RECYCLING CENTRES FOR CONSTRUCTION AND DEMOLITION WASTES IN BRAZIL: A STUDY CASE FOR THE CITY OF RIO DE JANEIRO

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SUMMARY: There are very few construction and demolition (C&D) waste recycling centres in Brazil. Data relating to C&D waste management and recycling in Brazil were collected and analysed to encourage the building and operation of new units. Based on the results of this analysis, a conceptual model was proposed to perform feasibility studies of future C&D waste recycling centres.

Applying this model to verify the feasibility of private recycling centres, negative results show that C&D waste recycling centres in current market conditions in Brazil are not financially feasible if based solely on revenue from the sale of processed products. A case study for the city of Rio de Janeiro is discussed.

The conceptual model, results of its applications in the city of Rio de Janeiro and their analysis can strongly support public authorities and private initiatives in their decision-making about investments in waste recycling centres in Brazil and in other developing countries.

I. INTRODUCTION

Only eleven (0.2%) of the 5,507 Brazilian municipalities have C&D waste recycling centres. Thirteen centres (seven in operation, one restarting its operation and five have shut down) are stationary plants and recycle part of the C&D waste produced in local communities. It can, therefore, be concluded that a large part of this waste is not recycled in Brazil. Nonetheless, this situation is changing. Since the publication of CONAMA (Brazilian Environmental Protection Agency) Resolution no. 307 in 2002, all Brazilian local governments are obliged to prepare and adopt strategies for sustainable management of C&D waste (MMA, 2002). In the justifications for this resolution, mention was made of the feasibility of the production and use of C&D waste materials. However, there has been relatively little research in Brazil to prove the technical and economic viability of C&D waste recycling centres.

This study was carried out with the objective of bringing together the data relating to C&D waste management and recycling in Brazil. Based on the conceptual model for financial viability

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studies of C&D waste recycling centres proposed by Nunes (2007), the feasibility of private recycling centres in Brazil was verified through a study case for the City of Rio de Janeiro.
The data collection involved bibliographic review, consultations to professionals from the sector and visits to the recycling centres. Most of the data were collected between January and November 2003. The phase of the research showed that there are no large-scale private C&D waste recycling centres in Brazil. With the objective of changing this situation and increasing the amount of private plants in the country, the present study targets in special to private enterprises.

Professional inquiries in the sector in Brazil showed that private projects with less than 20 tons per hour (t/h) of C&D waste processing flow will probably not be financially viable, due to low productivity and low prices of the processed product. Since the use of recycled products is still not widespread in Brazil, investments in large-scale recycling centres with complex facilities will have more chance of failure rather than simpler ones. It was, therefore, concluded that two different recycling centre projects should be analysed: one small scale (20 t/h), and the other midsize (100 t/h). It was also assumed that, due to the lack of tradition in the use of processed products and the absence of C&D waste recycling projects in the country, the feasibility of future private recycling centres will initially be somewhere between the two capacities above.

The scenario technique with alternating hypotheses was used in this analysis, providing results through the Net Present Value method (NPV), which indicated which conditions of the facilities under study would be viable.

1.1. The Municipality of Rio de Janeiro: General information

Rio de Janeiro is the second largest city of Brazil. The population is around six million inhabitants and 100% urban. There are 1,802,347 domiciles in an area of 1,261 km² (IBGE, 2000). The urban infrastructure is reasonable with regard to the water supply, street lighting and sewer system. 345,257 domiciles (around 20% of the total of domiciles) are located in slums. Ninety-five percent of the domiciles are attended by the water supply net and 69% have sewage nets. The Rio de Janeiro Municipal Urban Cleaning Company provides public cleaning and waste management services. These services supply around 96% of the commercial and residential units in Rio de Janeiro (IPP, 2001). The population of the metropolitan region is around 12.5 million inhabitants over an area of 10,222 km². (IBGE, 2000)

2. FEASIBILITY ANALYSIS: CONCEPTS

UNIDO (1987) presents a structural model for feasibility studies of complex projects, involving heavy investments from various fundings sources. By simplifying this structure and adding the elements described by Kohler (1997), the following key stages in pre-feasibility studies of C&D waste recycling centres were identified: (a) market and competition analysis; (b) estimated generation of C&D waste; (c) estimated revenues and costs; and (d) investment analysis. These stages form a conceptual model for feasibility studies for C&D waste recycling centres. Stages (a) and (b) depend on the geographic location of the centre. In this research the location was in the Municipality of Rio de Janeiro.

The comparison method between alternative investments used in the financial analysis of this research was the NPV that is one of the most commonly used dynamic methods. In addition to the NPV, the scenario technique is also applied in the analysis. This technique in a financial analysis permits an estimate of favourable and unfavourable results considering the occurrence of different hypotheses (Motta; Caloba, 2002). An exchange rate of US $1 equal to R$ 3.00 was used in the financial analysis (Basis: November 2003).

3. MARKET AND COMPETITION ANALYSIS

In Brazil the resources for civil construction aggregates are abundant. The major consumer centres are generally located in regions with good quality reserves. According to DNPM (2003), "sand and gravel are low in price and produced in large quantities. Transport costs correspond to around 2/3 of the end price of the product, which make it necessary to produce sand and gravel as near as possible to the consumer market, which are the urban agglomerates".

The consumption in Brazil is estimated to be around 1.5 tonnes per inhabitant/year (Sindipedras, 2004). In developed countries this consumption is approximately 7.0 and 10.0 tons per inhabitant/year. The population of Brazil is around 178,116,860 inhabitants (IBGE, 2000), so total aggregate consumption corresponds to 267 millions tons (about 170 millions m^3).

Considering the normal demand plus the extra demand for the Pan-American Games (July 2007), the estimate for aggregate consumption in the Metropolitan Region of Rio de Janeiro between 2004 and 2011 is presented in Table 1.

Current prices for the civil construction aggregates have had little chance since 1994, and the average prices per aggregate type (prices without transport) are detailed in Table 2. The costs with transport are estimated to be around 0.22 R$/($m^3$.km).

Both aggregate prices and the number of new construction projects have been low for a long time. Consequently, there is currently a large supply of aggregates. Even the most optimistic forecasts do not believe in price rise. So in order to attract and fix clients, the prices of the recycled aggregates must be lower than the natural aggregates.

The transport firms that carry C&D waste to recycling centres in regions close to the city centre have probably lower transport costs. In this case the recycling centres can charge higher prices for receiving waste and cut prices for selling the recycled aggregates. On the other hand, central areas are often located close to densely populated areas. This can cause licensing problems for the recycling centre.

In relation to C&D waste reception, the recycling centres compete with the landfills. According to Brazilian state-of-art, the landfills need large amounts of inert material to cover the landfill cells. The material is also required to build access roads and manoeuvring areas for the

Table 1: Estimate for aggregate consumption in the Metropolitan Region of Rio de Janeiro (between 2004 and 2011) (adaptation from Sindibrita, 2003)

Demands	Aggre-gates	Yearly estimated consumption (in 10^3 tonnes)							
		2004	2005	2006	2007	2008	2009	2010	2011
Normal + Pan-American	Sand	3,325	2,813	2,250	2,250	2,250	2,250	2,250	2,.250
	Gravel	13,500	11,250	9,000	9,000	9,000	9,000	9,000	9,000
	Total	16,825	16,825	16,825	14,063	11,250	11,250	11,250	11,250

Table 2: Aggregates in the Metropolitan Region of Rio de Janeiro (Sindibrita, 2004)

Aggregates	Aggregate grading (diameter in mm)	Prices (excl. taxes)		Prices (incl.taxes[1])	
		(US $/m³)	(US $/t)	(US $/m³)	(US $/t)
Sand	< 4.8	4.67	2.75	6.00	3.53
Stone powder	< 4.8	4.67	3.00	6.00	3.85
Gravel 0, 1, 2, 3	from 4.8 to 76.0	5.72	3.94	7.33	5.06
Gravel mixed	from 4.8 to 50.0	4.67	2.67	6.00	3.41

[1] It was considered a simple company a tributary load around 22%.

waste-collection trucks on the landfills. Moreover, Brazilian landfills operating companies need C&D waste and in its absence they would use natural aggregates. However, according to some estimates (Nunes, 2004) C&D waste corresponds to a significant fraction (20%-50%) of municipal solid wastes. In the event that all produced C&D waste is collected and carried to the landfills, the landfill operating companies and the local government must reassess whether in technical terms a potential recyclable material (C&D waste) is wasted. Besides, this procedure leads to an acceleration of the landfill life cycle.

It must be considered that the landfill operating companies (in the municipalities that have given the operation of their landfills to private companies earn often per received tonne. Then, the more waste an operating company receives in the landfill, the more it earns. The inert landfills are also competitors of recycling centres in relation to reception of C&D waste. There are in Rio de Janeiro plain areas to where the city is expanding that may be elevated. According to the municipal government authorities (Nunes, 2004), this elevation would be advantageous to the city, what would lead to lower risks with floods and improvement of the ground carrying capacity. The Resolution CONAMA n. 307 defines C&D waste landfill as area where only the mineral and inert part of C&D waste can be disposed. As it will put in practice in the municipality must be an important concern of the municipal government authorities.

4. DEMAND ESTIMATE

For the Metropolitan Region of Rio de Janeiro was estimated in 2000 to have a deficit of 391,000 residential units and a deficit of 520,000 residential units without adequate basic infrastructure (IPP, 2001). For 2006, these figures are likely to be the same or even higher, so it can be observed that the population of this region has been growing and there is still no proper local social housing policy.

Use of recycled aggregates has been a rarely explored alternative to solve the housing problems. Chenna and Lima (2000) described experiences of a Brazilian city (Belo Horizonte) with C&D waste recycling, and said that “100 waste collection trucks with 5m³ of C&D waste can provide (…) enough bricks to build 55 simple houses of 60m² or aggregates for approximately 1000 m² sub-base”.

Ângulo (2002) described “successful experiences in the large scale use of recycled aggregates as a road surface base, as in the cities of São Paulo and Belo Horizonte”. In 2004 were published five ABNT (Brazilian Association of Technical Norms) norms about C&D waste that, among others, normalize specifications about the use of recycled aggregates as base of pavements. With the existing positives experiences and specific technical norms, in technical terms it seems that the major potential for using recycled aggregates is as the road surfacing base und sub-base.

In the market for aggregates used by civil construction in Brazil only 30% of the produced gravel is found to be directly allocated to road surfacing. Seventy percent of the produced gravel and 100% of the produced sand are consumed by other markets (mixed with cement, production of concrete and pre-cast components and mortar). (DNPM, 2006)

According to Ângulo (2002), “national data show that the road surfacing market alone is not able to consume all recycled aggregates as road surfacing base or sub-base (…). At the present stage of technical know-how in Brazil, only the use of recycled aggregates as road surface base and sub-base is consolidated. It is necessary to develop other markets to warrant the large-scale recycling of C&D waste”.

In a scenario considering that 30% of the present sand and gravel market could be replaced by recycled aggregates, a market for at least 3.4 millions tonnes yearly would be obtained for the Metropolitan Region of Rio de Janeiro in the next eight years[2].

An important aspect about the feasibility of C&D waste recycling centres is the concern about the flow of recycled aggregates into the market. The publication of norms about the uses of recycling aggregates makes available procedures to the quality assurance of products and services that use this material.

The public authorities themselves are a large consumer of aggregates, for example, in the building of state-financed housing and infrastructure projects, and street maintenance services. The public authorities can therefore encourage the consumption of recycled aggregates. Moreover, the local governments can make contacts and establish partnerships with neighbouring local and state government and the private sector. For the success of these partnerships, there must always be focus on the technical and economical feasibility.

Opportunities should also be evaluated, such as redeveloping old mining plants located in the municipalities and filling former mines. Other incentives to use recycled aggregates could be obtained by tax reductions for production and sale of recycled aggregates or for building recycling centres. An option can also be public-private partnerships, where governments and the private sector work together

It must be emphasised that marketing measures to promote the use of recycled aggregates in the construction industry should be adopted to increase consumption. There are still many preconceived notions about recycled products, such as, as for example the idea that these products would have always bad quality. Among the processes and technology presently used in Brazil, only the downcycling is possible. It can be said that recycled aggregates, mainly those for private corporate consumption, will be sold in large amounts, if recycled aggregates prices are lower than the prices for natural aggregates.

5. ESTIMATED PRODUCTION OF C&D WASTE

The estimative for production and collection of C&D waste in some Brazilian cities is presented in Table 3. The Rio de Janeiro Municipal Urban Cleaning Company estimates a collection of 1,000 ton/day (0.17 kg/inhab.day), an amount below the average in another seven municipalities under study (0.51 kg/inhab.day). A reason for this may be that the illegal disposals are considered public waste in the official statistics. The Table 4 provides information about the collected averages of domestic waste and public waste in the Municipality of Rio de Janeiro between 1990 and 2003.

The gravimetric composition of the C&D waste in the municipality under analysis is shown in Table 6 (column %). The column (x 2,877) represents the multiplication of the composition by the total C&D waste generated (see Table 5). When the inert fractions of Table 6 are added, it can be concluded that there is a potential production of inert mineral material of approx. 2,712 t/day (one million tons a year), which can be recycled and sold in the municipality.

[2] It was considered 30% of the smaller value among the values between 2004 and 2011 presented in Table 2.

Table 3: Estimative for production / collection of C&D waste in some Brazilian cities (Nunes, 2004)

Municipalities	Estimative of C&D waste (em toneladas por dia)		Year-Base	Population (IBGE, 2000)	Production per inhabitant (kg/inhab.day)	Collection per inhabitant (kg/inhab.day)
	Produced	Collected				
Rio de Janeiro	n.a.	1,000	2003	5,857,904	n.a.	0.17
Salvador	n.a.	2,746	2000	2,443,107	n.a.	1.12
São Paulo	16,000	3,360	2001	10,434,252	1.53	0.32
Ribeirão Preto	1,000	250	2003	504,923	1.98	0.50
São José dos Campos	733	n.a.	1995	539,313	1.36	n.a.
Piracicaba	620	n.a.	2003	329,158	1.88	n.a.
Vinhedo	n.a.	11	2003	47,215	n.a.	0.23
Guarulhos	n.a.	n.a.	-	1,072,717	n.a.	n.a.
Ribeirão Pires	n.a.	n.a.	-	104,508	n.a.	n.a.
São José do Rio Preto	687	n.a.	1996	358,523	1.92	n.a.
Santo André	1,013	n.a.	1996	649,331	1.56	n.a.
Belo Horizonte	n.a.	2,220	2000	2,238,526	n.a.	0.99
Londrina	1,280	n.a.	2003	447,065	2.86	n.a.
Brasília	n.a.	n.a.	-	2,051,146	n.a.	n.a.
Macaé	-	35	2003	132,461	n.a.	0.26
Florianópolis	636	n.a.	2001	285,281	2.23	n.a.
Averages					1.92	0.51

n.a.: not available

Table 4: Municipality of Rio de Janeiro: Averages of domestic and public wastes (COMLURB, 2002)

Years	Average of collected waste (in tonnes)		Years	Average of collected waste (in tonnes)	
	Domestic waste	Public waste		Domestic waste	Public waste
1994	3,230	2,310	1999	4,889	2,734
1995	3,371	2,456	2000	4,838	2,643
1996	4,214	2,812	2001	4,880	2,848
1997	4,759	2,469	2002	n.d.	n.d.
1998	4,915	2,361	2003	n.d.	n.d.

Table 5: Estimative of the total produced C&D waste (t/day) in the Municipality of Rio de Janeiro

Estimative of the total produced C&D waste	tonnes / day
C&D waste produced in the construction of new licensed buildings	940
C&D waste produced in licensed renovations	115
C&D waste produced of the construction of not licensed buildings	222
Amount of C&D waste collected by the municipality at the residential units	1,000
Amount of C&D waste collected by the municipality in illegal disposals	600
Total C&D waste generated	2,877
Production per inhabitant daily	0.49 kg/inhab.day
Production per inhabitant yearly	180 kg/inhab.year

Table 6: Gravimetric composition of the C&D waste and the totals produced daily (COMLURB, 2004)

Components	%	x 2,887 t/day
Concrete	51.2	1,473
Gravel and aggregate	29.2	843
Ceramics	13.7	396
Paper and plastic	1.5	44
Metals	1.2	35
Gypsum	1.7	49
Wood	1.5	44
Total	100.0	2,887

6. ESTIMATED REVENUES AND COSTS

Item 2 presented the essential stages in pre-feasibility studies. Stages *a* (market and competition analysis) and *b* (estimated C&D waste production) depend heavily on the centre's geographic location. Stage *c* (estimated revenues and costs) depends partially on this location. Because of these dependences, the results from stages *d* and *e* are also affected by the definition of the location of centre.

In Nunes (2007), a feasibility study for C&D waste recycling centres in Brazilian was carried out without considering the geographic location. This occurred because it was a preliminary study and a location for the recycling centre had not still been defined. This paper continues the preliminary study of Nunes (2007). The location to be evaluated is a plot of land in the Municipality of Rio de Janeiro, seen in the following items. The estimated cost presented by Nunes (2007) was divided in two parts: (I) estimate of fixed capital investment and (II) estimate of operational costs.

The equipment used in C&D waste recycling centres requires substantial investment. Since the used equipment market, based on the mining sector, is strong in Brazil, this was taken into account in the analysis. Table 7 illustrates in a summarised form the fixed capital investments necessary for 20 t/h and 100 t/h recycling centres, according to production volumes and choice of new or used equipment.

After defining the site for building the recycling centre, it is possible to add in the previous cost estimations made by Nunes (2004) the costs with land acquisition and for transportation and proper disposal of the recycling centre rejects.

Through consultations to many professionals, it was found that the minimum size of a site for a recycling centre would be: (a) 6.000 m² for the 20 t/h recycling centres; oder (b) 30.000 m² for the 100 t/h recycling centres. From consulting the municipal authorities, the information given was that because of the municipal zoning plan the construction of this type of installation could only be possible in industrial areas that are currently three in the Municipality of Rio de Janeiro. The prices of the plots of land in the area in question would be at least US $ 14,500.00 for 20 t/h plants and R$ 72,500.00 for 100 t/h plants.

Having defined the recycling centre site, it is possible to estimate the transport costs. This is by multiplying the freight price (0.22 R$/(m³.km) by the distance from the recycling centre to the Rio de Janeiro landfill (around 10 km). Considering the 20% for the percentage of rejects from C&D waste recycling, the daily reject production from a 20 t/h and for a 100 t/h recycling centre are 26t/day and 128t/day respectively. For a larger amount than 8t/day the municipal landfill charges US$ 3,33/t for receiving C&D waste. Calculating the estimates, a 20t/h centre would spend an annual US$ 7,040, and for the 100 t/h, centre US$ 96,800.00 for the payment of the municipal landfills alone.

Table 7: Investment in fixed capital and the operational costs (summary)

		20 t/h Capacity Total Costs (in US$)		100 t/h Capacity Total Costs (in US$)	
Investment in fixed capital		Used Equip.	New Equip.	Used Equip.	New Equip.
1	Construction works	13,300	13,300	13,300	13,300
2	Equipment	150,000	309,000	370,000	776,500
3	Special facilities	13,300	13,300	26,600	26,600
Total (not including land)		176,600	335,600	409,900	816,400
Total / Capacity		8,835	16,770	4,090	8,170
Operational Costs					
Fixed Costs					
1	Labour	39,400	39,400	84,800	84,800
2	Other fixed costs	98,200	114,070	420,280	460,980
Variable Costs					
3	Variable costs	36,000	36,000	140,000	140,000
Total		173,600	189,467	645,080	685,780

Sources: SINDIBRITA, suppliers of crushing equipment and producers of finished products.

7. ANALYSIS OF INVESTMENTS

As already mentioned, the paper herein has continued the preliminary study by Nunes (2007), in which eight scenarios were used. These scenarios were based on three hypotheses: (a) nominal capacity (20 t/h or 100 t/h); (b) equipment: new or used; and (c) revenue from acceptance of C&D waste (yes or no). When a scenario includes revenues from acceptance of C&D waste (gate fee), the estimate of the minimum value to be charged for financial feasibility becomes positive. It will happen when the financial analysis has a NPV higher than zero. The results of Nunes (2007) did not include the cost with land to location of the plant, as already mentioned.

For the Municipality of Rio de Janeiro 24 scenarios were investigated (Table 8: Scenarios 9 to 32). These scenarios were based on five hypotheses: (a) nominal capacity (20 t/h or 100 t/h); (b) equipment (new or used); (c) revenue from acceptance of C&D waste (yes or no); (d) the cost of land included (yes or no); and (e) transport and waste disposal costs are included (yes or no).

Table 8 shows from the negative results of the scenarios that do not consider revenues from C&D waste acceptance that private recycling centres in the present market conditions of the Municipality of Rio de Janeiro would be not economically feasible. The revenues alone from the sale of recycled aggregates do not make the plants feasible. A similar conclusion was also obtained from the preliminary feasibility study by Nunes (2007) for the market conditions in Brazil, but without considering a geographic location.

The gate fees give an additional option of revenue for the plants. Some of the scenarios with gate fee presented in Table 8 and the best results (lower prices to be charged per ton to make the project feasible) considering location as defined, were scenario 23 (US $ 1.09/t with 100 t/h second-hand equipments) and scenario 29 (US $ 1.26/t with 100 t/h new equipments).

For the feasibility of 20t/h plants, considering location as defined, were scenario 11 (US $ 2.80/t with second hand equipments) and scenario 17 (US $ 3.24/t with new equipments).

Table 8: The scenarios and their results

Sce-nario	Nominal capacity (t/h)	Equipment	Land included?	Revenue from acceptance of C&D waste?	Expense with transport and disposal of waste?	Price charged for acceptance C&D waste NPV=0 (US$)	NPV value without C&D waste accep-tance value (US$)
09	20	Secondhand	No	Yes	Yes	2.81	-
10	20	Secondhand	Yes	Yes	No	2.52	-
11	20	Secondhand	Yes	Yes	Yes	2.80	-
12	20	Secondhand	No	No	Yes	-	- 553,423
13	20	Secondhand	Yes	No	No	-	- 509,883
14	20	Secondhand	Yes	No	Yes	-	- 566,420
15	20	New	No	Yes	Yes	3.18	-
16	20	New	Yes	Yes	No	2.96	-
17	20	New	Yes	Yes	Yes	3.24	-
18	20	New	No	No	Yes	-	- 625,533
19	20	New	Yes	No	No	-	-581,996
20	20	New	Yes	No	Yes	-	-638,530
21	100	Secondhand	No	Yes	Yes	1.00	-
22	100	Secondhand	Yes	Yes	No	0.49	-
23	100	Secondhand	Yes	Yes	Yes	1.09	-
24	100	Secondhand	No	No	Yes	-	-986,158
25	100	Secondhand	Yes	No	No	-	- 484,193
26	100	Secondhand	Yes	No	Yes	-	- 585,920
27	100	New	No	Yes	Yes	1.19	-
28	100	New	Yes	Yes	No	0.66	-
29	100	New	Yes	Yes	Yes	1.26	-
30	100	New	No	No	Yes	-	-392,070
31	100	New	Yes	No	No	-	-651,237
32	100	New	Yes	No	Yes	-	-1,241,196

Through these results it can be seen that the gate fees for the feasibility of 20 t/h plants are higher than the gate fees for 100 t/h plants. This means that a larger production of recycled aggregates makes it easier for financial feasibility of the recycling plants.

Table 8 also shows that the scenarios that considered the transport and waste disposal expenses showed even less favourable results than the scenarios that did not consider these expenses. It means that these expenses significantly impact the economical feasibility of the recycling plants. By shortening the distances between the landfills and recycling centres, the reject transport costs will be reduced. The possibility of working on more than one shift was not considered, but perfectly possible to implement if a demand for the recycled material exists..

10. CONCLUSION

In Brazil the resources for civil construction aggregates are abundant, good quality and close to urban consumer centres. Both prices of aggregates and the number of new construction projects have been low for some time. So, in order to attract and fix clients, the prices of the recycled aggregates must be lower than the natural aggregates.

Concerning C&D waste reception, the recycling centres have to compete with the landfills. According to the Brazilian state-of-art, the landfills need large amounts of inert material to cover the landfill cells. The material is also required to build the access roads and manoeuvring areas for the waste collection trucks on the landfills. The inert landfills also compete with recycling centres in relation to reception of C&D waste. There are in the Municipality of Rio de Janeiro has low-lying areas to which the city is spreading, and which may be elevated.

In the Metropolitan Region of Rio de Janeiro in 2000 a deficit was estimated of around 400,000 residential units. The public government authorities are large consumers of aggregates, for example, for building state-financed housing and infra-structure projects and street maintenance services. Therefore, the public authorities could encourage the consumption of recycled aggregates.

The economical feasibility of C&D waste recycling centres in the city of Rio de Janeiro was investigated by means of scenarios. It was found from the negative results of the scenarios that do not consider revenues from C&D waste acceptance, that private recycling centres in the current market conditions would be not economically feasible in the municipality. The revenues alone from the sale of recycled aggregates do not make the plants feasible. It is suggested that other sources of revenue be found, such as charging for acceptance of C&D waste in recycling centres and the reducing tax and loans at lower costs than practised in the market. An option can also be the public-private partnerships, where the governments and the private sector work together.

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