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Cost Study for Implementing the Green Roof in Boa Vista/RR CostStudyforImplementingtheGreenRoofinBoaVistaRR

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Abstract

Tendo como sustentabilidades como alternativas viáveis e concretas, o telhado verde surge como uma inovação exitosa e tecnológica para a construção civil a fim de amenizar os efeitos nocivos ao meio ambiente desta indústria em Boa Vista/RR. Assim, foi estabelecida uma análise do custo da instalação da cobertura verde em um protótipo construído no Centro Universitário Estácioda Amazônia em Boa Vista/RR. Ao analisar o custo da cobertura sustentável mostrou-se significativo para o Estado de Roraima, além deuma promoção de qualidade socioambiental com custos acessíveis para população boa vistense.

Index terms— green roof; surface drainage; sustainability.

1 Introduction

he city of Boa Vista/RR has been going through a process of disordered urban growth, there is a great degradation caused by real estate subdivisions due to the collapse of the riparian forest, causing silting and damaging the water sources in T Permanent Preservation Area (APP), damaging the flora, fauna and the well-being of the population of Boa Vista.

It's essential that the impacts arising from the actions of the civil construction industry need to be minimized, adapting the way of acting, to achieve greater sustainability. This article has been gaining greater prominence in recent years in the area of civil construction, since, according to Righi et al (2016), the sector is responsible for consuming 2/3 of natural wood and about 50% of natural resources, being a large part of non-renewable resources.

In this context, the technique of green roofs becomes an alternative that helps both in the thermal comfort of homes and in addition to mitigating the effects that this change brings to the environment. That can be applied to roofs and slabs having as prerequirements waterproofing the surface, dimensioned drainage, minimum slope of 2% and maximum of 35% (up to 75% with locking and barriers) and structure that supports overload **??**KIST, 2011).

A major obstacle in the use of alternative technologies with sustainable materials is related to durability and costs. In view of the aforementioned problem, the proposal to analyze costs when implementing a green roof was considered.

The importance of this project is noted since during the research there were no studies on the comparison of budgets for the implementation of a Green Roof in Boa Vista/RR. This project also seeks to promote the proposed technique to be carried out in the city's dwellings in an accessible way, that is, low cost, advantages generated for the citizens in addition to contribution to public infrastructure, with a view to less rainwater discharge into the urban drainage.

One of these problems is well punctuated in the data from the Single Registry of the Ministry of Citizenship -CadÚnico (2019) which show the increase in extreme poverty in Roraima and already reaches 47 thousand people. In the last seven years, more than 4 thousand people have been in extreme poverty in the state, an increase of 10.5%. Thus, this proposal is even more justified by seeking the application of successful and accessible alternatives, since it contributes to the quality of life and well-being of citizens, and to reducing the flow of rainwater.

This study aimed to analyze the implementation of the green roof in a prototype built at the Centro Universitário Estácio da Amazônia in Boa Vista/RR. As well as checking the material costs of the sustainable roof built in the experiment comparing it with the Green Roof of the author of the literature ??Nascimento, 2019); point out the benefits in a sustainable way in the construction of an ecological roof; expose the costs of this solution, built with French fiber-cement and ceramic tiles, in addition to promoting the reuse of rainwater to irrigate the built vegetation cover.

2 II.

3 Theoretical Reference a) Allotment and environmental impacts

With urban growth, buildings and urban infrastructure works such as streets, public sidewalks, parking lots and others, significantly alter the land cover and topography. In addition to the direct impacts on terrestrial and aquatic ecosystems, the urban climate is modified (TASSI et al 2014).

According to Setrabes (2019) many families have poor conditions, that is, they are between low income and extreme poverty, with 42% of the population in the state of Roraima. Another point is the absence of vegetation in the homes, causing a high sensation of heat in the homes, as the internal part of their houses is influenced by the external climate. Thus, it is necessary to use alternative methodologies to solve or reduce these problems (FERREIRA; COSTA, 2010).

Therefore, it is evident that buildings with green roofs, since ancient people, have been providing excellent thermal performance. This is due to the function of the layer between the soil and vegetation, which in hot climates environments, prevents the passage of heat into the buildings and in cold climates it retains the heat inside the buildings for a longer time ??ARAUJO, 2007).

In view of this, the relevance of this study is even more justified, as it aims at alternatives for sustainable buildings that make conscious actions possible, meeting the current demand, contributing to the environment and meeting housing needs, promoting a sustainable society and thinking about the future.

According to Caixa Econômica Federal (2008), norms related to the environment and society were created for popular houses, whose purpose was to mitigate the consequences in the place, taking advantage of the resources of nature through the saving of water and energy. Medeiros (2012) reports that the market on this sustainable issue, appears with more focus on enterprises, due to changes in the law. But, that these products are not well received by society, due to the high price.

4 b) Definition, Advantages and Disadvantages of the Green Roof

According to Araújo (2007), the use of the Green Roofs technique provides great comfort both in and around homes, as vegetation helps to improve the region's climate as well as protect the roof from solar radiation, with the purpose of cooling the environment on hot days.

For Vacilikio (2011, p. 15), in addition to the Green Roof keeping the air fresh on hot days, it also has the capacity to store heat inside homes during the winter, and can then be installed in both cold and hot regions.

Another advantage is that it also provides a much cooler environment than other roofs, keeping the building protected from extreme temperatures, especially in the summer, reducing by up to 3 ° C, thus minimizing energy costs with heating or cooling, consequently saving energy. In extremely artificial environments such as the urban, they promote environmental rebalancing, bringing the benefits of vegetation to public health and biodiversity, when using native plants of the place. Sometimes, green roofs have solar panels that further reduce electricity consumption (NASCIMENTO, 2014).

For Castro and Goldenfum (2010), in addition to the advantage of reducing the speed of rainwater flow on the roof, increasing the retention of this water, it also reduces the thermal amplitude, among others. However, some disadvantages may arise with the implementation of green roofs, such as: cost of implementation, infiltration problems and increased load on the structure of the property.

5 c) Conventional roofs

To determine the choice of these roofs, the most used in Boa Vista / RR were considered as an alternative to cover buildings due to the cost of implementation. For construction of buildings with fiber cement tiles follows NBR 7.196/2014 -Sheet of Corrugated Fiber Tile: procedure. As for the use of French type ceramic tile, its execution is standardized by NBR 8.039/1983 -Design and Execution of Roofs with French Type Ceramic Tiles.

6 d) Costs and Comparison with the author Nascimento (2014)

Always thinking of the lowest cost and return on investment, ??liveira et al. (2009, p. 28), addresses even in the face of the mishaps about the cost of sustainable roof arises if we consider the entire life cycle, and the duration is on average twice the time of the conventional option. It is unlikely that such a solution will last more than 20 years without maintenance, since the green roof lasts 2x longer, in addition to protecting the roof, it can with stand temperature differences (BONI, 2015).

To analyze the cost of implementing this roof under study, it was compared with the cost of the green roof built by the author Nascimento (2014) who budgeted for implementation in the housing units of the Minha Casa Minha Vida program in the city of Campo Mourão, PR.

7 III.

8 Methodology

The study was carried out in two prototypes built on the premises of the Centro Universitário Estácio da Amazônia which have the dimensions of 1.40 mx 1.40 m in its internal part. The research was bibliographic, descriptive, qualitative, quantitative and field, where initially the ideal class for its use on the Green Roof in the municipality of Boa Vista/RR was studied, after a literary survey in articles, theses and newspapers, among others.

In order to present the composition of the Ecological Roof layers, literary articles were analyzed, as well as checking the plants of the region with the best adaptation. After looking for literary information in order to seek more accessible materials in a sustainable way for the implantation of the green roof, aiming at the population with less purchasing power in Boa Vista/RR, the layers were assembled. Emphasizing that both units were built with the same materials, with the exception of the tiles that in one used fiber cement and in the other tiles, with a distance of 2m, the same situations were subjected and the intention was to build the green roof.

In order to raise the costs of the materials of the green roof built, a comparison was made with a study already carried out in the literature, through a search in databases of the virtual library on monographs, published in the last 06 years. In sequence, the values for the layers were determined as follows: the waterproofing layer, two companies were used (A and B); for the draining layer and pipe for draining and reusing water in three different companies (C, D and E); for the filtering layer, two companies (F and G) linked in the fabric business; for the substrate layer, two locations (H and I); linked to the landscaping sector, the vegetation that two companies were used (J and K); also linked to the landscaping business, and finally two companies (L and M) to analyze the cost of the reservoir, companies A, B, C, D and E that are linked to the civil construction sector and all companies from A to M are located in Boa Vista/RR, and also two companies (N and O) in the landscaping business as a source of research for expanded clay and three companies (P, Q and R) to consult the cost of the geotextile blanket. Only companies P, Q and R are not located in Boa Vista, since the material was not found for sale in the state.

In step 2, the costs of each Roof (fiber cement tile and ceramic tile) were raised and compared with the inclusion of the built Green Roof, this solution aims at the composition of the economic viability, and the use of the technique, using the same companies (C, D and E) to consult the wooden structure and the fiber cement tile, and the company (C and N) to consult the ceramic tile.

It is noteworthy that the choice of tile types was due to being the most used in roofing in buildings, due to its low cost of implementation. To demonstrate the feasibility of the project, two water outlets were made from the system to drain the excess rainwater to obtain the drainage volume, thus promoting the reuse of water.

IV.

9 Results and Discussion

With regard to its applicability according to the company website Ecotelhado (2010), it can be installed on practically any type of structure including waterproofed concrete slabs, asbestos-cement, ceramic or metallic roofs and wooden decks, with a slope of at least 5° which will contribute to the drainage of the waters, and whose estimated weight of the finished vegetation cover is about 50 kg/m².

Initially the green roof was appliedin two environments built on the premises of Estácio da Amazônia/RR, with a roof area of 4.5m² and a 5% slope for drainage. Therefore, we opted for the extensive class, as according to Mendonça and Melo (2017) it is a simple system, has low irrigation requirements, requires little maintenance, subsoil height 60 to 200 mm, and weight 60 to 150 kgf/m², with small plants and low execution cost.

The waterproofing layer, serving as a block and/or barrier preventing the water from overtaking into the building, and Nascimento (2014) used the asphalt blanket Figure **??** (A). In this study, the white liquid blanket, Figure **??** (B), was used, because this blanket, in addition to being more affordable than the asphalt blanket, is also recommended for fiber cement and ceramic tiles that are exposed to the sun. **??**014) in his study carried out the price analysis in 3 companies presented in Table 1, however to calculate the costs of the author's green roof, the same area of the 4.5m² roof was adopted, so that he can compare the values found for each technique, and the values of R $ 90.00 for 4.5m² were obtained for the author's asphalt blanket. In the Table 2 experiment, the value was R $ 47.14 for the net blanket. For waterproofing, Savi (2015) states that the most common way to waterproof reinforced concrete slabs is the asphalt blanket. However, based on the results presented in this experiment, it was preferable to use the white liquid blanket, both in terms of value and location, in addition to having the same waterproofing functions.

Regarding the anti-root protection layer, it sought to separate the waterproofing membrane from the vegetation layer and protect the roof from possible damage that could occur with the penetration of roots and microorganisms (Heneine, 2008). Thus, Nascimento (2014) used the resistant black plastic tarpaulin Figure 2 (A). In the experiment, the blue plastic canvas was used, Figure 2 (B). In table 3, considering the same roof area of 4.5m^2 in the work Nascimento (2014), the result was R $ 3.38 the total price of black canvas. The price found for the blue canvas in the experiment was R $ 3.96. Nascimento (2014) does not mention the reasons in his work for the use of this tarpaulin, he probably followed the same reasoning with the lowest cost in the city. Note that when comparing the values, the difference was R $ 0.58, the value was more accessible than that found in the experiment.

10 Source: Nascimento (2014).

Regarding the drainage layer, in the works carried out Heneine (2008), Savi (2015) and the websiteANDcoefficients(2017)expanded clay was used, as they are the most porous, they absorb more water. However, Nascimento (2014) used gravel # 0, Figure 3 (A) to remove excess water and prevent waterlogging. In the experiment, Figure 3 (B) used 20mm conduits, with holes in its length for the water to drain and the canvas to help in the process.

11 Source: AND coefficients(2017)

Source: Nascimento (2014). Source: Author (2019). Adopting the same area of the 4.5m^2 roof, the cost obtained by Nascimento (2014) in table 5 was R $ 13.86, however, Company C does not sell the product. In the experiment, the price was R $ 33.54, Table 6. However, when comparing the values, the price of Nascimento (2014) was more accessible than that of the experiment, this may have occurred because the State of Roraima is located far from large centers. However, the use of the conduit was due to the lower weight compared to gravel, thus reducing the weight on the roof.

It is worth mentioning the difficulty of availability of expanded clay in Boa Vista / RR, which raises the price of the material in the region according to Table 7. And when comparing the price of expanded clay with the experiment, the difference is R $ 63.60. Thus, the conduit became more accessible to the low-income population, which is the main focus of the work. And to prevent the soil from being drained by the rains, Nascimento (2014) used a Figure 4 (A) geotextile blanket in the filter layer, a product made with polypropylene fibers, whose purpose is rapid water percolation. In the experiment, however, he used Figure 4 (B) silicone fiber as it is a material that is easy to locate and can be reused if you already have it at home.

12 Source: Nascimento (2014).

Source: Author (2019). However in table 8,the data ofNascimento (2014), adopting the same area of the 4.5m^2 roof, was R $ 9.54. Already in Table 9the experiment data was R $ 43.75 for the silicon fiber. When comparing the values, there is a very high cost, but the material was not found in the city, so there was a need to use materials that could replace it and fulfill the same functions as the silicon fiber. However, in Table 10, there is the price of the geotextile blanket outside the State, it is noted that it would add the freight cost for the use of the material, due to the logistics problem in the State of Roraima.

Not to mention the difficulty with supplying supplies due to the delay in arriving the material in the State of Roraima, due to the means of transport, the conditions of the transport routes, and mainly the non- Cost Study for Green Roof Implementation in Boa Vista/RR demand and its supply from suppliers in other regions of the country.

Thus, the cost of silicon fiber for the experiment was more affordable. For the vegetation to develop, Nascimento (2014) used a 7 cm thick soil layer, containing sheep manure, vegetal soil, sand and normal soil, Figure 5 (A). And in the experiment, he used a compound containing: black earth, cattle manure, rice straw, sawdust and lime, its thickness is 2 cm, figure 5 (B). Remembering that this manure was made manually with the remains of organic residues existing in the residence.

13 Source: Birth (2019).

Source: Author (2019). In Table 11, it is noted that the values are high in the study by Nascimento (2014), remembering that the fertilizer is sold in 40 kg bags. However, the author costs the same area of 4.5 m^2, was R $ 78.92. And in the experiment the cost was R $ 15.00, according to Table 12. And to finish the construction of the green roof, Nascimento (2014) used emerald grass in the vegetation, Figure 6 (A) scientific name zoysia japonica. This vegetation adapts easily to the hot climate, has little maintenance and a maximum height of 15 cm. In line with this experiment, Figure 6 (B) also used Esmeralda grass for its price, ease of installation and because it is common in Boa Vista/RR. In Table 13, Nascimento's costs (2014) when adopting the same 4.5m^2 roof area, was R $ 24.75. And in the experiment, the cost of the grass was R $ 36.00, Table 14. When comparing the results, the difference was R $ 11.25 cheaper than the experiment, this may be due to the location of the State of Roraima. When observing Table 15, the result of the total cost of the two green roofs studied is noted that even with the replacement of some materials, but that maintained the same functions due to their absence in Boa Vista/RR, the roof of the experiment remained 18.64% cheaper than the roof of the studied literature. In view of the results, and in order to carry out the implantation of this green roof in the residences in Boa Vista, this work according to **??**liveira et al. (2009, p. 28) always thinks about the lowest cost and return on the return on investment made.

And in order to mitigate the impacts, Baldessar (2012) reports that there has been a great growth in the use of green roofs, as they help to control the greenhouse effect, reduce heat islands and reduce air pollution. In addition, I also emphasize that with the ecological awakening, the proposal seeks greater integration with nature, because through concerns about the greenhouse effect, the energy crisis, CO2 emissions, and the rationalization of water, they were already in alarming levels, immediate improvements were thought of.

In view of this report, the costs of the green roof constructed with fiber cement and ceramic tiles are presented, not considering the structure of the studied site, calculations of the wooden structure and the fiber Year 2020

Cost Study for Green Roof Implementation in Boa Vista/RR cement and ceramic roof constructed at work, considering the area of 4, 5m², which are described in tables 18. Tables 19 and 20 show the cost for fiber cement and ceramic tiles and Table 21 shows the total cost for the roofs above. Below, Table 22 presents a summary of the cost/m² of all types of roofs studied in the article. In view of the above context, it sought to strengthen the idea and/or encourage the adoption of this proposal by the population of Boa Vista, as among the benefits of the green roof, promoting and/or disseminating the reuse of rainwater to irrigate or use it for other purposes. Thus began the construction of the gutter, Figure **??** (A), whose importance is to carry the precipitated water to the reservoir, which can later be reused. The materials used were 100mm PVC tubes, the value of which is more accessible than the zinc gutter that would cost an average of R $ 35.00/m, that is, for the green roof built it would be an expense of R $ 129.50 with the gutters.

-gutter construction; B -Reservoir and Piping Source: Author (2019).

Figure **??** (B), on the other hand, used a 30L reservoir to store rainwater and a collection system was made with 50mm PVC pipes for water to be conducted to the reservoir, which was used to irrigate the roof in the experiment. This is in line with Garrido Neto (2012) who reused water by directing it into a reservoir or cistern, using gutters and conductors.

As for prices, the price of the reservoir and piping used in the research reuse system in companies is shown in Tables 15 and 16. According to Quiza (2017) apud Zatta (2018) a small cistern of 200 or 500 liters has a very simple structure, depending on the needs of each residence, it can be built or bought ready, its cost varies between R $ 200.00 and R $ 300.00 .

Thus, according to Table 17, the total cost of the water reuse system is R $ 102.98, using reusable materials that fulfill the established functions and at a lower cost. In view of the results found, it is suggested that further research be carried out on the subject, as it was observed that there is a difference in the prices of materials, so it is necessary to seek new reusable materials, further reducing the cost found in this study. And also build a sustainable pump to capture water and subsequently irrigate the roof.

It is also suggested incentives for the use of green cover with partial exemption from property tax and urban land -IPTU, according to incentives that occurred in Santa Catarina, São Paulo, Rio Grande do Sul, according to law 01-0622/2008.

Tax incentives are recommended for people who use the Green Roof, in order to expand the vegetation of Boa Vista/RR, reducing the thermal sensation and improving the quality of air and life.

Incentives are proposed, such as the reduction in the tax of civil companies that use ecological materials, called IPI (Tax on Industrialized Products). Another suggestion would be the IPTUGREEN, which focuses on a 3% discount for taxpayers whorestructure and/or build your homes using this system presented here.

Thus, theintroduction of special taxes for rainwater management in Boa Vista/RR, since according to Igra (2013) apud Vieira (2018) a large number of cities in Germany have adopted this practice. According to the author above, green coverage areas with high water retention capacity are rewarded with rates up to 50%.

V.

14 Conclusion

It is concluded that the construction of the green roof was efficient and it can be said that the environmental damage was minimal, due to the reuse of materials, not to mention the cost-benefit for the population of Boa Vista.

Also through this work it was possible to build an efficient Green Roof with reused materials, so it can be said that with these results presented here this technique can be developed for low-income people.

In addition, the total cost of the water reuse system was affordable, in addition to using reusable materials that fulfill the functions established by the standard and with less burden.

In this context, the implantation of this proposal in popular houses is a viable alternative for the population of Boa Vista, which seeks to improve the quality of life, in addition to helping to reduce water consumption through its reuse, promoting a more sustainable society.

Figure 1:

2

Figure 2: Figure 2 :

Figure 3:

Empresas	Área da manta (m²)[6]	Preço/m²	Área do Telhado (m²)	Preço Total
Empresa A	10	20,00	61,60	1.232,00
Empresa B	10	25,00	61,60	1.540,00
Empresa C	10	25,00	61,60	1.540,00

Figure 4:

3 

Figure 5: Figure 3 :

4 

Figure 6: Figure 4 :

5

Empresas	Área da lona (m²)[5]	Preço/m²	Área do Telhado (m²)	Preço Total
Empresa A	600	0,80	61,60	49,28
Empresa B	600	0,75	61,60	46,20
Empresa C	600	1,20	61,60	73,44

Figure 7: Figure 5 :

Figure 8:

6

Figure 9: Figure 6 :

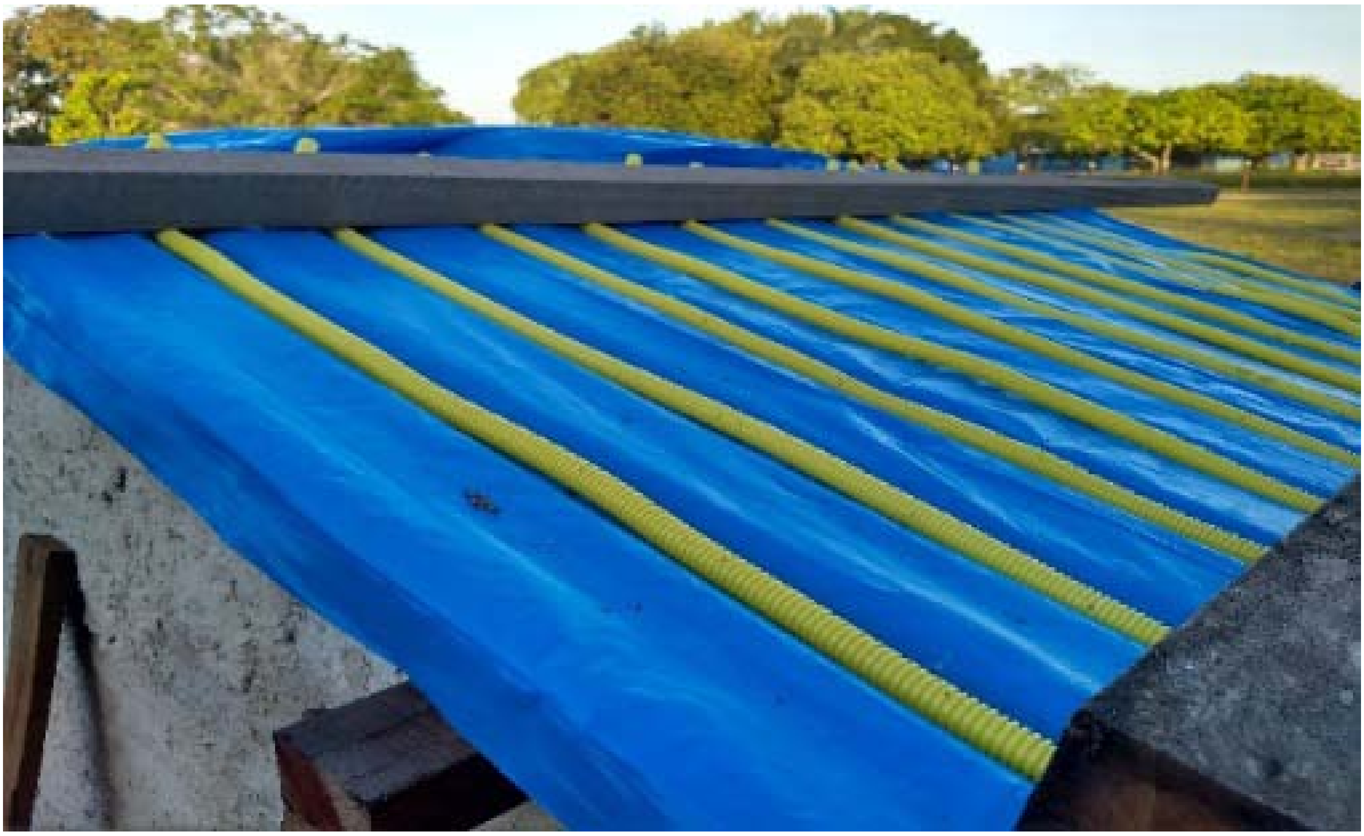

Figure 10:

1

[Note: Source: Nascimento (2014).]

Figure 11: Table 1 :

2

Company	Price (UN)	White Liquid Blanket 2.25kg Yield / m²	Roof Area (m²)	Total price
Company A	47.14	4.5	4.5	47.14
Company B	48.50	4.5	4.5	48.50

[Note: Source: Author (2019).]

Figure 12: Table 2 :

3

Source: Nascimento (2014).

Figure 13: Table 3 :

4

Item	Consumption	Unit Price (C)	Unit Price (D)	Unit Price (E)	Total Price (C)	Total Price (D)	Total Price (E)
Canvas (m^2)	4.50	1.63	0.88	1.25	7.33	3.96	5.63

Source: Author (2019).

Figure 14: Table 4 :

5

Source: Nascimento (2014).

Figure 15: Table 5 :

6

Item	Consumption	Unit Price (C)	Unit Price (D)	Unit Price (E)	Total Price (C)	Total Price (D)	Total Price (E)
Conduit (m)	26.00	1.29	1.40	1.30	33.54	36.40	33.80

[Note: Source: Author (2019).]

Figure 16: Table 6 :

7

		Expanded Clay -20 kg			
Company	Thickness (m)	Roof Area (m^2)	Quantity (kg / m^2)	Price / kg	Total price
Company N	0.07	4.50	4.44	5.00	100.00
Company O	0.07	4.50	4.44	7.50	150.00

Source: Author (2019).

Figure 17: Table 7 :

8

Source: Nascimento (2014).

Figure 18: Table 8 :

9

Company	Silicon Fiber Consumption (kg / m²)	Price / m²	Roof area (m²)	Total price
Company F	0.28	10.83	4.5	48.75
Company G	0.28	9.72	4.5	43.75

[Note: Source: Author (2019).]

Figure 19: Table 9 :

10

Company	Price / m²	BIDIM blanket Consumption (m²)	Roof Area (m²)	Total price
Company P	10.99 (+ 89.00 shipping)	4.5	4.5	138.46
Company Q	3.51 (+ 79.90 shipping)	4.5	4.5	96.70
Company R	5.90 (+ 86.92 shipping)	4.5	4.5	113.45
			Source: Author (2019).	

Figure 20: Table 10 :

11

[Note: Source: Nascimento (2014).]

Figure 21: Table 11 :

12

		Prepared Substrate -30kg			
Company	Thickness (m)	Roof Area (m²)	Quantity (kg / m²)	Price / kg	Total price
Company H	0.02	4.5	6.66	0.50	15.00
Company I	0.02	4.5	6.66	0.66	20.00

[Note: Source: Author (2019).]

Figure 22: Table 12 :

13

Figure 23: Table 13 :

14

Company	Emerald Grass Consumption (m²)	Price / m²	Total price
Company J	4.50	8.00	36.00
Company K	4.50	8.50	38.25

[Note: Source: Author (2019).]

Figure 24: Table 14 :

15

Green Roof Birth (2014)		Green roof of the experiment	
Material	Total price	Material	Total price
Asphalt Blanket	90.00	White liquid blanket	47.14
Canvas	3.38	Canvas	3.96
Gravel nº 0	13.86	Conduit	33.54
Geotextile blanket	9.54	Silicone fiber	43.75
Substrate	78.92	Substrate	15.00
Emerald Grass	24.75	Emerald Grass	36.00
Total for 4.5m²	R $ 220.45	Total for 4.5m²	R $ 179.39
Cost / m²	R $ 48.99	Cost / m²	R $ 39.86
		Source: Author (2019).	

Figure 25: Table 15 :

18

		Fiber cement roof									Ceramic Roof			
Item	With juice	Unit Price (C)	Unit Price (D)	Unit Price (E)	Total Price (C)	Total Price (D)	Total Price (E)	With juice	Unitá Price river (C)		Unitá Price River D)	Unitá Price river (E)	Tot Pri (C)	
Clapboard (m)	15	2.16	2.00	1.70	32.40	30.00	25.50	22	2.16	2.00	1.70	47.52	44.00	37.40
Lame Leg (m)	11	4.66	5.42	3.90	51.26	59.62	42.90	13	4.66	5.42	3.90	60.58	70.46	50.70
Nail (kg)	0.5	10.00	9.42	10.00	5.00	4.73	5.00	0.5	10.00	9.42	10.0 0	5.00	4.73	

Sou

Figure 26: Table 18 :

19

Figure 27: Table 19 :

20

Source: Author (2019). Source: Author (2019).

Figure 28: Table 20 :

21

Fiber cement roof		Ceramic Roof	
Material	Total price	Material	Total price
Clapboard (m)	25.50	Clapboard (m)	37.40
Lame Leg (m)	42.90	Lame Leg (m)	50.70
Nail (kg)	4.73	Nail (kg)	4.73
Fiber cement tile (UN)	50.40	Ceramic Tile (UN)	100.80
Fiber-cement cloak (UN)	19.15	Ceramic Cloak (UN)	40.00
Total for $4.5m^2$	R $ 142.68	Total for $4.5m^2$	R $ 233.63
Cost / m^2	R $ 31.71	Cost / m^2	R $ 51.92
		Source: Author (2019).	

Figure 29: Table 21 :

22

	Green Roof Built	Green Roof of Birth (2014)	Fiber cement roof	Ceramic Roof
ROOF COST / M^2	R $ 39.86	R $ 48.99	R $ 31.71	R $ 51.92
			Source: Author (2019).	

Figure 30: Table 22 :

15

RESERVOIR -30 Liters	
Company	Total price
Company L	37.00
Company M	27.00
	Source: Author (2019).

Figure 31: Table 15 :

16

Item	Consumption	Unit Price (C)	Unit Price (D)	Unit Price (E)	Total Price (C)	Total Price (D)	Total Price (E)
Tube 100mm (m)	3.7	6.45	7.50	7.00	23.87	27.75	25.90
Tube 50mm (m)	4.2	4.67	5.14	4.67	19.61	21.59	19.61
Knee 100mm (UN)	2	4.50	5.89	4.00	9.00	11.78	8.00
Knee 50mm (UN)	1	2.00	2.36	2.50	2.00	2.36	2.50
Reducing bushing 100mm / 50mm (UN)	2	4.50	8.24	4.50	9.00	16.48	9.00
CAP 100mm (UN)	2	4.00	7.65	4.50	8.00	15.30	9.00
Knee 50mm 45º (UN)	1	2.50	3.65	3.00	2.50	3.65	3.00
Tap	1	3.00	3.00	3.00	3.00	3.00	3.00

Source: Author (201

Figure 32: Table 16 :

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Water Reuse System	
Material	Total price
Reservoir	27.00
Tube 100mm (m)	23.87
Tube 50mm (m)	19.61
Knee 100mm (UN)	8.00
Knee 50mm (UN)	2.00
Reducing bushing 100mm / 50mm (UN)	9.00
CAP 100mm (UN)	8.00
Knee 50mm 45º (UN)	2.50
Tap	3.00
Total cost	R $ 102.98

So u rce: Author (2019).

Figure 33: Table 17 :

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