, DGNB, HQE, Protolo ITACA, Certificacion VERD, SBTool, Green Globes, BEAM Plus s- investigacion USevilla [16]	X			X	X	X
G	Incorporar criterios de alimentación saludable para personal obra y vincular con manejo RSU, mejora del ambiente fisico laboral a traves : generación compost + vegetación + show room[17]		X	X			X
H	Conceptos Responsabilidad Social Empresaria	X	X		X		
I	Protocolos de acción por etapas de obra		X	X			
J	Protocolos de acción para mudanza					X	

Table 5 “Campaigns and actors combination under 4.2 Stakeholders”

5.6.- CDW local commercial packaging characterization.

In table 6 most commonly used products were studied. Their packaging was characterized by type, amount of content, measurement unit, material and dimensions.

That data was collected to evaluate the most favorable strategies and the normally used plans for collection and dispersal. Paper and cardboard were weighed, and expanded polystyrene (EPS) was evaluated in terms of volume.

	Building finishings	Packaging (P) and protections (p)												
	Construction product name	Packed Unit			Protection / packaging material	EoP	Unit dimensions optimized storage mts			Aparent volume		Optimized volume	Rel apa/opt volume	weight clean
							large	length/R	with	m^3	shape	m^3	vol	kg
							a	b	c	´d:est medition		e:axbxc	d:e	weight
1	Tiles adhesives	bag	30	kg	papel kraft	P	0,53	0,74	0,004	0,027	roll	0,0016	17,2	0,2
2	Joint paste (big)	box	5	kg	paperboard	P	0,30	0,20	0,02	0,003	crush	0,0012	2,5	0,22
3	Ceramics 30cm x 30cm average	box	1	m^2	paperboard	P	0,50	0,50	0,005	0,005	crush	0,0013	3,6	0,25
4	Porcelain tiles 30 x 60 average	box	1,08	m^2	paperboard	P	0,40	0,90	0,005	0,006	crush	0,0018	3,5	0,325
5	Engineered Hardwood Flooring	box	3,08	m^2	paperboard	P	0,40	1,40	0,005	0,014	crush	0,0028	5,1	0,5
6	Joint filler plaster/gypsum panel w/cover**	bucket	30	kg	plastic G2	P	0,31	0,20		0,0390	ext vol	0,0135	2,9	1
7	Paint (large no-cover**)	bucket	20	lts	plastic G2	P	0,30	0,17		0,0272	ext vol	0,0095	2,9	0,87
8	Sanitary, faucets	box	1	u	paperboard	P	0,30	0,50	0,005	0,0032	crush	0,0008	4,2	0,4
9	Sanitary, Toilte, bidet	box	1	u	paperboard	P	0,41	0,60	0,010	0,0098	crush	0,0025	4,0	0,2
10	Gas cooker W-heaters water storage	package	1	u	EPS	´p	0,60	0,60	0,300	0,11	package	0,054	2,0	s p
	Gas cooker	package	1	u	nylon	P	1,30	0,90	0,001	0,005	roll	0,001	3,8	s p
11	Air Aconditioning Compresor	box	1	u	EPS	´p	0,95	0,35	0,20	0,07	package	0,050	1,3	s p
	Air Aconditioning Compresor	box	1	u	paperboard	P	1,30	1,20	0,010	0,0624	crush	0,0156	4,0	3,25
12	Air Aconditioning Evaporator	box	1	u	EPS	´p	0,85	0,35	0,20	0,06	package	0,045	1,3	s p
	Air Aconditioning Evaporator	box	1	u	paperboard	P	1,20	0,60	0,010	0,0288	crush	0,0072	4,0	1,5

	Carcassing/structural work	Packaging (P) and protections (p)												
	Construction product name	Packed Unit			Protection / packaging material	EoP	Unit dimensions optimized storage mts			Aparent volume		Optimized volume	Rel apa/opt volume	weight clean
							large	length/R	with	m^3	shape	m^3	vol	kg
							a	b	c	´d:est medition		e:axbxc	d:e	weight
1	Cement unitary	bag	50	kg	paper kraft	P	0,53	0,74	0,004	0,027	roll	0,0016	17,2	0,2
2	Cement x pallet x 40 bags	pallet	40	b	nylon strech	P	1,43	4,00	0,002	0,0387	roll	0,0114	3,4	s p
3	Lime (common)	bag	20	kg	paper kraft	P	0,44	0,64	0,004	0,018	roll	0,0011	16,0	0,15
4	Non hydrated lime plaster / gypsum	bag	40	kg	paper kraft	P	0,55	0,80	0,004	0,027	roll	0,0018	15,3	0,18
5	Masonry mixtures	bag	30	kg	paper kraft	P	0,55	0,80	0,004	0,027	roll	0,0018	15,3	0,17
6	Common Bricks	pallet	800	u	nylon strech	P	1,65	4,00	0,002	0,045	roll	0,0132	3,4	s p
7	Elastoplastic plasters	bag	25	kg	paper kraft	P	0,44	0,64	0,004	0,0225	roll	0,0011	20,0	0,15
8	Ceramic brick 8 12/33/18	pallet	198	u	nylon strech	P	1,32	4,00	0,002	0,036	roll	0,0106	3,4	s p
9	Ceramic brick 12 12/33/18	pallet	144	u	nylon strech	P	1,32	4,00	0,002	0,036	roll	0,0106	3,4	s p
10	Ceramic brick 18 12/33/18	pallet	90	u	nylon strech	P	1,32	4,00	0,002	0,036	roll	0,0106	3,4	s p
11	Ceramic block 12 port 14/33/19	pallet	126	u	nylon strech	P	1,32	4,00	0,002	0,036	roll	0,0106	3,4	s p
12	Ceramic block 18 port 18/33/19	pallet	90	u	nylon strech	P	1,32	4,00	0,002	0,036	roll	0,0106	3,4	s p
13	Concrete block 15 port 14/39/19	pallet	126	u	nylon strech	P	1,54	4,00	0,002	0,0423	roll	0,0123	3,4	s p
14	Concrete block 20 port 19/39/19	pallet	105	u	nylon strech	P	1,54	4,00	0,002	0,0423	roll	0,0123	3,4	s p
15	Water-resistant vinyl+Additive s/lid **	bucket	4	lts	plastic G5	P	0,19	0,10		0,0060	ext vol	0,0020	3,0	0,225
16	Water-resistant vinyl+Additive s/lid **	bucket	20	lts	plastic G2	P	0,38	0,13		0,0202	ext vol	0,0066	3,0	0,87
17	Insulation: fiberglass 2"	roll	21,6	m^2	nylon	P	1,20	1,88	0,001	0,0045	roll	0,0023	2,0	s p
18	Insulation foam 10mm	roll	20	m^2	nylon	P	1,00	1,73	0,001	0,0045	roll	0,0017	2,6	s p
19	Watervapour control (tyvec or similar)	roll	20	m^2	nylon	P	1,00	0,63	0,001	0,0015	roll	0,0006	2,4	s p

Table 6 “CDW Local packaging characterization”

5.7.- Action protocols by stages, type of waste and packaging

The precursor ideas of "Valuation Methods of RESCON" (construction waste) proposed by Mercante [18] arise in Table 7 in an integral protocol ,with the analysis made by waste generator guilds, that distinguish between remnants and packaging, identifies stages and guilds that will allow the further development of specific forms for each selected material. The registration of the indispensable tools for handling and fractionation are crucial in order to ensure the ultimate success for meeting goals and objectives considering the hours spent in the preparation and anticipation of purchases are less than the required without any programming. This is magnified in large projects with administrative bureaucracy and in isolated or remote sites far from marketing tools, accessories and equipment work centers. The search for stakeholders in the RCD that cannot be reused and / or recycled to the work itself reduces the cost of own human resources as it can coordinate actions so that they are in charge of reducing time, space and personal insurance.

A	B	C	D	E	F	G	H	I	J	K
			CONSTRUCTION STAGES			GENERATION TYPE			MATERIAL RECOVERY / DESTINATION	
	TYPE OF WASTE GENERATED ACCORDING TO ITS MATERIALITY	GUILD / WORK AT CONSTRUCTION SITE	STRUCTURAL WORK	FINISHINGS	MOVING	CUT-OFFS LEFTOVERS	PACKAGING	MATERIALS NEEDED / TOOLS	RE-USE AT CONSTRUCTION	SALES / DONATION
1	MASONRY BRICKS / MIXES		X			X		work machines crusher	Light concrete, filllings y Blocks	
2	TILES/FLOORING			X		X		Packaging item 12	Building Decoration	mosaicist
3	CONCRETES	STRUCTURAL CONCRETE	X			X		work machines	Fillings various	
4	WOOD	H° and carpentry	X			X		Nailpullers Packaging item 12	Protections	Artisans decoration, woodwork
5	ASPHALTS		X			X		brushes	Waterproofing	
6	PAPERBOARDS	ALL		X	X		X	Cutter, processor	Paper Cement plates	
7	PAPER BAGS cement, lime, etc		X	X			X	Cutter, processor	Paper Cement plates	
8	METALS	BLACKSMITHS	X			X		Packaging item 12		Scrap merchants
9	GLASS	GLASS		X		X		Packaging item 12		Artisans decoration, woodwork
10	PLASTERS	PLASTER		X		X		Cutters, crusher	Panels for enclosure	
11	EPS	SANIT, AC, USER		X	X		X	Cutter, crusher , sieve	Light concrete, filllings - Blocks	
12	PLASTICS packaging w/ no contaminants	MASONRY PLASTER PAINT		X			X	Spatulas, gloves, bags	CDW classification, Compost , plants	
13	PLASTICS Nylon/Strechs	ALL	X	X	X		X	Bags	Protections	Artisans, art, office Leather goods manufacture
14	PLASTICS nets	SANITARY		X			X	strengthened scissor	Paper Cement plates reinforcements	
15	FEEDING	ALL				X		Packaging item 12	Compost Plants	

Table 7 “CDW characterization + USW from buildings with re-use proposal”

5.8.- CDW reuse proposal in the same building

Besides overall reuse and recycling as Table 7, the proposal to do in situ seeks to reduce CO^2 emissions generated in transfer to recycling centers recycling process and redistribution of the product as feedstock. There is a building, where demolition is reused in manufacturing block for walls, made at SolarCities [19] Congress. The dosage of the soul of the blocks is 1: 1: 1: 3.25 corresponding to cement, sand and rubble respectively measured in liters kilos and EPS. Every soul of each block is 12 cm thick containing 2 kg of cement, sand and rubble and 7.5 liters of EPS additivaded. Surface faces correspond to cement mortar 1: 3 to 1 cm thickness of 0.5 cm outside and inside. The walls will be completed with double layer of insulation and finish plasterboard rock to reach a U-value of 0.60 to 0.70 W / m^2C. The blocks were tested for compression in the laboratory of the INTI with average results of 3.10 MPa, being suitable for non-bearing walls [20].

In rehabilitation work ceiling plates with RCD and RSU papers were produced, a formula designed by the architect Susan Caruso used for TRP18 FADU ½ SI project. Formula: 1/1/8 paper, cement, sealant with a density of 700 kg / m^3, was applied on a prototype of 2.4 m^2 space in order start using it in various housings.

6.- Achievements

- Progress in the study of the area defining typologies, selecting 4 works and contacting studying architecture and construction companies.
- Dumpsters were studied and its contents were classified.
- Generic application forms were adapted for the project.
- Computation of one of the buildings involved.Typology: MCC4
- Packaging product sheet anaysis was developed for all work stages, with the evaluation and quantification in weight and unit volume. Risk situations that could complicate the selective sorting and subsequent reuse of RCD were stated.
- Awareness campaigns sheets were designed acording to actors.
- Action protocols were developped acording to payrolls and type of waste generated.

- In Model MCC2 has already begun working with the recycling CDW. Demolition rubble mixtures have been used for making external walls blocks [19]. Reuse of 2 tons of demolition rubble is estimated.

7.- Difficulties

- In many cases, after we received data from architecture firms, we discovered that they were still defining important construction details during the construction process.
- In the anticipation of local variants for the adaptation of the system considering different shapes, sizes and packaging materials.
- The existence of dynamic processes related to changes in marketing and product packaging. Added to, the commercial release of new conventional materials with their own characteristics and packaging features.

8.- Conclusions

Displays an innovative advance in the management and quantification of CDW in Argentina, considering there are only some isolated initiatives of professionals in the field of research on the topic but there is no legislation nor interest in moving in that direction by local or national governments.

Specific characterization forms of CDW were created as a surpassing stage of building protocols aimed to reduce existing waste.

Moreover handling protocols for proper pre-sorting and subsequent reuse for specific uses were raised.

Is a contribution to the management of CDW in Argentina when considering the use of construction waste to manufacture products for the building itself reducing the consumption of virgin materials, fuel and human resources for transfers. Products for their properties collaborate with the building envelope thermal performance, reducing energy consumption and improving the degree of comfort for its inhabitants were also designed.

As an example of application of the work of this investigation it was determined that a building of 57 units that applied CDW management to the area of packaging generates a local productive economic impact:

- Cardboard with a minimal generation of 3TN to $ 700 / tn gives a yield of $ 2,100;
- EPS from crushing packages are obtained as a minimum 20 m³ of material to $ / m³ 250 generate $ 5,000
- Nylon with sum wrappers and protections of a work of this size can be manufactured 120 handbags for sale value of $ 100,000 as an example of a micro enterprise that collects this material for free in the area of Buenos Aires.
- These values can be considered a small part of a building budget but have an impact on local development, especially to cooperatives and micro enterprises. Amounts in Argentine pesos.

MCC2 developed blocks for surrounding walls with an area of 400 m² = 6000 blocks rescuing the movement of 12 tons of rubble in its processing state, density 1000 kg / m³ ton use , this implies 12 m³ but in the transportation state has a density of 500 kg / m³ this would represent 24 m³.

With the insertion UBA, National University S. Martin, professional and DGNB enrollment [21] is predicted to have colleagues interested in training in the project.

Depending on the inclusion of the authors in teaching and research field, is expected to be auxiliary data collection needed for the completion of the project through internship programs and ITC Final CEP program.

Strong links with two of the studies involved, will verify CDW generation estimates, management and reuse on their buildings.

While the issue of CDW management is widely discussed, the project links the three dimensions of sustainability and creates tools to reduce RCD and its application in construction products demonstrating feasibility and economic viability. With the "University Capacity for Development Production" program will be possible to train people without previous training covering the social pillar.

We analyzed the volume of collection and transfer of packaging may vary from 3 to 17 times depending on the format chosen. This is considered in the management protocols manual for CDW and the must do steps and must use tools.

REFERENCES

[1] Reed, David, (1996) Ajuste estructural, ambiente y desarrollo sostenible, Caracas WWF, CENDES, Editorial Nueva Sociedad.

[2] Source: National Weather Service www.smn.gov.ar

[3] Allenbach, Martin 2005. Die Cartoneros. HGKZ. Zurich.

[4]Yajnes, Sutelman et all (2014), http://cep-fadu-uba.blogspot.com.ar/ pdf El camino del Cascote en Buenos Aires, Argentina

[5] Mercante, I (2008) Environmental impact of CDW management alternatives. http://www.imd.uncu.edu.ar/upload/mercante-residuosconstruccion.pdf Cuyo National University. San Juan, Argentina

[6] Reixach, Barroso, Cusco. (2000) waste management plan in the works of construction and demolition, Institute of Technology for the Construction of Cataluña, IteC. Programa Life 98/351 Direccion General Medio Ambiente Comunidad Europea. Barcelona, Spain.

[7] Diaz, Ruggeri, (2009) Guide to good environmental practices for construction sites, Classrooms and Scaffolds, Buenos Aires

[8] CIMPAR, Municipal Environmental Protection Commission Interempresarial Rosario; Galdos, Baud et all (2010) Good environmental practices in construction. Rosario. Argentina

[9] Putruele (2015) http://cep-fadu-uba.blogspot.com.ar/ Encuestas RCD.pdf

[10] Fuente: INDEC National Institute Statistics and Census. R. Argentina

[11]Mercader-Moyano, Ramírez-de-Arellano-Agudo, 2013 Selective classification and quantification model of C&D waste from material resources consumed in residential building construction. Waste Management & Research. 458–474

[12] Source: General Directorate of private constructions of Vicente Lopez

[13] INDEC Instituto Nacional de Estadisticas y Censos. R. Argentina, constructed m2.

[14] Yajnes (2012) http://cep-fadu-uba.blogspot.com.ar/ pdf Modelo de Computos ITC

[15] Trulls, Putruele (2015) http://cep-fadu-uba.blogspot.com.ar/ MCC 4.pdf y MCC 3.pdf

[16] MMoyano;GPiñero;RA Agudo(2014) A review of environmental impact assesment methods for historic districts 4th Conference on Heritage and Sustainable Development. edited by Amoedo,R; Lira,S; Pinheiro, C.Green LInes Institute, p347-357, Barcelos, Portugal.

[17] Knut, Jane, James, Construction Health and Prevention. Encyclopedia of health and safety at work. Tomo 3.93. National Institute of Safety and Health at Work.

[18] Mercante, I (2007) Characterization of construction waste. Applying generation rates to environmental management. Scientific Journal UCES Vol.XINº2pag 86,109.

[19] Yajnes, Caruso, Sutelman, Tosi, Moreno (2014) Resources Waste, incor poration concrete with aggregates from construction waste products with generation of green jobs 5ºCongreso International Solar Cities, APRA, pp 201-225, Bs Aires, Argentina.

[20] http://cep-fadu-uba.blogspot.com.ar/ pdf INTI ENSAYOS COMPRESION.pdf

[21] DGNB Deutsche Gesellschaft Nachhaltiges Bauen German Sustainable Building Council