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The impact of an urban cable-car transport system on the spatial configuration of an informal settlement.

The Case of Medellin

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Abstract

In Latin American, informality is fast becoming a recognised part of cities, increasing awareness of urban poverty and segregated communities. This has led to the rapid rise of urban interventions of which cable-car transport systems is one of the most popular. These address physical causes of segregation such as steep slopes and poor road layouts, whilst offering fast connections into the city. In Latin America these transport systems can be seen in Medellin, Caracas, Rio, Manizales and most recently La Paz. Their appeal is low cost, relatively quick construction, minimum disruption to existing urban fabric and low emission levels, making them very attractive to municipalities. However, many believe they only benefit immediate residents, offer limited socioeconomics gains and are merely political tools. Even their integrational worth is questioned, as the presumption that these alone can integrate the urban poor is queried. So how can we better interpret their impact and does this form of integration alter informal settlements?

Through the case of Medellin, this paper will explore these issues, looking at the role spatial integration (in this case urban cable-cars) plays in the upgrading process and its relationship to other urban conditions that contribute to this transformation. This is done by comparing the spatial configuration of the city and the areas surrounding the cable-cars, 'WITH' and 'WITHOUT' the cable-car connection, through a variety of different metric scales. This is then correlated to a series of onsite observations into pedestrian movement patterns and land-use locations at two sites – San Javier and Santo Domingo. This demonstrates the spatial configuration of each case at a city and meso scale, is very important when implementing a new direct spatial connection, especially in terms of its integrational impact. However, this analysis also shows that whilst the cable-car clearly provides better connectivity into the city, local socio-components and possibly topology has a strong influence on the impact and benefits of the intervention at a local scale. Nevertheless, this paper argues, through its analysis and background research that the cable-car still played a pivotal role in the transformation of the informal settlement, especially in Santo Domingo, since without good spatial integration, the upgrading would have remained introvert and localised, whereas the cable-car offered this transformation the opportunity to synergize with the wider city.

The lack of good citywide integration often leads to isolation, encouraging local socio-components to dominant, which is prevalent in informal settlements. This paper demonstrates the role spatial integration can play in these complex environments, so that we can better interpret and predict its impact.

Keywords

Spatial integration, configuration, informal settlement, cable-car, upgrading.

1. Introduction

In today's cities, slums are fast becoming a recognised part of the urban fabric, especially in the developing world, increasing an awareness of their poor living conditions. UN-Habitat estimated that 863 million people live in slums today and 33% of the urban population in the developing world (UN-Habitat, 2013). This has led to a rapid rise in urban interventions, were built environment professionals attempt to improve living conditions. Recently, one of the most popular has been the urban cable-car transport system. These connect people in areas of isolation to parts of the city that may provide better social and economic benefits, without destroying the existing urban fabric. They provide municipalities with a quick, cheap and clean way to integrate segregated areas of the city, whilst also providing a strong political tool for local mayors. Yet, there is little understanding of they spatial impact and if this form of direct spatial connectivity benefits areas of urban segregation and if it can benefit an overall upgrading process.

Therefore, the aim of this paper is to discuss the role of urban cable-cars in the upgrading process of an informal settlement through the case of Medellin. Examining some of the spatial and social conditions that contributed to the transformation process and discuss the different scales at which the cable-car impacts.

2. 'Social Urbanism'

One region that has played a huge role in the development of slum upgrading is Latin America. Its consistent urban environment has allowed the region to be *'home to some of the greatest experiments in urban living of the twentieth century'* (McGuirk, 2014). Seen with internationally acclaimed interventions like Urban Think Tank's Vertical Gym in Caracas and Elemental's Half-house in Iquique, Chile. However, the city that has typified this development in recent times is Medellin, Colombia.

It is the second largest city of Colombia, with a population of around 2.5 million and lies within the Metropolitan Area of the Aburra Valley in Antioquia. The city came into existence via Spanish settlers in the mid 1600's, steadily growing over the next two centuries, as a result of its position along an important route between gold mines in the south and the coastline in the north. The city's population grew fast at the turn of the 20th century as a consequence of industrialisation driven by coffee farms, going from 59,815 in 1905 to 358,189 in 1951. Then when internal conflict in Colombia exploded into violence throughout the countryside, there was large migration to cities. This resulted in the Medellin's population quickly rising to 1,071,252 in 1973 and large areas of informality appearing. Later these troubles became entangled with a drugs war and cartels turned Medellin into one of the most deadly places in the world during the 1980's and 1990's, and it was in the informal settlements much of this violence was cultivated.

Since then Medellin has transformed itself, much of this is credited to forwarded thinking urbanism (McGuirk, 2014). When Sergio Fajardo was elected Mayor in 2004, one of his main goals was to create an *'equal city for all and were all citizens can construct relations stimulated by a city rich in services, culture and public space'* (Davila, 2013). This developed into a strategy for implementing urban projects that simultaneously combined physical transformations, social programs and participation. To do this the metaphor "Social Urbanism" was used. The most important project to develop from this was "Proyecto Urbano Integral" (PUI) – Integral Urban Project, created by the municipality, to increase the quality of life of inhabitants, focusing on areas where poverty and violence is most visible. Its strategy focuses on an integral and comprehensive approach, providing each project with three main components - physical, social and institutional. This can be best observed in PUI Noriental (North-east), which oversaw the construction of large community facilities such as the Library-Park and Business Development Centre (Cedezo), 15 new or upgraded public spaces and streets, 3 new bridges offering connections between local neighbourhoods, new housing including the upgrading and consolidation of existing homes, a wide range of community meetings, workshops and events, a series of social and participatory programs (Calderon, 2008). Unlike past upgrades, this approach combined different interventions at different scales, and aimed to transform the neighbourhood as one.

3. The Urban Cable-cars

The intervention that arguably started this transformation, preventing the upgrade becoming isolated, was the urban cable-car. However, this was implemented before the PUI Noriental and under a different mayor - Luis Perez. This transport has it's *'origins in aerial lifts that have been used for decades in Alpine ski resorts'*, though they have also been previously used in cities (Alshalalfah et al., 2012). In New York there has been a cable-tram to Roosevelt Island since 1976 and similarly a cable-car has been used in Singapore since 1974 to cross the Keppel Harbour. However, in 2004 Medellin built the first system to become an integral part of a city's transport system and this quickly became the symbol of a new city. Line K was built in the Northeast of the city, connecting Santo Domingo, one of the poorest and most violent barrios, to the metro train line A, which connects the north and south (Figure 1).

Figure 1: Barrio Santo Domingo with Cable-car line K and Biblioteca Espana in the background (photo by author, 2014).

A second line was built in 2008 in the west of the city and likewise connecting to the east-west metro train line B. Currently two more lines are being built in the east of the city, connecting to a new tramline and another line is proposed in the northwest.

This has created an extensive transport system for the whole city, yet it is still the microbuses that are most popular, used for 37% of all trips (walking is second at 25%). These cover the whole metropolitan area, yet the busy roads will often affect travel times and are often used to compliment the metro system; to get to and from home. (Sarimiento et al., 2013)

Whilst the cable-car is often thought of as a tool for integration the first line in Medellin it became a mechanism to promote social and spatial change. '*In the four years following its introduction, the city invested seven times the cost of the cable-car system in complementary urban projects'*, harnessing its potential to not only spatial reconnect the poor, but also socially and economically improve lives (Davila, 2013). Yet, this was not the case with the second line, where a lack of investment in secondary projects, meant there was an over reliance on its transportation value.

At present cable-cars are a novel urban trend, as they are now in many cities across Latin America, including Caracas, Rio and La Paz, however it is not the physical object that is beneficial, but its ability to spatially connect areas of extreme segregation. This is done with minimal impact on the ground, respecting the urban fabric below and potentially offers greater socioeconomic opportunity through improved mobility. This paper aims to demonstrate some of the spatial and social conditions that are important for this type of spatial connectivity to work. This is done through the examination

of both cable-cars lines in Medellin and by investigating, at various scales, the spatial and social impact these have had. This provides an opportunity for a greater discussion into the role cable-cars play in reinforcing an urban upgrade and how they contribute towards transforming areas of urban segregation.

4. Urban Segregation

One of the principle aims of slum upgrading is to address the issue of urban segregation. This subject has been widely discussed in the past and continues to be a topic of huge concern, as the scale of the problem grows fast. Yet within informal settlements, *'there are certain parameters and elements which, are increasingly present and should be part of any serious attempt to address issues of poverty'* (Serge 2009).

These 'parameters and elements' can be understood further in Bill Hillier's paper *'A theory of the city as object'*, where he explains *'a local process generates differences in local grid patterns and apparently reflects differences in spatial culture; and the other a global process generates a single overriding structure that seems to reflect a more generic or universal process'*. Highlighting that whilst socio-components create the underlying pattern of differences, there is a set of *'autonomous spatial laws that are governing the affects on spatial configuration'* and it is these 'invariants' that allow for greater spatial integration (Hillier, 2002). These principles can be observed in informal settlements, as often the lack of global integration leads to isolation, encouraging local socio-components to dominant, making slums turn their back on the city, allowing them *'to remain hidden, out of sight of the dominant society'* (Vaughan and Arbaci, 2011).

These spatial laws are further understood in Hillier et al, extensively study of 17 informal settlements in Santiago, Chile. Were pedestrian and vehicular patterns of movement and land uses was studied alongside typical spatial configuration models, to critical assess the spatial aspects that lead to consolidation. This established the settlements that were better equip to develop 'edge orientated commercial activity, can participate in the wider local economy' and would therefore consolidate quicker, whereas the settlements that have no, or little, edge-activity consolidate a lot slower (Hillier et al., 2000).

These issues are again explored by Karimi et al in the paper, *'Evidence-Based Spatial Intervention for Regeneration of Informal Settlements'*, which investigates how limited physical interventions can start to facilitate the spatial integration of informal settlements, through the case of Jeddah. It attempts to demonstrate that with a deeper understanding of the elements and invariants that consolidate informality, the upgrading process can be greater improved. The final output identified weak points and proposed spatial solutions, which aimed to *'reinforce the internal structure of the unplanned areas while reconnecting them back to the whole of the city'* (Karimi et al., 2007). This shows that an extensive spatial analysis of existing urban conditions, not only reveal problems, but also reveals solutions.

These studies used a space syntax theory, which has a long established connection to urban theory that can *'link physical aspects of the urban system with its functional, social and behavioural aspects, directly and seamlessly'* (Karimi et al., 2013). Part of this focuses on urban segregation, theorising how societal conditions can be linked to spatial isolation. Laura Vaughan discusses how *'life in a poor neighbourhood is different from one in mixed-income neighbourhood and it is vital to consider this difference in order to understand everyday constraints on integration, such as access to work or the mixing of population* (Vaughan and Arbaci, 2011)'. This shows the importance of connecting conditions in society with space, *'the reason this matters is that the way in which urban spaces both acquire social meaning and have social consequences comes out of how they form part of the city's layout'* (ibid).

Vaughan further stats *'what is evident is that without a multi-scalar approach that takes account of the relationship between localised patterns of mutuality and division and wider-scale opportunities for movement across space and time, the ability to handle the social complexity of the subject is lost.'* (Vaughan, 2007).

Examples like Medellin start to demonstrate how a multi-scalar approach can combine different physical, social, institutional and political interventions, to transform an area of urban poverty. Yet, professionals within the built environment often struggled with this approach, as its multi-layered method makes the process complex and non-standard. Yet, the methods of space syntax allow the complexities of space within informality easier to understand, allowing local socio-components to be associated with this.

It is clear from past failing that improving spatial connectivity alone is not enough to generate change, yet cable-cars are currently being branded as exactly this by municipalities across the world. Therefore, the aim of this paper, through the use of space syntax and onsite observations method, is to highlight some of the spatial and social conditions necessary to make urban cable-cars successful, discussing the scale at which they are most influential. This reveals how certain local socio-components impact the spatial reconfiguration and how these maybe understood in the future.

5. Data and Method

To achieve this an evidence-based methodology is formed of two parts – spatial analysis and onsite observation, to examine the spatial and social impact of the cable-cars at varies local scales.

The spatial analysis uses a segment map, which covers the whole metropolitan area, allowing angular analysis to take advantage of many small segments created from large areas of informality. This model is adapted into two, the first with just streets ('WITHOUT' the cable-cars) and a second with the cable-car lines ('WITH'). This was done by connecting each station with a new segment and unlinking connections that are not stations. The spatial model focused on two main measurements, Normalised Choice (NACH) and Normalised Integration (NAIN). Normalise measurements are used so that different areas of the city can be compared. NACH allows the most important 'through' spaces to be highlighted, typically the principal movement routes and NAIN highlights the 'to' spaces, usually urban centres. This type of segment map does not take into account local conditions, such as transport connectivity and steep topology, as has been done in the past (Law et al, 2012), instead it focuses on established space syntax measurements so that this initial study can discuss results accurately, without the question of using untested measures.

Onsite observations are used to support the spatial analysis, focusing on movement and land-uses pattern. To do this two separate case studies from each lines are selected – Santo Domingo, end of Line K and San Javier, start of Line J (Figure 2 &3). The observations used standard space syntax observational techniques. Firstly, a Static Snapshot of the location of people and informal vendors was used, once in the morning and once in the afternoon. Then Gate Counts, this counted the number of people passing important points, during 3 different times of the day – 8am-10am, 12pm-2pm and 4pm-6pm. At the same time Directional Splits recorded the direction people went from important junctions, likewise this was during 3 different times of the day (Vaughan, 2001). Finally a Land-use survey recorded areas of entertainment (bars, restaurants, cafes, bakeries, billiard halls and places to gamble), municipal services (police station, hospital, school, etc) and upgrading intervention. The area observed was roughly 500-1000m from the main station entrance and only included areas deemed safe.

This aimed to examine both spatial and local social data to observe some the conditions necessary for an urban cable-car to succeed and to allow the impact to be scrutinised at different scales.

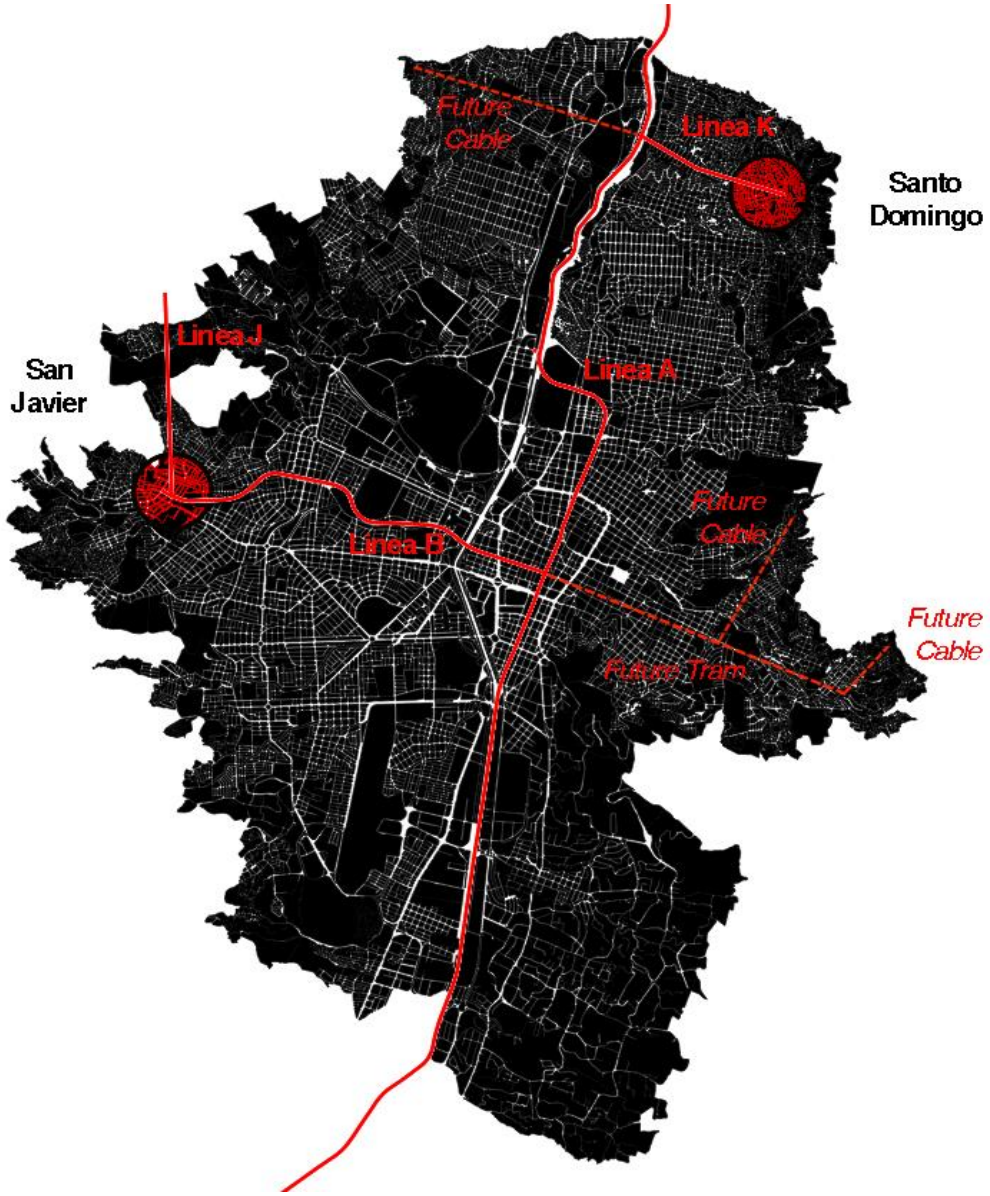

Figure 2: Map of Medellin and the case studies. The red lines indicate the main transport system. The first case Santo Domingo is situated high up the valley, in a dense area of informality. The second case San Javier is located to the west on flat land, in a mainly formal neighbourhood, but is located next to an informal settlement.

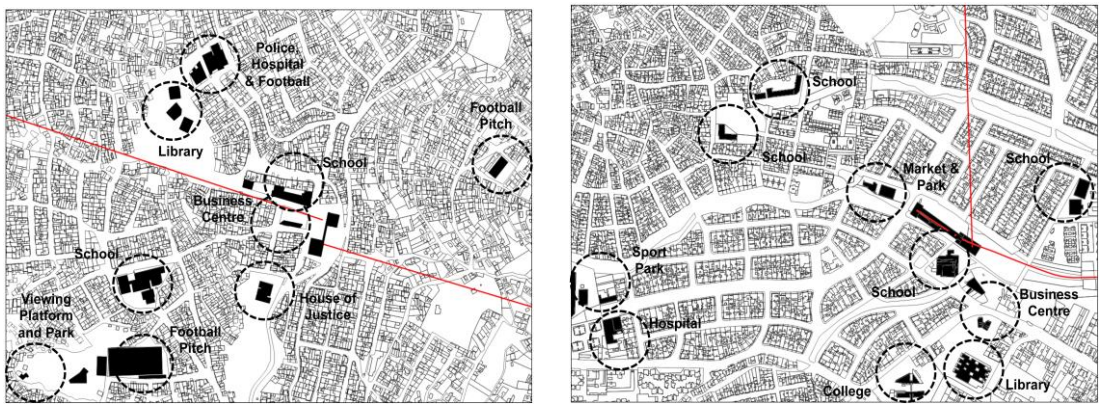

Figure 3: Plan of each case study. Santo Domingo (left) and San Javier (right). Interventions in black and transport in red.

6. Results

In order to explore this results are discussed in three sections. Firstly, the spatial analysis looks at the results of NAIN and NACH, comparing these 'WITH' and 'WITHOUT' the cable-car at various metric scale. Secondly the onsite observations examine movement patterns and local socioeconomic conditions. Finally, both are overlaid to examine correlations and discuss the differences between both cases.

Spatial Analysis

To start the spatial analysis the impact of the whole city at n-scale was examined. At this scale when the NAIN results 'WITH" and 'WITHOUT' are visually compared, the area surrounding the first cable-car line appears to be integrating better to the whole spatial network, whereas the impact surrounding the second cable-car is subtle. When similar results are compared through a variety of metric scales, integration increases at around 2000m for the first cable-car, steadily improving as the local scale increases. The biggest impact along the first cable-car line occurs at the first station, Acevedo. Along the second cable-car line there is no visual sign of citywide integration until metric scale 6000m though this is very subtle, yet at n-scale there is obvious improvement to each station (Figure 4).

When the same type of analysis is done with NACH there are no major differences visually (Figure 4).

Figure 4: Spatial Model Results - n-scale. NACH (left) and NAIN (right) Measurements 'WITH' cable-car. Bubbled areas indicated the two cable-car lines.

After this the results of the spatial model are examined more closely, focusing only on the area surrounding each cable-car line. The NAIN results for the second cable-car shows improved

integration starting slowly at around 4500m, but only at the first and third station, San Javier and Vallejuelos. At 7500m, there is more significant improvement, but still there is visual improvement at the second or last stations, Juan XXIII and La Aurora, until n-scale. At the first cable-car line, integration is improved instantly at 2000m (the length of the line), with the final station, Santo Domingo gaining the most benefit. At 5000m the impact allows the third station, Popular and Santo Domingo to become increasingly more integrated with the whole urban network, forming distinct local centres (Figure 5 & 6).

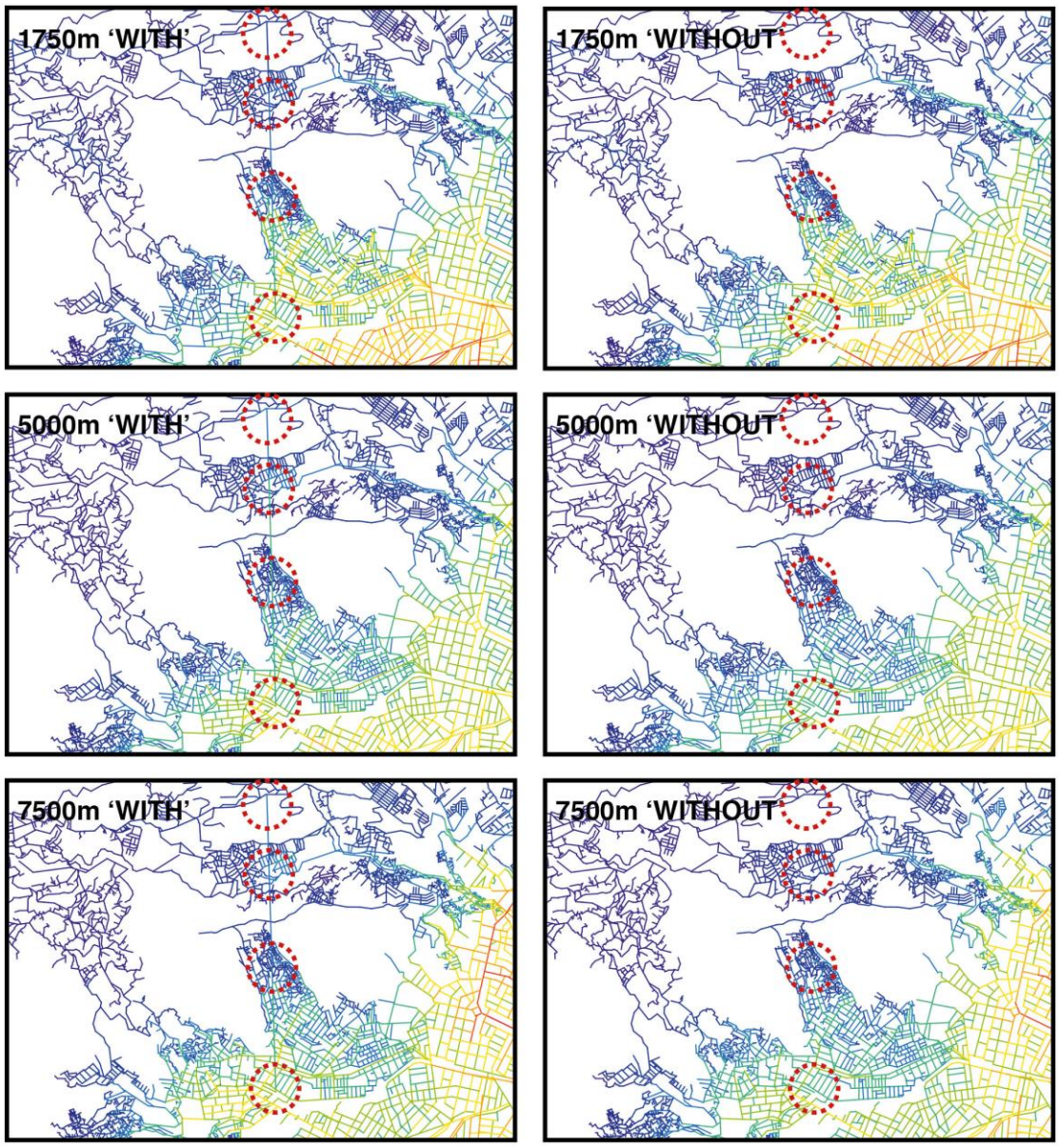

Figure 5: Comparisons between NAIN results 'WITH' and 'WITHOUT' at the second cable-car. Red-dashed bubbles indicates the stations.

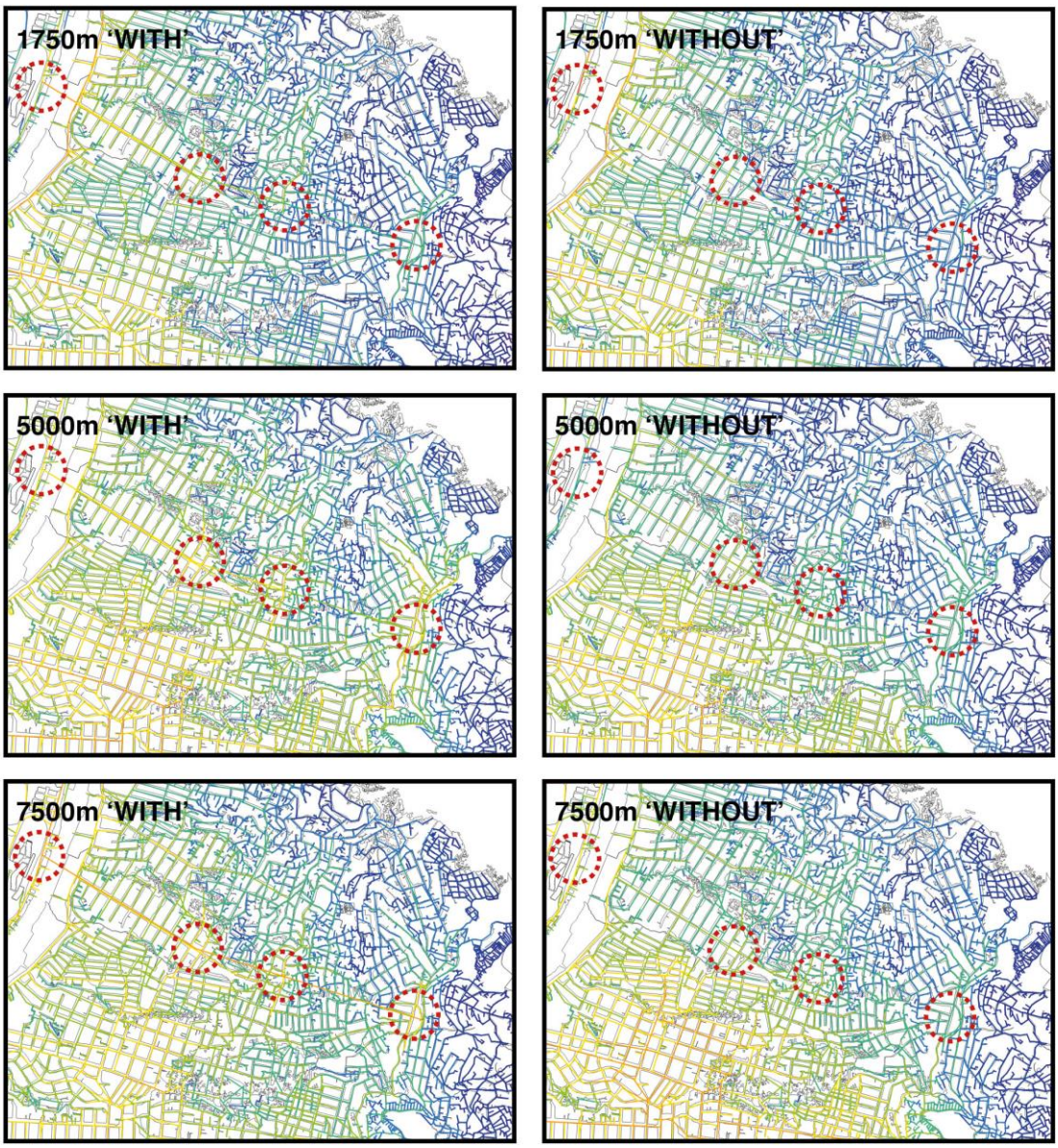

Figure 6: Comparisons between NAIN results 'WITH' and 'WITHOUT' at the first cable-car. Red-dashed bubbles indicate the stations.

A similar exercise using the NACH results, showed no or very little differences.

When both individual cases are viewed individually, the 'through' spaces can be easily identified in the spatial model and are perpendicular to both stations, suggesting pedestrian and vehicular movement is well connected to the cable-car stations.

Onsite Observations

With the spatial model suggesting where movement occurs, it was necessary for onsite observations to confirm this and start to understand how the cable-car is impacting each case locally.

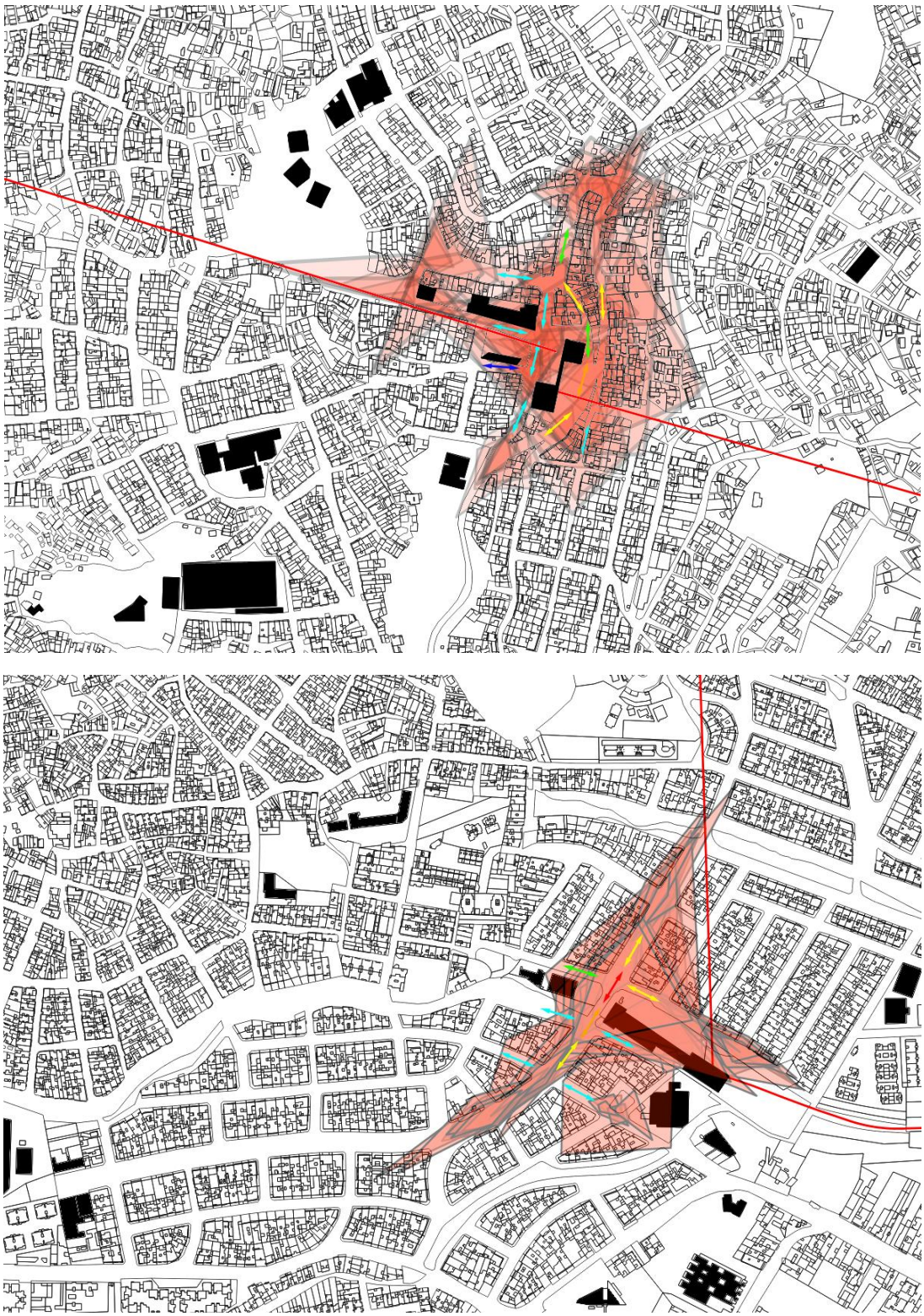

Figure 7: Movement Patterns– Santo Domingo (top) and San Javier (bottom). The red areas show the movement flows recorded from the Directional Splits, whilst the arrows indicate the Gate Counts – ranging from 0 to 250 (people per hour) for dark blue and 1500 to 2000 for red.

In San Javier, Carrera 99, the street perpendicular to the station, is this most popular for movement with the vast majority of people moving up and down this. The busiest point is between the exit of the station and microbus pickup zone, with 18.67% of movement. The streets feeding into Carrera 99 are quiet during the day, though they get busier during afternoon rush-hour when people head home. This pattern is generally observed at Santo Domingo, where the majority moves northwards up Carrera 31 or Carrera 32, streets perpendicular the station, towards the microbuses. The busiest point is also between the exit and towards the microbuses, picking up 13.06%. A large number of people also moved south down Carrera 31 during afternoon rush hour and along Carrera 31a, which connects Carrera 31 and 32. However, the directional splits in Santo Domingo showed there is a much wider variation in movement, instead of the predominantly linear movement observed in San Javier, where people mostly move up and down Carrera 99. This is reflected in the differences between the percentage of people using the gates, in San Javier the difference between the highest and lowest, is 18.67% and 4.21% respectively and Santo Domingo this is 13.06% and 3.91% (Figure 7).

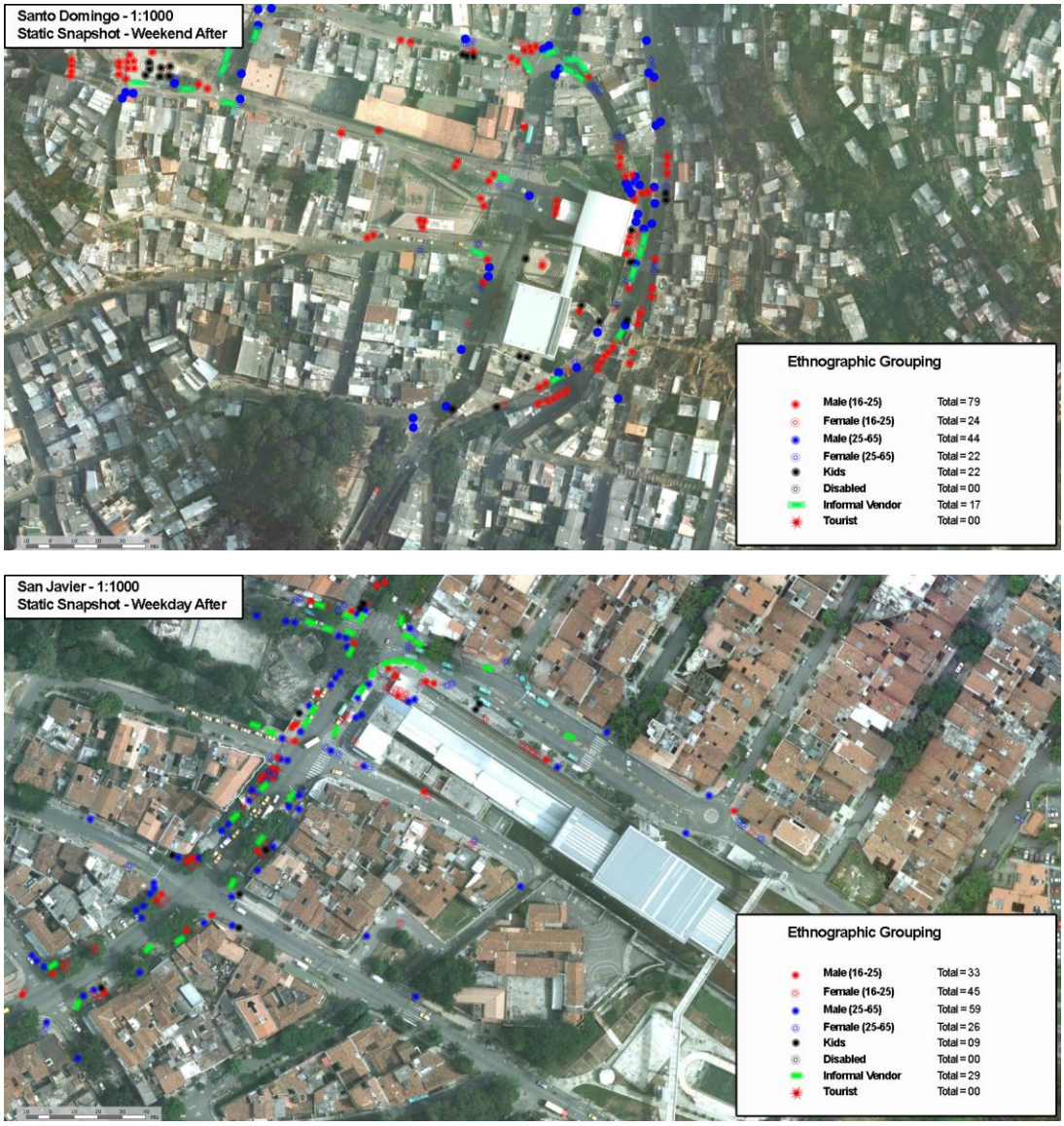

Figure 8: Static snapshots of both case – Santo Domingo (top) and San Javier (bottom). These show the location of pedestrians and informal vendor for both during the afternoon.

Figure 9: Land-use maps – Santo Domingo (top) and San Javier (bottom). The area surveyed is highlighted. The black blocks are interventions and the coloured blocks commerce (red = drink, blue = food, green = bakery, yellow = gambling, purple = supermarket, orange = billiards). The bubbles in Santo Domingo indicate land-use clusters.

In San Javier snapshots strengthened the importance of Carrera 99, showing the majority of people and informal vendors located along this street, with this fading further away from the station. As people and vendors steadily increasing between morning and evening, they do so in the same locations, in front of the station and along Carrera 99. Informal vendors increased from 7.25% of the total people counted in mid-morning to 14.48% during afternoon rush-hour. In Santo Domingo people gather near the station and along Carrera 31a, but in the evening people congregate at a variety of open spaces, mostly for socialising. Informal vendors reflect this by gathering nearby and increase from 2% of the population counted in the morning to 8.2% in afternoon (Figure 8).

The land-use survey in San Javier indicates that Carrera 99 is a traditional high street with the majority of commercial facilities positioned here, yet a small commercial area also appears at Carrera 100, on the way to the neighboring informal settlements. In Santo Domingo there are less commercial land-uses and instead of being arranged along the main streets of movement, they are clustered at important junctions. In San Javier the variety of land-uses is also stronger, however, it should be noted that in Santo Domingo there is a larger number of informal and irregular forms of commerce, mostly place to eat and drink, which only open or appear when there is an opportunity to make money, such as when the streets are busy and are generally located all around the neighbourhood. An interesting contrast is in San Javier only one billiards hall (these are common places for Colombian men to socialise) was recorded, whereas in Santo Domingo there were 7. This suggests that the differing socioeconomics conditions influence the types of commerce (Figure 9).

Also other land-uses were observed, these were the interventions and municipal facilities, but there was no clear spatial pattern from these.

Results Overlaid

When results are overlaid it becomes obvious that Carrera 99 in San Javier and Carrera 31 and Carrera 32 in Santo Domingo are the most important 'through' spaces, as 'Choice' and movement strongly relate. In the case of San Javier the relationship between movement and land-use is clear, yet in Santo Domingo this is not obvious but a relationship can still be established.

In San Javier, the importance of Carrera 99 as a 'through' space is reinforced by the majority of commercial land-uses locating themselves along this street fading the further you go from the station. This is also the case for informal vendors, as they mainly locate themselves along this street and in front of the station creating a recognisable 'high street'. This is not the case in Santo Domingo along Carrera 32 and Carrera 31, instead the widest variety of land-uses cluster at important junction. This relates to a larger variety of movement, as land-uses settle at junctions where the busiest roads converge, instead of along one individual streets. Both cases show informal vendors located heavily opposite the station and increasing significantly across both cases as people increase during rush-hour (Figure 10).

When site contours are overlaid this suggests that the topology in Santo Domingo affects movement and commerce. As the streets with the lowest percentage of movement, are some of the steepest and the location of the clusters of land-uses are on areas of flat land. This is not the case in San Javier, where topology is flatter and not affecting movement (Figure 10).

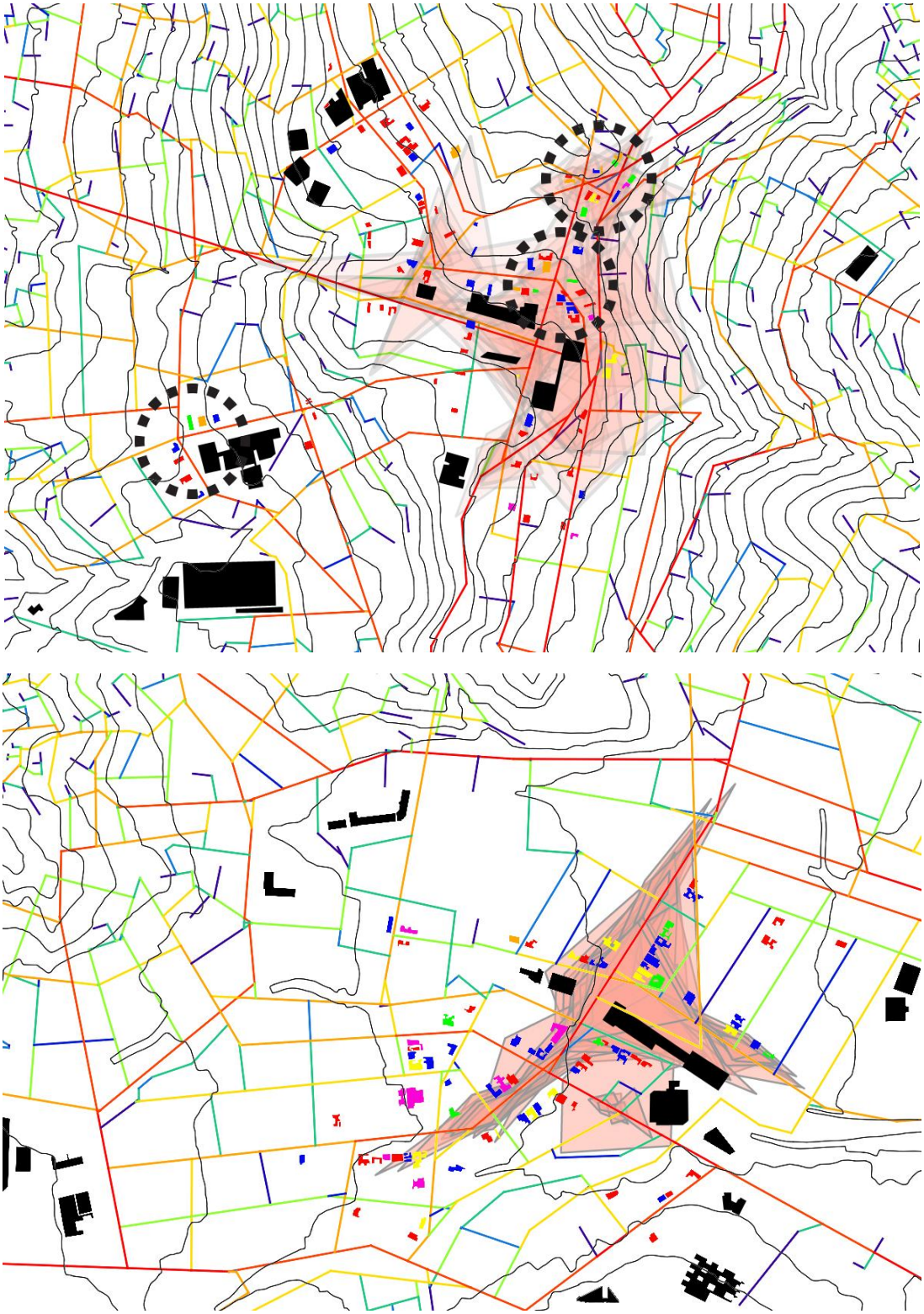

Figure 10: Overlaid results, Santo Domingo (top) and San Javier (bottom). These show how movement patterns and land-use relate to NACH (3500m).

7. The Finding

These results start to show some of the spatial and social conditions that exist around the cable-car lines and suggest some of the likely impacts that this intervention has had. Yet, it is very clear the level of impact differs significantly, between both cable-car lines.

Firstly, the spatial model suggests that the differences in urban consolidation mostly likely affected the impact of integration for each line. Integration in the first cable-car line is instantly improved once the full length of the line is a part of the analysis, whereas the impact (which is very subtle) around the second does not occur until a local scale of 4500m, twice the length of the cable-car line. These differences can also be understood through the urban grid. The first is heavily compacted with each station configurationally connected, after extensive consolidation, whereas the grid surrounding the second has large gaps of open space between and around the stations, a result of early stage settlements and mass housing. This effectively means that the improvements in connectivity reached fewer people. The biggest affect of improved integration was around Acevedo the first station on the first line. This is because at around 5000m it is connected to both the city centre and the informal settlement, yet this impact on the ground is minimised due to location next to a major motorway.

It is also worth noting that a well-established road network prevented the cable-cars lines having any global impact on the city's main 'though' spaces, which the NACH result show.

At a local scale it is likely that the form of the urban grid surrounding each case had an impact. Santo Domingo's grid is very compact with small segments throughout, typical of an informal settlement, making integration difficult, so the introduction of a direct connection increased this instantly. Whereas in San Javier the grid is more regular and is well connected to the city, so when this is connected to the segregated areas there is little benefit at the local scale, since the grid is already well connected.

Whilst the cable-car connection shows no apparent impact on the road network, NACH successfully pick up the main 'through' spaces, which the onsite observations confirmed. Both cases revealed clear movement patterns along the streets perpendicular the stations. In San Javier, land-uses, movement and spatial analysis all relate, as a regular linear pattern is observed along Carrera 99, establishing a recognisable 'high street'. In Santo Domingo this is less clear as the informal configuration and topology affects movement and combined with local socioeconomic conditions, this forces commerce to organise itself within local restraints, thus clusters are formed, yet these clusters form where the busiest roads meet as observed from movement patterns and spatial analysis.

Whilst it is hard to associate local conditions like movement and commerce with the impact of the cable-car without historic data, the positioning of the cable-car along important routes suggests a direct impact on the number of people moving along these. This is witnessed during rush-hour when numbers increased, as do the informal vendors who serve these people. This increase in movement clearly impacts on commerce, as it always next to where the heaviest foot traffic is and in the case of San Javier this is enhanced by its configuration, flat topology and stable socioeconomic conditions.

The findings show that the cable-cars impacted differently depending on spatial and social conditions. The first cable-car had more integrational impact, due to the urban grid allowing more people to reach the stations and its informal configuration was greatly improved by a direct link. This was not the case for the second line, where its broken up urban grid, a consequence of early stage urban consolidation and mass housing stopped the cable-car reaching many people. The positioning of the cable-car stations can also be judged to impact on the neighbourhood by providing more foot traffic along its main routes. This potentially benefitted San Javier more, where its strong urban grid unaffected by topology and secure socioeconomic condition allowed a 'high street' to be established. Whereas, in Santo Domingo the grid and topology affected the potential for a high street to develop and poorer socioeconomic conditions prevents regular commerce forming.

These finding start to pinpoint certain social and spatial conditions necessary for a cable-car intervention to be successful. At a meso-scale the importance of targeting areas of high urban consolidation and areas that are configurationally poor, since alternative road transport is slow. At a local scale, it is clear that the positioning of a station on a busy street will increase foot traffic, enhancing commerce and if the urban grid is unaffected by local conditions, such as topology and socioeconomic restraints, this can thrive. Whilst, this reveals some of the spatial and social impacts, there are other conditions impacting on the success.

8. Reflections

This paper has aimed to reveal and discuss some of the urban conditions that are necessary to allow an urban cable-car to have an important role in the transformation of an informal settlement. However, it also revealed local conditions affecting the results, demonstrating the need to incorporate these into future research.

The methodology focused on measuring space, movement and land-uses. In the case of Santo Domingo movement is affected by topology and the rapid connectivity of the cable-car, but neither are picked up using a standard Space Syntax model. Also, the way movement is measured onsite, needs refining, as clearly 10/13 gates do not cover a large area and both gate counts and directional splits provide roughly the same results. Also, informal and irregular vendors are a hugely important source of commerce for an informal settlement, yet their dynamic nature is hard to record using a standard land-use survey, which focuses on static measurements. Therefore the way we measure movement and commerce in these dynamic environments need to be adapted to take into account local conditions.

As we adapt the way we measure movement, it is worth considering the spatial impact of the whole transport system, as not only does the cable-car take you from one station to another, it connects with other forms of transport. So people continue beyond the terminal station, this continuation is something that should be understood and incorporated.

Then, the cable-cars are a part of a larger urban upgrade, where a wide variety of social and spatial intervention work together to transform a whole neighbourhood. Which is a comprehensive approach aimed at preventing individual interventions becoming introvert. Both cable-cars line had different interventions supporting its urban upgrade. The area around the first cable-car had various connecting spatial, social and institutional interventions implemented after its construction. Whereas the second cable-car had significantly less, making the urban upgrades more about the transport. Whilst this paper discussed some of the spatial and social condition needed to improve the impact, it is important to understand that improved spatial connectivity cannot be successful without complimentary interventions reinforcing the upgrade. Yet it is still possible that these may come in the future, just as further urban consolidation may happen and this may eventually contribute to an increase in use of the second line.

Therefore, whilst it is clear that the spatial connectivity of these cable-cars are important, it is worth remembering that their social and economical success is often connected to their relationship with supporting intervention. The clearly ties into the research by others, most notably Julio Davila of the DPU, so the way we measure the impact, needs to be more closely connected to other interventions.

There is a big question about the spatial and social impact of cable-cars in informal settlements and what exactly the role of these are. By examining the case of Medellin, this paper attempted to understand some the spatial and social conditions necessary to improve the integration of an urban area in isolation, discussing how these conditions may relate. Whilst it is clear that the conditions discussed here are important for a new mode of transport to succeed, it has to be understood that there are many other factors contributing to the transformation process. However, by understanding these all as one, forming a comprehensive approach, the process of change in informal settlements can be improved and space will always play a pivotal role in this process.

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