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Between Investment Risk and Economic Benefit: Potential Analysis for the Reactivation of the Hershey Railway in Cuba

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ABSTRACT: The present potential analysis for the reactivation of the railway of the sugar company Hershey deals with the evaluation of economic data, population statistics and rail transport infrastructures of the Cuban provinces of La Habana del Este, Mayabeque and Matanzas. Economic and socio-structural interdependencies can reveal potential for the development of a railway system in Cuba after rail traffic came to an almost complete standstill in 2018. However, the country is insisting on increasing demand through sustainable tourism. Even with increasing urbanization, the search for reliable transportation options has become greater. Project outlines are intended to examine all route relations of the Hershey Railway on the basis of various transport economic criteria, which also include population statistics and the rail transport infrastructures in Cuba.

KEYWORDS: public rail transport, reactivation, potential analysis, Cuba

1. BACKGROUND

Railway lines have significant economic value for a country like Cuba. They enable goods to be transported cost-effectively over long distances, which is particularly important for a country with very limited resources like Cuba. By using the railway, the government or small businesses can reduce their production costs. In addition, a railway contributes to the creation of jobs, both directly in railway operations and indirectly in the industries that benefit from efficient transport. A global phenomenon of urbanization is that cities are expanding and mobility plays a major role in the population's everyday working life, also in socialists countries. One the other hand spatial planning by railways is one of the most expansive expansion options in the public transport. Especially the construction costs might be high and it takes over ten to 15 years in general to construct a new one. If a railway has been constructed yet, the transport option could often be reopened in a very short term. It depends on what the status of the rail infrastructure is and what options the rail company has to repair and reactivate a line. Sometimes, there might be an investment risk, if the reparations won't guarantee a sustainable functional operation. Such sustainability is vulnerable, if there are climate catastrophes like high tide, monsoon or blackouts in the electrical power supply or manipulations on the route like in unsecure states. Another important question of spatial planning economics is the optimal use of space, for example such as the number and distribution of residents and workplaces of a location. Their development, in turn, creates new needs with regard to various public tasks and creates economic potential in the context of urbanization, since many people live in a densely populated area (cf. Bodenmann, 2003, 1). As a means of development, public transport infrastructure is the decisive component, as without it the possibilities are strictly limited. For any economic transport infrastructure, an understanding of how and why people or companies settle in a certain place is required in order to be able to predict settlement development and economic conditions. Geographically, the analysis will focus on the Hershey Railway in the east of the Cuban capital Havana, which has been largely shut down since 2018:

When there was a shortage of sugar beet in Europe during the First World War, a sugar factory was founded in Cuba between Havana and Matanzas with the Swiss and US-born chocolatier Milton Hershey, who marked the beginning of the Cuban sugar empire Hershey. Originally to speed up the export of goods, the Hershey company built an electrified streetcar with the Hershey Cuban Railway on March 31, 1916. From the outset, it was assumed that the surplus transport capacity that is not used for the company's freight transport will be used for general passenger transport. Because a railroad already existed, Hershey made himself popular by offering a reduced ticket price of $2 instead of the $4 for a train ticket that was customary at the time (Office of Foreign and Internal Trade, 1922, 117). The common goal was to increase the awareness of the region and at the same time to increase the attractiveness of the location and development of the small towns (ibid.). During construction, Havana's largest railway operator prohibited Hershey trains from using the tracks up to the downtown stations, because on the one hand it is a foreign company and on the other hand there would have been capacity bottlenecks during peak hours: For this reason, a new terminus was built for the Havana development in Casablanca, on the other side of the port of Habana Vieja, connected by a ferry (Maller, 2010).

Between 1919 and 1920 alone, the value of the company's production increased from $455 million to $1 billion, and Hershey now had five sugar factories operating in the region, all connected to the electrified railroad. After a period of economic strength, Cuban assets were sold in 1946 and nationalized in the 1960s. However, production declined significantly, so that in 2002 sugar production was finally stopped and since then the railway was no longer needed. Of course, the gradual demise of the sugar industry had a direct impact on the region and its local transport services. For decades, the communist government had offered seven trains a day on the 94 km route between Havana and Matanzas. The infrastructure damage

caused line dismantling and capping. Between Havana and Matanzas, the service was cut by 60 percent, so that in 2012 there were only two train journeys between the two major cities. The closure of 90 percent of the Hershey rail network found in 2023 is a significant deterioration in transport connectivity compared to before the turn of the millennium. However, this decline in Cuba does not only affect Hershey, but also the long-distance services of Ferrocarril de Cuba, where 500 locomotives and 230 passenger coaches are in operation and which are to receive material support from the Russian and Chinese railways again since 2019 (Organisation for Cooperation between Railways, 2021). The plan is to triple passenger traffic by 2030, as well as the reconstruction of the most important railway lines (ib.). However, at Ferrocarril de Cuba, as well as at Hershey, the line closures in the 2010s took place at quite short notice. According to Cruz (2019), a sudden shutdown occurred just days before Hurricane Irma in 2017. According to the report, the diesel railcars used for power repair work were not returned to the railway operator during a harvest. As a result of the hurricane, some of the overhead lines and wooden posts have collapsed. Without the lost locomotive, the damage could not be repaired to this day. Accordingly, cables and masts were also taken by the locals to use the material as support beams for houses (ibid.). After a tornado in 2019, the Hershey-Guanabo line was cancelled due to infrastructure damage, and the last train service between Hershey and Margot is active, which is in low demand. Because the last 7 km stretch between Margot and Matanzas was interrupted by similar infrastructure damage, the route currently ends "in the middle of nowhere" (Cruz, 2019). One transport policy question is whether a reactivation could be worthwhile in terms of transport economics in view of the relatively manageable economic sectors of the economy or whether there could be too great an investment risk for the central administration economy in Cuba.

The elaboration is special because the basic economic conditions relate to a planned economy oriented country with a low gross domestic product and that the scientific data base is extremely small. Due to the extreme weather caused by climate change, many districts of Havana were flooded in autumn 2023, which directly indicates climate extremities that could have a further influence on the route damage described (cf. Rodriguez, 2023). On the other hand, Cuban-U.S. economic studies confirm that Hershey sees development potential as a sustainable tourism destination and a source of local employment, especially the urbanized region of the capital (Chávez et al., 2017, 426; Delgado & Chávez, 2016, 26). Because international tourism concentrates on Varadero with their Caribbean beaches, the cultural capital region could rewin those tourist with sustainable infrastructure, which would be also a symbol against overtourism.

The latest economic forecasts see Cuba on an upward trend again in 2023, which may also include a comeback of rail transport projects (cf. Raschke, 2023). The aim of the elaboration is to list the potentials and risks of a reactivation of the Hershey Railway in economic terms on a section-by-section basis and to evaluate them conclusively.

2. METHODOLOGY

In the transport sciences, there are various ways to carry out an analysis of the potential of railway lines. The study of the reactivation of Hershey Railway lines in Cuba includes the comparative relational determination of the passenger potential on seven individual lines of the Hershey Railway's local rail passenger transport according to a uniform methodology. In traffic science there is a so-called combined assessment. As a rule, the reactivation routes should also be evaluated individually. On some routes there are direct traffic connections between several reactivation routes, so it makes sense to investigate route combinations (cf. Franke, 2018).

Since it is a contiguous route network with line branches, all route combinations should be examined. In doing so, route parameters, structural potentials and any infrastructural conditions are determined and systematically evaluated according to a uniform procedure. The result of the elaboration is an approximate classification of the routes in various investment risk assessments, which result from determined potential indicators. Of course, the different route lengths are viewed relatively, so the factors are counted proportionately. The network effect, i.e. considering all potential connection options for a route, should also be taken into account for identifying gaps (cf. Bešinović et al., 2022, 4).

In this section of the section, we will first provide information on the data basis on which the study was conducted. Classically applicable transport model applications of public transport cannot be used for a Cuban regional rail transport model, since relational demand data on rail transport or overall transport are not available. On the one hand, the analysis model was shaped by Lobrada (2015), who created the official rail network plan for Ferrocarril de Cuba and presented the status in 2015. In terms of transport economics, this makes it clear which routes were still in operation, at least before the hurricane and Corona. These basic data are supplemented by the timetable data provided by Zollenkopf (2022) and Maller (2010), as well as direct in-house research from March 2023 in Havana, Casablanca and Matanzas. Structural data on economic and population data could be accessed by Cuba's official statistical authorities (cf. Oficina Nacional de Estadisticas, 2022). An additional picture of the route conditions was created by means of aerial photographs in Google and the information provided by the open map services Openstreetmaps and Openrailwaymaps. In addition to the unclear passenger numbers, a real gap is the question of what condition the power line infrastructure is in and whether appropriate rehabilitation material is available on site. Nevertheless, there is a sufficient basis for the upcoming project profiles. To map the current timetable status, the more progressive timetable data from 2015 were taken over and imported. This includes the train schedules in full. In the present model, all reactivation routes of the Hershey Railway, including all information required for the potential analysis, were included. Various routes will then be listed in project outlines and presented in a standardised format.

First of all, in addition to the route lengths, today's line numbers and number of stops, the original degree of electrification of the line is to be shown. These data can provide brief information as to whether the Hershey Railway was originally still electrified on the line until recently or whether sections of the line have already been used independently of a power line in the long term.

Subsequently, the structural data on the population will attempt to estimate potential demand. In this case, it is not possible to use an average line load for the assessment of typical demand potentials, but in a first approximation a potential of passengers over the generously chosen 3 km radius of the stations can be determined and shared with the route lengths. Especially in countries with below-average transport facilities, significantly more kilometres are usually walked on foot. For this reason, population figures and jobs in the catchment area of the reactivation route will be much wider than is usual in Europe. Instead of only taking into account a 1 km radius, 3 km is cited as a scoring criterion in Cuba. For this purpose, the following categories are formed:

- Less than 500 people/km: 0
- More than 500 people/km: +
- Over 1,000 people/km: ++
- More than 1,500 people/km: +++

As a further category, there are business locations in the 3 km catchment area of the reactivation route, whose jobs can only be estimated with the help of the structural data. The forecasting methodology of the potential estimation takes into account commuter traffic as a whole. As a result, the traffic of regionally important employers who are within walking distance of the catchment area can be underestimated in individual cases. The following assessment is made:

- Rural farming: low importance 0
- Farming close to towns: +
- 0,25/km factories, refineries, quarries, tourism infrastructure in the catchment area: high importance ++
- 0,25/km factories, refineries, quarries, tourism infrastructure in the 1km catchment area: very important +++

In addition, the current infrastructure status is presented as a further criterion. A line that is still functional is expected to return to service more quickly than largely dismantled lines and can therefore contribute to development sooner. Whether the reactivation of a route makes sense from a higher-level point of view depends on a possible spatial planning network effect. In the Cuban case, however, it is an extensive existing network that consists mainly of individual train journeys. It is not a given that a railway has positive network effects as a gap closure in view of the fact that routes are often only used once a week. Gaps are more likely to be closed if the routes can connect central bus stations to regional rail transport. It is acceptable that the Hershey Railway basically functions as a diversion route or returns in tradition as a freight service. The effect of the network must therefore be weighted much less as a further evaluation criterion:

- Gap closure/connecting line (connection to several existing lines)
- Line extension/branch line (connection to an existing line)

The additional evaluation criteria can be incorporated into further considerations as to whether a route should be pursued economically. The potentials examined in the present analysis and the assessments carried out do not replace benefit-cost studies, standardized assessments or elaborated assessments in five-year plans in order to obtain a country-specific infrastructure investment by the Cuban state. The present study determines the key route and demand parameters according to a uniform transport economic approach and compiles them transparently. Qualitatively, the investments are estimated and routes that are suitable for reactivation are presented. This is also done taking into account the economic potential and leads to a recommendation on the extent to which a route reactivation makes sense on the basis of the existing investment risks and economic potential.

The following lines are eligible for the reactivation of the Hershey Railway, which takes into account all railway lines except for the completely dismantled Cojmar – Fesser connection.

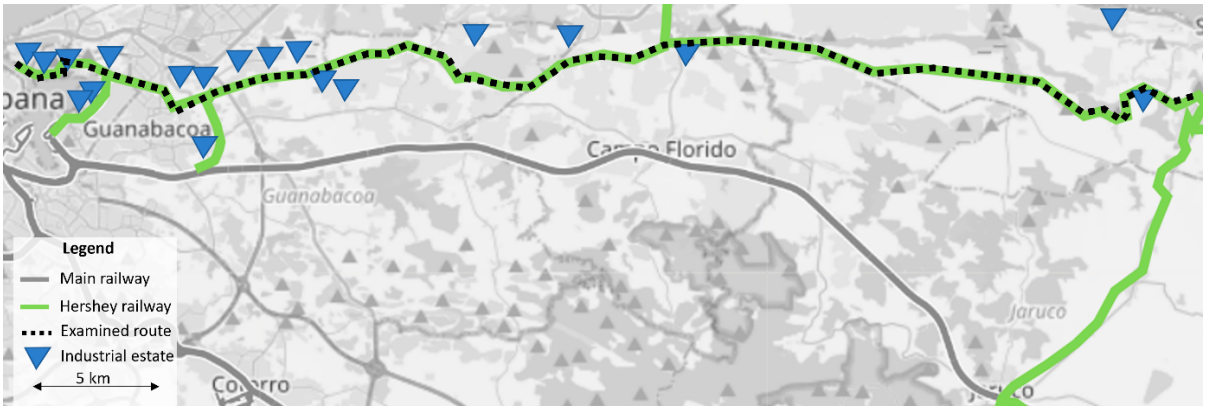
Camilo Cienfuegos (Hershey) – Matanzas
Camilo Cienfuegos (Hershey) – Casablanca
Cienfuegos (Hershey) Camilo - Jaruco
Camilo Cienfuegos (Hershey) – Cayajabos
Santa Cruz del Norte – Jibacoa
Playa del Este – Guanabo
Cuadra – Estacíon Central de Ferrocarril (EDF)

Figure 1: Non-served Station Casablanca after the hurricane on March 1, 2023 (Author's picture)

A1: Camilo Cienfuegos (Hershey) – Matanzas

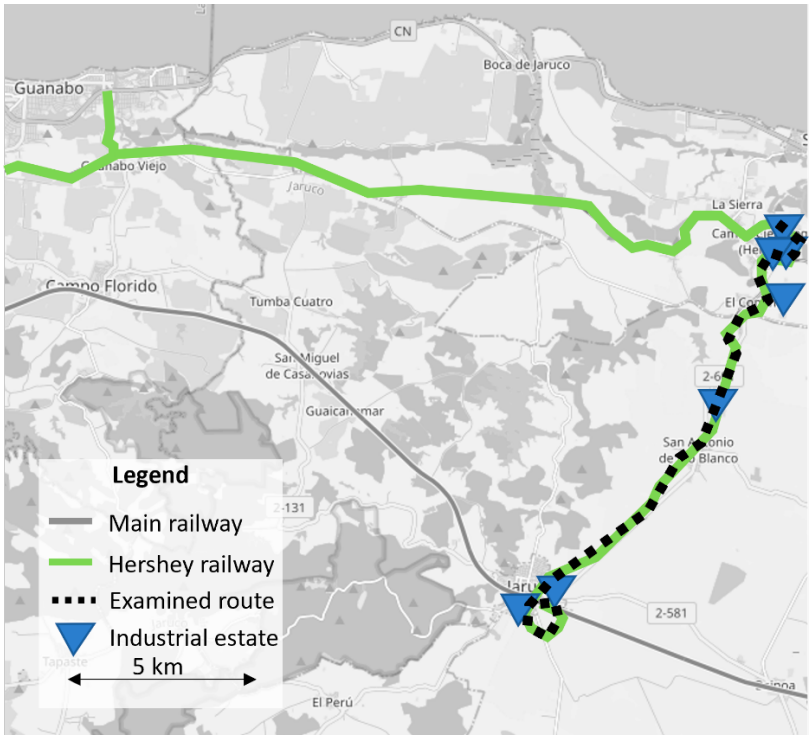
Distance	43.6 km
Line number	8 (Casablanca – Matanzas)
Stops	22
Type of electrification	Electrified until Margot - Matanzas
Population in the 3 km catchment area	++
Workplaces within a 3km radius	++
Infrastructure status	Margot – Matanzas not passable (7.0 km)
Network effect	Closing the gap
Investment	Maintenance Margot – Matanzas Re-electrification Margot – Matanzas Reactivation of 3rd track Jibicao
Reactivation Options	Havanna-Hershey – Matanzas (inkl. fast train) Hershey-Matanzas (tram) Santa Cruz del Norte-Matanzas (tram)
Economic potential	High: Connection to business locations High: Havana Line for Mayabeque High: Workshop connection to Hershey Medium: Second Matanzas-Havana Line Low: Matanzas-Santa Cruz-Line Low: Rural Railway Stations
Recommendation	The current cap is the biggest risk. Fast Havana line has to be integrated into the operating concept despite challenges. Electrification is feasible, diesel trains should be available as a fallback concept. Hershey hookup is more likely to be prioritized than Santa Cruz. The current offer for rural stations is to be retained and can also be implemented faster than an express train, which would still require permits for the A7.

A2: Camilo Cienfuegos (Hershey) – Casablanca



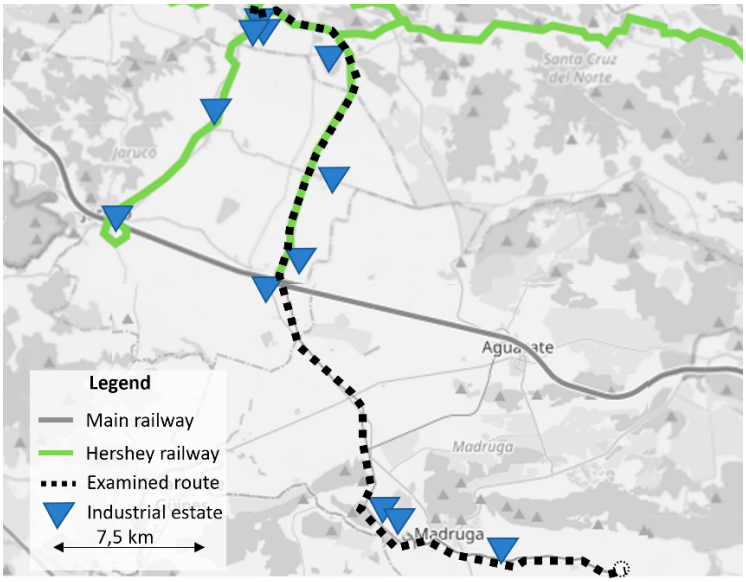
Distance	43.9 km
Line number	8 (Casablanca – Matanzas)
Stops	18
Type of electrification	electrified (1.2 km no longer electrified)
Population in the 3 km catchment area	+++
Workplaces within a 3km radius	+++
Infrastructure status	Casablanca to Bahía not passable
Network effect	Closing the gap
Investment	A lot of re-electrification after hurricane 2017 Maintenance Casablanca – Cuadra & Guanabo Reactivations Stations Casablanca
Reactivation Options	Casablanca-Matanzas (tram) Cuadra-Matanzas (incl. express train) Hershey-Casablanca (tram)
Economic potential	High: Havana Line for Mayabeque High: Workshop connection to Hershey Hoch: Havanna - Agglomeration Medium: Second Matanzas-Havana Line Low: Tourism promotion Playas del Este Low: Connection Casa Blanca
Recommendation	The effort is greater in the west of Hershey than in the east. There is potential in a connection to Havana, which has added value. From Cuadra, there are two possible lines. A7 to the city centre and northern Casablanca. If you want to strengthen the districts, the shortest connection to the city centre would make sense. Casablanca has a ferry connection and would only be the second most important train station. However, since the city center is not passable as of 2023, the reactivation would be faster to Casablanca. In order to reduce the investment risk, the connections should cover a long distance if possible and re-electrification in Casablanca should be avoided, as 1 km of the last route is on a waterfront without flood protection.

A3: Camilo Cienfuegos (Hershey) – Jaruco



Distance	13,9
Line number	8A (Camilo Cienfuegos (Hershey) – Jaruco)
Stops	8
Type of electrification	electrified (1.0 km non-electrified)
Population in the 3 km catchment area	+
Workplaces within a 3km radius	+
Infrastructure status	Passable
Network effect	Closing the gap
Investment	Re-electrification of some sub-areas Platform Jaruco Re-closure Jaruco- Jaruco Station
Reactivation Options	Hershey-Jaruco (-Jaruco Station) Santa Cruz – Jaruco - Estacion Jaruco
Economic potential	Medium: Travel time savings by train vs. bus Medium: Possibility of using electric railways Low: Main line connection Zero effect: accessibility of rural places Zero effect: Santa Cruz – Jaruco tie-through
Recommendation	Because bus line 670 runs a parallel structure between Santa Cruz and San José de las Lajas via Jaruco, the potential of a route to Santa Cruz is low. However, the travel time gains between Jaruco and Hershey are significant with the railway. In addition, the route is very suitable for the use of the electrified traditional Hershey railway, as there is not much to renovate. An electrification of the last section between the city centre of Jaruco and the long-distance railway station is recommended on the main line if there is an appropriate offer.

A4: Camilo Cienfuegos (Hershey) – Cayajabos



Distance	41,7
Line number	8B (Camilo Cienfuegos (Hershey) – Carabello)
Stops	9
Type of electrification	electrified (18.6 km up to Carabello)
Population in the 3 km catchment area	++
Workplaces within a 3km radius	++
Infrastructure status	Passable
Network effect	Closing the gap/ Branch line
Investment	Maintenance San Mateo Curve 4 x station construction (new building in Hershey) Double-track island construction for extension 2. track Hershey – San Mateo Re-electrification after hurricane 2017
Reactivation Options	Hershey – Carabello (tram) Hershey – Cayajabos (tram) Santa Cruz – Cayajabos (tram)
Economic potential	High: Business location connection High: Re-connection of Madruga to regional rail transport High: Stop at Bainoa (main line) Medium: Workshop Connection to Hershey Medium: Carabello – Santa Cruz tie-through Low: Connection Cayajabos Low: Rural Railway Stations
Recommendation	The connection to Hershey is at its limit in view of the various lines, which is why a new building would be necessary. These are unrealistic due to a high investment risk. The business location connection Santa Cruz and Madruga is recommended without electric locomotives. With 36 km of single track, a double-track island at Bainoa would make tactical sense.

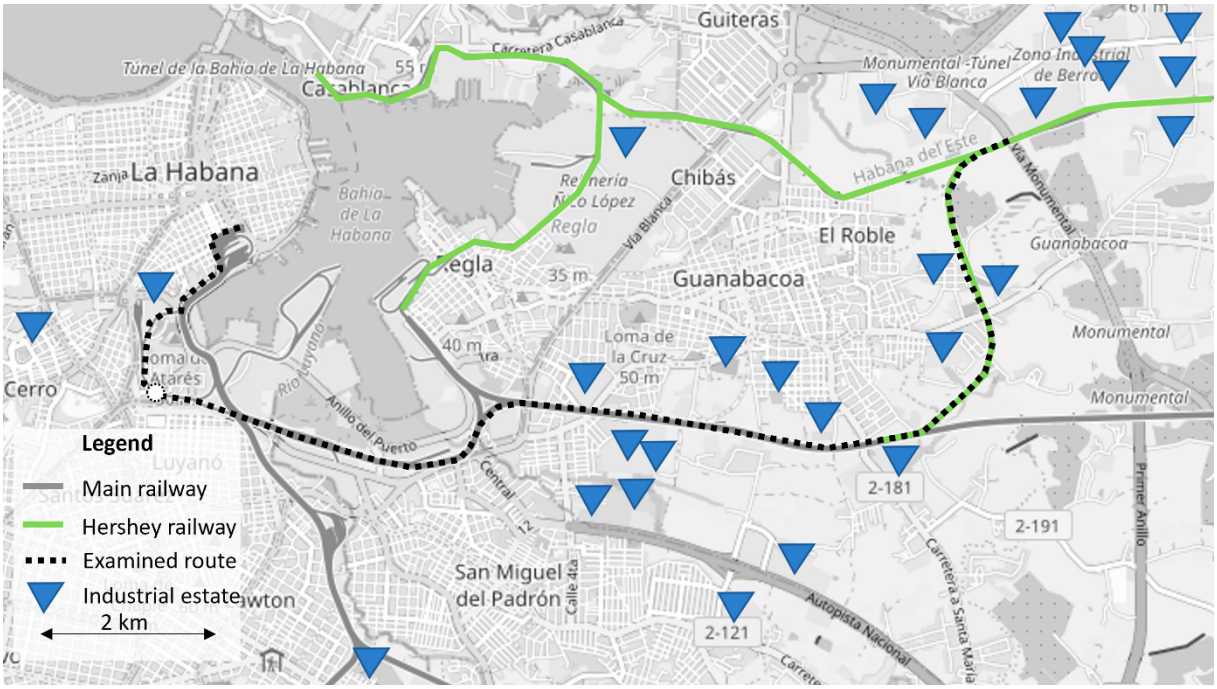
A5: Santa Cruz del Norte – Jibacoa

Distance	6,5
Line number	-
Stops	2
Type of electrification	non-electrified
Population in the 3 km catchment area	++
Workplaces within a 3km radius	+++
Infrastructure status	Passable
Network effect	Branch line
Investment	Maintenance of tracks and Santa Cruz station
Reactivation Options	Santa Cruz – Jibacoa (tram) Santa Cruz - Cayajabos (tram)
Economic potential	High: Business location connection High: Re-Clonnection Santa Cruz to railway Medium: Connection to Hershey Railway Low: Bundling of branch line
Recommendation	With Jibacoa, there is a three-track station where a single train can make heads without giving up the possibility of double-track island use. In view of the low frequency, a commute between the points is not recommended, but rather a bundling via a connection to Cayajabos. Electrification is not recommended because, on the one hand, the risk of flooding is greater on the coast and, on the other hand, the inlets are not electrified.

A6: Playas del Este – Guanabo

Distance	1,9
Line number	4 (Terminal La Coubre – Playas del Este)
Stops	2
Type of electrification	Electrified
Population in the 3 km catchment area	+++
Workplaces within a 3km radius	+++
Infrastructure status	Passable
Network effect	Branch line
Investment	Green waste on the Río Guanabo Track maintenance on the Río Guanabo
Reactivation Options	Playas del Este – Havanna ECF (tram) Playas del Este – Casablanca (tram) Playas del Este – Havanna ECF (fast train)
Economic potential	High: Connecting business locations High: Tourism promotion Playas del Este Medium: Regional development Medium: Reduction of travel times by train Low: Accessibility to Havana Zero effect: accessibility to Casablanca Zero effect: connection to Guanabo Viejo
Recommendation	Both the population size and the connections of business locations speak for a connection to Playas del Este. A reconstruction of the former electrified line is likely to depend on the A2. However, re-electrification is likely to be too risky from a topographical point of view. As part of a connection to Havana, Playas del Este could be well considered and increase the economic potential if new stops at bus terminal hubs are added here. Due to a high volume of transfers, this would be much more economical than improving travel times by express train.

A7: Cuadra – Estacíon Central de Ferrocarril



Distance	14,1
Line number	5 (Terminal La Coubre – Playas del Este)
Stops	11 (2 NEW)
Type of electrification	electrified (up to Cambute)
Population in the 3 km catchment area	+++
Workplaces within a 3km radius	+++
Infrastructure status	not passable for 4 km from Patio Bustamente to ECF
Network effect	Closing the gap
Investment	2 x new stations Track safety at Patio Bustamente Turnout renovations
Reactivation Options	Havanna – Matanzas/ Playas del Este Fast train variant & tram variant
Economic potential	High: Economic link High: Main commuter destination for Hershey High: Tourism promotion Medium: Development of Playas del Este
Recommendation	Although the remediation effort in this area is intensive by Cuban standards, the reactivation section has the decisive potential of the entire reactivation. By connecting the inner-city train station, the commuter flows are centralized. The railway makes faster progress, and regional access can be maximised by stopping at the central bus station. At best, these should be served by trams, express trains to Matanzas are economical. The Playas del Este connection by tram gives a push, but fast trains would be economically counterproductive.

Nr	Route	Length in km	Type of Electrification	Population	Workplaces	Infrastructure Status	Network Effects	Investments	Economic potential	Recommendation
A1	Camilo Cienfuegos (Hershey) – Matanzas	43.6	84% electrified	++	++	84% passable	Closing the gap	low	medium	✓ fast trains (ECF) ✓ tram(Casablanca) ✗electrification
A2	Camilo Cienfuegos (Hershey) – Casablanca	43.9	97% electrified	+++	+++	95% passable	Closing the gap	high	high	✓ tram (Matanzas) ✗direct fast trains ✗electrification
A3	Camilo Cienfuegos (Hershey) – Jaruco	13.9	93% electrified	+	+	100% passable	Closing the gap	low	medium	✓ tram ✗tram (Santa Cruz) ✓ electrification
A4	Camilo Cienfuegos (Hershey) – Cayajabos	41.7	44% electrified	++	++	100% passable	Closing the gap / Branch line	medium	medium	✓ tram (Santa Cruz) ✗tram (Hershey) ✗electrification
A5	Santa Cruz del Norte – Jibacoa	6.5	non electrified	++	+++	100% passable	Branch line	low	low	✓ tram (Santa Cruz) ✗tram (Matanzas) ✗electrification
A6	Playas del Este – Guanabo	1.9	100% electrified	+++	+++	100% passable	Branch line	low	medium	✓ tram (ECF) ✗ fast trains (ECF) ✗electrification
A7	Cuadra – Estacíon Central de Ferrocarril	14.1	30% electrified	+++	+++	72% passable	Closing the gap	medium	high	✓ fast trains (ECF) ✓ tram(Casablanca) ✗ tram (Matanzas) ✗electrification

4. RESULTS

The following graphic shows an overview of a reactivated route network that can be implemented in a short time. Some routes have been combined with other routes. This applies to the A7 sections, which merge into the A1, A2 and A6 lines, and the A4 section, which merges into A5 via a small section of the A2.

Essentially, the elaboration comes to the conclusion that it is possible to reactivate all lines shown in the Hershey network plan without great effort, or to extend them meaningfully over the tracks of the state-owned railway company Ferrocarril de Cuba. However, it must also be taken into account that, on the one hand, the reactivations of some lines should be prioritized and that in many cases the re-electrification of the rail line cannot be implemented in a timely manner due to too high an investment risk, despite a better climate balance than diesel locomotives. Both significant indicators will now be explained on a route-specific basis. Overall, it can be assumed that a reactivation of the Hershey Railway can lead to a trend reversal in the Cuban railway system. The infrastructure, which is quite intact, could be used again and significantly increase regional accessibility. This reinvigorates Hershey's desire that many workers get the chance to travel to their workplace easily and that they can expand their radius of flexibility. Even though the sugar industry no longer has its foothold in Cuba, there are still unfilled positions in the economy, which are also due to the lack of good public connections. The railway opens up the possibility of reviving the economic potential. However, this also includes a clear message that growth opportunities are unevenly distributed in the course of urbanisation. This is precisely why it is of great importance that the capital Havana, with more than two million inhabitants, is connected to La Habana del Este, the province of Mayabeque and the province of Matanzas with a much denser frequency of local rail passenger transport through its surrounding area. No project is as important for the reactivation as the A7 Cuadra – Éstacion Central de Ferrocarril link, because all the potential of the other routes depends on it. The connection to the capital is therefore the most important as the most populous and economically strongest connection. Due to the fact that the line from Cambute is not electrified and the cost of a new power line would place a heavy burden on the budget of a planned economy, the drive via the power line has already been technically eliminated for many lines. Electrification is also no longer realistic on lines to Matanzas, since eight overturned power branches were hijacked there, hindering operations to Matanzas (cf. Cruz 2019). Closing the gap between Havanna ECF and Matanzas with an express train is a high priority, as the state railways usually only serve the connection every three days, so this new express route could run in just under two hours. The issue of closing the gap would be reduced to absurdity here if it were compared with the earlier time table values: before 2015, five long-distance trains were on their way from Havana to the whole country (cf. Zollenkopf, 2022). A synchronized regional connection between Havana and Matanzas (A1 & A2) would maximize domestic traffic between all affected areas.

At the second level, it is of great importance to coordinate all other Hershey traffic around that fast train route. Different investment risks can be identified. The historically grown A3 Hershey – Jaruco line could revert to the original Hershey railways with minimal electrification corrections. An extension to the long-distance train station would be irrelevant if the service is still only available once a day. Equally important is the reactivation of the western route towards Casablanca (A2) and the resumption in the tourist region of Playas del Este (A6). Regionally, two special stops at central bus stations (A7) could establish links to bus transport, for linking the province of La Habana del Este in particular optimally with the capital city options.

Last but not least, there are those projects on the third level where a potential is recognized, but which is greater than other routes in terms of investment risk. Specifically, it is about the reactivation of former freight lines via the former alignment of line 8B between Hershey and Carabello. In order to block as little distance as possible on an express train route with a slower tram, the combination of the A4 and A5 provides for the new line Cayajabos – Santa Cruz del Norte, a special north-south branch line. Without electrification, a long line could be created here that connects the remote Madruga on their old freight tracks to various connections of Cuba and also connects the business location of Santa Cruz without having to change trains. This can be made possible by turning heads at Jibacoa station, which has three func-

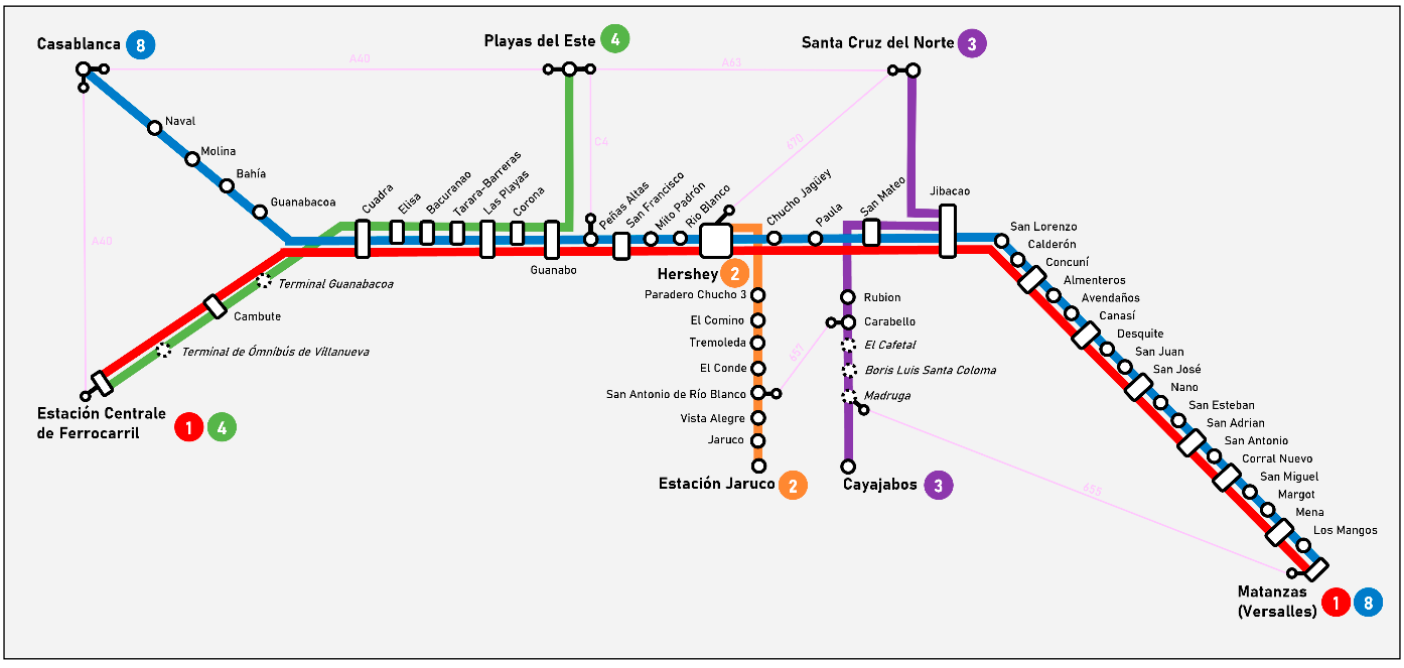


Figure 2: Hershey Network Plan After a Reactivation (Own creation)

tional tracks. This means that the single-track express train line between San Mateo and Jibacoa will be used without additional stops. At just under 50 km, however, it is the second longest route, and its profitability depends particularly on the 30,000-inhabitant city of Madruga. Also with great potential, but riskier, would be the long tram between Casablanca and Matanzas, where all stops are served. The fact that the Cuban capital can be reached in four hours by train is not the basic consideration for the route. It is about the use of the old historic route with all its stops, which have a special historical function. Occasional train journeys could be operated between the express trains in order to connect even the smallest stops on the route. However, the focus here would be on reaching the nearest intermediate centres, which is why this connection would not be equivalent to that of fast express trains. Another associated advantage is that parts of the route could already be resumed by electricity from Cuadra to Margot, with diesel the connection would be possible again. It is realistic that this variant can be implemented faster than an express train in terms of timetable, which is why it comes to a positive result.

Thus, the potential analysis shows only optimal results in all the routes examined and therefore recommends the reactivation of all routes under appropriate conditions.

5. DISCUSSION AND CONCLUSION

The aim of the elaboration was to assess the economic potential for reactivated lines in Cuba. The analysis suggests, within the scope of its possibilities, that operations are possible again on many lines with only marginal maintenance work.

However, the study must distinguish itself from the assumption that it is possible to make clear assessments of the upcoming maintenance work, as not much reliable content is public at this point: It should be emphasized that no more repairs were made to the overhead line after the hurricane, as in September 2017 the train responsible for repairs to the power supply taken to the sugar harvest and never returned (Cruz, 2019). Years later, continuous line cuts continue to exist, and it is concluded that Cuba no longer has the ability to repair overhead line damage. However, because Cuba managed to repair its tracks after the hurricane, it is assumed that they will be able to carry out maintenance work in principle. Although, in principle, electric trams would always be more advantageous than vehicles independent of power lines for climate protection reasons and geopolitical oil independence, the current basic conditions in Cuba, which impair transport economics and infrastructure, must be systematically considered. These problems go beyond the lack of an electricity repair system: Cuba often has power shortages that would bring an electrified railway to a standstill. Furthermore, in several regions, such as Casablanca or Playas del Este, the risk of flooding is too high. Today's masts are often made of plain material and can certainly hardly withstand the future challenges posed by extreme weather events due to climate change. Infrastructure reconstruction requires a high investment budget from the Cuban state. In view of possible operational problems and the lack of resilience for a country with few financial resources, this allocation of funds is extremely risky. For this reason, the use of old train equipment and their passenger cars would remain the most cost-effective, as only low maintenance costs are to be expected. After Ferrocarril de Cuba, there should be a sufficient number of deployable diesel trains that could replace the entire service, except for the electrically functional Jaruca line (A3).

However, it also became clear that many of the possible routes are dependent on the implementation of the largest project - the connection of the downtown station via the line to Cuadra, the track use of which had previously been prohibited to the foreign Hershey company. The network, which is almost completely free of supply, has enough capacity for a reactivation line of the Hershey Railway. With a clear rhythm that even takes connections into account, it can be possible in Cuba to better connect the citizens as well as to link the economic areas. It remains to be seen how tight this frequency can be, as there are often long single-track lines, which require traffic planning efforts. The fact is that seven pairs of trains from the recent past are quite realistic. A two-hour service could be worthwhile if there are regular connections again. The vehicle technology options are already available today. The study could become more reliable if the Cuban public authorities compare the number of passengers and commuter flows they previously collected and also present the investment amounts in an overall calculation. This would make it possible to show an approximate benefit-cost ratio (since a lot of traffic in Cuba takes place outside of public transport). What would be particularly interesting for trip planning would be whether the smaller rural stops actually have a certain demand potential or whether you could in principle rely entirely on 2-hour express trains. In addition to this passenger potential, the economic situation in Cuba is also unclear, where economic locations could be established in the long term, which would also have to be available internally.The economic developments predicted by Chávez et al. (2017), which necessitate the resumption of the Hershey Railway, could occur in 2024 and give Cuba the final push for reactivation.

Figure 3: Destroyed masts in Casablanca on March 1, 2023 (Author's picture)

BIBLIOGRAPHY

All links checked on January 30, 2023.

Bešinović, N., Nassar, R., Szymula, C. (2022). Resilience assessment of railway networks: Combining infrastructure restoration and transport management. In: Reliability Engineering & System Safety. Vol. 224. https://doi.org/10.1016/j.ress.2022.108538.

Bodenmann, B. (2003). Connections between space use and accessibility using the example of the St. Gallen region between 1950 and 2020. Postgraduate thesis as part of the postgraduate programme in spatial planning at ETH Zurich. https://archiv.ivt.ethz.ch/docs/students/sa90.pdf

Chávez, E., Delgado Mesa, F., Henthorne, T., Milleret, M. (2017). The Hershey sugar mill in Cuba: from global industrial heritage to local sustainable tourism development. In: Journal of Heritage Tourism. Vol. 13 (5). 426-439. https://doi.org/10.1080/1743873X.2017.1391270

Cruz, L. (2019). Cuba's Hershey Train Could Still Be Saved. In: Havanna Times vom 1. Juni 2019. https://havanatimes.org/features/cubas-hershey-train-could-still-be-saved/

Delgado Mesa, F. & Chávez, R. S. (2016). Industrial heritage and local tourism development. The case of the former Hershey sugar mill, Santa Cruz del Norte, Mayabeque, Cuba. In: Journal of Environmental Studies. Vol. 4 (2). 23-40. ISSN: 2347-0941.

Franke, B. (2018). Kombinierte betriebliche und verkehrliche Bewertung von Bahn-Angeboten. In: Verkehr & Betrieb. Schweiz: Bewertung von Bahn-Angeboten. DVV Media Group. 26-29.

Lobrada, A. (2015). Diagram of the Cuban railway network for passenger transport. https://upload.wikimedia.org/wikipedia/commons/thumb/d/de/Esquema_ferrocarril_cuba.png/800px-Esquema_ferrocarril_cuba.png

Maller, Y. (2010). Hershey Electric Interurban Network. In: World Tram & Trolleybus Systems. Cuba. http://ymtram.mashke.org/cuba/hershey/descr_en.html

Oficina Nacional de Estadisticas (2022). Cuba: Administrative Division. Provinces and Municipalities. In: City Population. https://www.citypopulation.de/en/cuba/admin/

Office of Foreign and Internal Trade (1922). Commerce Reports. — Bureau of Foreign and Domestic Commerce. United States Department of Commerce.

Organisation for Co-Operation between Railways (2021). Working meeting of the OSJD Committee Chairman and Ambassador Extraordinary and Plenipotentiary of the Republic of Cuba to the Republic of Poland. Pressemitteilung vom 1. Juli 2021. https://en.osjd.org/en/8821/page/106072?id=262080

Raschke, S. (2023). Karibik: Weiter im Aufwärtstrend. In: Touristik Aktuell. Nr. 47-48/2023. Hochheim. https://www.touristik-aktuell.de/nachrichten/destinationen/news/datum/2023/11/28/karibik-weiter-im-aufwaertstrend/

Rodríguez, J. (2023). 23rd Street in Havana, transformed into a river by the heavy rains. In: 14ymedio vom 15. November 2023. https://www.14ymedio.com/cuba/calle-Habana-transformada-intensas-lluvias_0_3642835691.html

Zollenkopf, G. (2022). Travel through Cuba by train. In: Kubareise. Published on December 18, 2022. https://kuba-reise-urlaub.de/transfers/eisenbahn/