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► **To cite this version:**

Saïd Hayat. The Cost and Benefits of Aerial Cable Cars Investment: A Case Study of Medellin City-Colombia. *Revue scientifique internationale Management et Ingénierie des systèmes*, 2023, MIS : Management et Ingénierie des Systèmes, 8 p. hal-04519756

**HAL Id: hal-04519756**

**<https://univ-eiffel.hal.science/hal-04519756v1>**

Submitted on 28 Mar 2024

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# The Cost and Benefits of Aerial Cable Cars Investment: A Case Study of Medellin City-Colombia

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## Abstract

As the world is experiencing an exponential growth in its urban population and over 54% of the world population today live in urban areas, there is rapid need for improve means of moving people from one place to another in cities, hence there has been major innovation in the transportation sector, and one of the such new innovation is the introduction of the aerial cable cars. Against this background, this study has investigated the cost and benefits of the aerial cable car system using Medellin City-Colombia as a case study. To achieve this objective, various literature and report on the development of the cable car systems in Medellin City were thoroughly reviewed. From what was gathered, the aerial cable car system is most advantageous in terms of cost and duration of construction. Additionally, the construction of the aerial cable cars in the City of Medellin in 2004 immensely help in making the city sustainable by economically empowering the residents of the city by providing employment opportunities, creating a sense of social belonging and promoting individual self-esteem, and by environmentally maintaining a fresh air free of CO<sub>2</sub>.

**Keywords:** Transportation, aerial cable cars, cost, benefits, sustainability, urban public transport

## I: Introduction

More people live in urban areas than in rural areas today globally. According to the UN, in 2007, for the first time in history, the global urban population exceeded the global rural population, and the world population has remained predominantly urban thereafter.



Figure 1: Mono-cable ropeway in Zaragoza-Spain

The planet has gone through a process of rapid urbanization over the past six decades. In 1950, more than two-thirds (70%) of people worldwide lived in rural settlements and less than one-third (30%) in urban settlements. In 2014, 54% of the world's population is urban. The urban population is expected to continue to grow, so that by 2050, the world will be one-third rural (34%) and two-thirds urban (66%), roughly the reverse of the global rural-urban population distribution of the mid-twentieth century. This continuing urbanization and overall growth of the world's population is projected to add 2.5 billion people to the urban population by 2050 (UN 2014)<sup>1</sup>. These statistics are glaring factors that put lots of stress on cities and its stakeholders to provide efficient mobility options which on the other hand will drastically increase the quality of life of urban inhabitants. Hence, urbanization is strongly linked to economic development and industrialization, which depends greatly on efficient transportation. In today's evolving world, to remain economically competitive, cities are now investing heavily in various modes of transport infrastructure, which in turn facilitates the efficient movement of people and goods. In this 21st century, cities are now going beyond the traditional means of transportation and innovating new mode of transportation (in the case of the aerial cable cars) to meet the demand of mobility in cities. But meeting these needs is a major challenge for cities in developing countries. In recent years, few cities have developed aerial cable cars (for the clarity of this report, it will be referred to as ropeway systems) as one of the main means of transport or as a complementary one. Aerial systems were installed among others in Rio de Janeiro (Brazil), Medellin (Colombia), Caracas (Venezuela) and in Constantine (Algeria). Single ropeways as part of public transportation system operate in Wellington (New Zealand), Lyon (France), London (Great Britain), Innsbruck (Austria) and in Ankara (Turkey). Additionally, ropeways are also used as an internal mean of transport in amusement parks (Chorzów, Poland), zoos (Kolmården, Sweden) or as river crossings (Koblenz, Germany). But to limit the scope of this report, we will focus on the aerial cable car system in Medellin, Colombia. The case of Medellin is worth reflecting on because it was the first city in the world to effectively use the ropeway system as a major means of transportation.

## **II: Objective**

The primary objective of this paper is to do a study on the cost and benefits of aerial cable cars investment. But since the scope is somehow broad in nature, we decided to limit our study using a particular city (Medellin) as a case study. In order to achieve the objective of this report, a thorough review of literature pertaining to the subject matter was done to get a vivid understanding of the topic under discussion, with specific emphasis on those literatures and reports that highlight the development of the ropeway system in Medellin as a major source of data upon which we based our analysis and conclusions.

## **III - General Overview of Ropeway System**

Before further elaborating on the ropeway systems of Medellin City, Colombia, it is vital to first get a clearer picture of a ropeway system (aerial cable cars) along with a brief description of the ropeway systems operated in different cities and other key important features of the system in general.

Although the origin of the ski lift from back to the Middle Ages in Asia, it is considered to be the first "aerial tramway" system dates back to 1644 and was built by Adam Wiebe to transport materials for building the fortifications of the city of Gdansk of the city of Gdansk, in Poland. The first modern modern ski lifts, including the cables are now manufactured entirely inmanufactured in factories, appeared during the industrial revolution. Until the beginning of the twentieth century, these systems wereonly used for transporting transport of goods, particularly for mining. of the fortifications of the city of Gdansk, in

Poland. The first modern modern ski lifts, including the cables are now manufactured entirely inmanufactured in factories, appeared during the industrial revolution. Until the beginning of the twentieth century, these systems were only used for transporting transport of goods, particularly for mining.



Figure 3: Cable cars designed by William Stiegler

Now, for many of us, the cable car is associated with mountains and winter sports. They are the means of transport that climb the slopes and provide easy access to mountain peaks. We also find cable cars in some cities where they play a role in tourism, to assess the view from the sky or to achieve a monument located on the heights.

But in New York, Brest, Caracas and other cities, the cable car is becoming a means of urban transport, just like the bus or tram.

Also cable cars have gained more attention worldwide, and now are considered one of the most popular, energy-saving modes of public transport for urban areas with topographical obstacles and limited space.

At present, the ropeway technologies that have been used as modes of public transport in urban areas include 3 technologies:

- Aerial Tramway (reversible),
- detachable monocable Gondolas (MDG),
- Bicable Detachable Gondolas (BDG) / Tricable Detachable Gondolas (TMD). **Définition :**

- *Reversible aerial tramway:*

*An aerial tramway is a type of gondola that uses one or two fixed ropes for support while a third moving rope provides propulsion. With this form of lifting, the handle of a cable car is attached to the propulsion rope and cannot be separated from it during operation.*



*Figure 4: Aerial Tramway Réversible*

*- Removable Gondola monocable (MDG):*

*A gondola is a cable transport system, including several small cabins (sometimes called "eggs" in France), ranging in size from 2 to 16 seats, arranged on a single cable for water and tractor (called a mono-cable system, as opposed to a bicable cable system) that forms a loop generally unidirectional movement*



*Figure 5: Monocâble détachable Gondoles*

*- Bi cable detachable Gondolas (BDG) and Tricable detachable Gondola (TMD):*

*BDG systems combine the features of both Gondola and reversible ropeway systems.*

*On the one hand, they use reversible ropeway technology in their operation, which enables the system to have long spans, and therefore overcome difficult terrain conditions. The difference between a BDG and an MDG system is that, unlike MDG systems, which are both moving and suspended by the same cable, BDG systems have two separate cables for the two functions.*





Figure 6: Bicâbles et tricâble détachable Gondola

## IV: THE DIFFERENT ALTERNATIVES

First of all, we're going to display the route on Google Map before making our decision. We've found that the distance between Delta 3 and Lesquin airport.

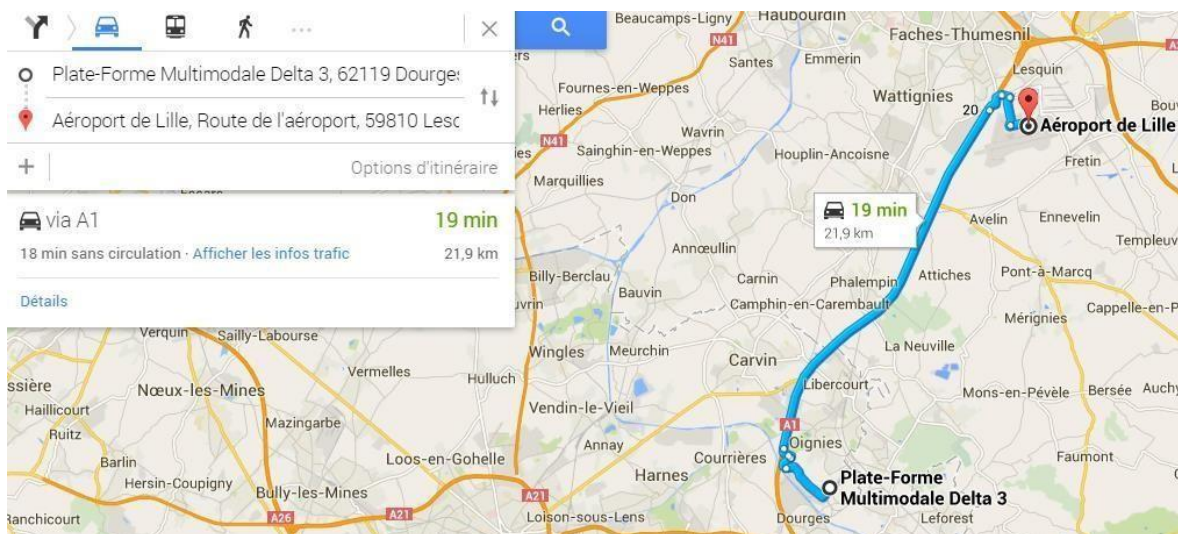
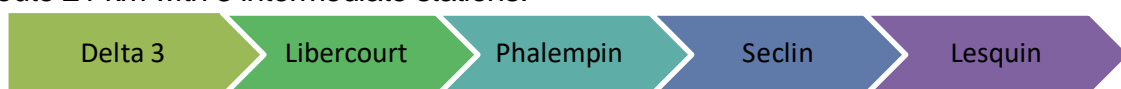


Figure 7: Lesquin delta route by the motorway

Bearing in mind that it is advisable to set up an intermediate station every 5 km, we have chosen to consider the following two routes:

- Route 21 km with 3 intermediate stations:



- 25 km route with 4 intermediate stations:



These two cable options must estimate the cost of these investments. For a transport project like this there are several points to consider:

- Infrastructure lines;
- Setting up the intermediate station;
- Cost of loading and unloading terminals;
- Urban development projects;

Cable car costs:

After some research, we decided to use data from a previous project carried out in the United States called the Aerial Tram Hercules Study. Here are the total prices for the two types of cable car:

Length of line	Type of cable cars	Project cost
<b>21 km</b>	MDG	232,05
<b>21 km</b>	BDG	333.77
<b>25 km</b>	MDG	276.25
<b>25 km</b>	BDG	397.25

*Table 1: The cost of each alternative*

As we can see above on MDG has the advantage of being 1.5 times cheaper than BDG. This price difference may be a reason for choosing the type of gondola.

For any transport system, it is also necessary to take into account the cost of maintaining the new transport network that is going to be put in place.

Here are the key points to bear in mind:

- Energy consumption ;
- The life cycle of the equipment;
- Insurance;
- Number of people required for operation.

Price of line maintenance:

Length of line	Type of cable car	Project cost (M€)
<b>21 km</b>	MDG	23.2

<b>21 km</b>	<b>BDG</b>	<b>33.38</b>
<b>25 km</b>	<b>MDG</b>	<b>27.62</b>
<b>25 km</b>	<b>BDG</b>	<b>39.72</b>

Table 2: Maintenance costs for each alternative

As can be seen from the table above, the price of BDG maintenance is much more expensive than the price of MDG maintenance. This element will contribute too much to the selection of the cable type.

To sum up, the total cost of this project must include the cost of installation, maintenance and the lifetime of the cable line.

□ Final costs:

	<b>MD</b>		<b>BDG</b>	
	21 km	25 km	21 km	25 km
Cost of Infrastructure (€M)	232.05	276.25	333.77	397.25
Maintenance cost (M €)	23.2	27.62	33.38	39.72
Total cost (M €)	255.25	303.87	367.15	436.97

Table 3: Final costs

## V: COMPARISON BETWEEN THE TRADITIONAL METHOD AND TELEPHERIC TECHNOLOGY

Today, goods are transported between the Delta 3 multimodal terminal and Lille Lesquin airport by lorry. The products are packed in 20-foot containers and the lorries cover a distance of 22 km using the Lille-Dourges motorway.

We decided to make an average comparison between the cost of the new means of transport (cable cars) and the current one (trucks).



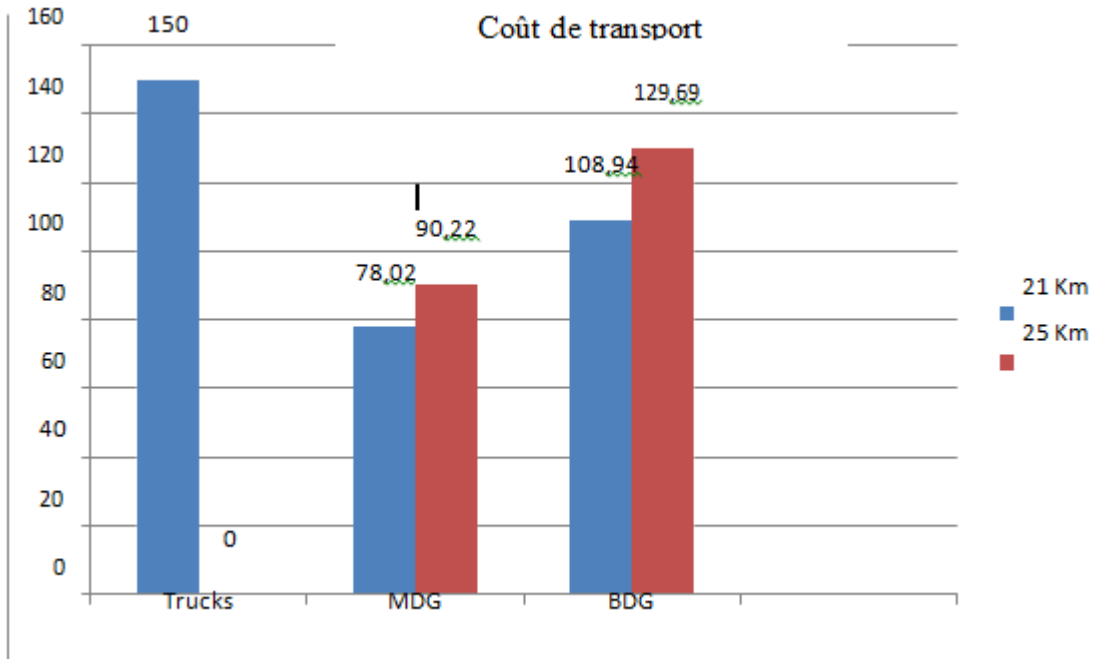


Figure 8: Transport costs

From the graph above, we can conclude that the cost of the new transport model is lower than the conventional one.

The table below shows that the best type of cable car to use for this new freight transport is MDGs, as they give the highest percentage of cost reduction.

Cable car	Cost of services (Euros)	Cost of services % (Euros)
<b>MDG 21</b>	<b>71,98</b>	<b>47,98%</b>
<b>MDG 25</b>	<b>59,78</b>	<b>40,09%</b>
<b>BDG 21</b>	<b>41,06</b>	<b>27,37%</b>
<b>BDG 25</b>	<b>20,31</b>	<b>13,54%</b>

Table 5: Cost reduction percentages

## VI: Conclusion

After all this analysis, we can say that the project to create a cable car line between Delta3 and Lesquin airport is worth a try because many of the benefits will be realised.

The tables in the last chapters show that MDG 21 is more efficient and cost-effective, with a total cost of 255.25 million euros and a percentage of service costs of 47.98%. This contrasts with BDG 21, which cost almost 367.15 million euros, which is far too expensive, and a percentage of the cost of services of 27.37%, which is not at all satisfactory.

As we said before, this new type of transport will help to save travel time, greenhouse gas emissions and vehicle maintenance costs, and we believe that MDG 21 is the type of lift to choose.

In conclusion, we can say that this project has encouraged us to take an interest in all types of transport and to discover cost-benefit analysis. It has allowed us to participate indirectly in the actual project by giving our personal suggestions which we hope can help in the future.

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