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COVID-19 Along With Autonomous Vehicles Will Put an End to Rail Systems in Isolated Territories

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Abstract—Even before the coronavirus (COVID-19) disease pandemic outbreak, the rail systems on islands turned out to be failures. The main concept of rail systems is to convey many people in one large means of transportation. However, on islands, the small area limits the ability of the train to go through a good path that can meet the need of a sufficient number of people. Therefore, the rail systems are unproductive. Moreover, in the near future, the trains will have tough competition with autonomous vehicles. Autonomous vehicles will go in platoons with a constant distance from the vehicle ahead, which will look like a long train. These autonomous vehicle trains will be much more efficient than the old-fashioned trains. COVID-19 influenced many passengers to leave the rails because the rails seem to be one of the most substantial disseminators of the virus. Train passenger numbers may perhaps rebound little by little following the COVID-19 crisis, but the looming technology of autonomous vehicles will be competition that is too tough for the rails, and such a passenger-numbers rebound is unlikely to succeed. Therefore, transportation authorities in isolated territories should refrain from investing in the infrastructures of rail systems.

The coronavirus (COVID-19) disease pandemic has severely harmed public transportation, whereas rail systems have particularly been harshly affected [1]. In some isolated territories, like Puerto Rico, the trains have been completely shut down until further notice.

According to [2], New York City's subway system has been one of the main disseminators of COVID-19. The gathering of interchanging groups of people in a crowded railroad car is one of the worst experiences for ensuring the good health of passengers. Most of New York City's subway users were from a low economic status and were identified to be associated with low testing rates. Nevertheless, a high proportion of positive tests was observed [3]. These users, many of whom cannot afford health insurance and have nobody to take care of their health, usually continue with their daily routines and infect other people. Therefore, COVID-19 has been massively disseminated in New York City's subway system.

Even before the COVID-19 pandemic, isolated, smaller countries did not have good reasons for the construction of railways. In a nonisolated country, even if it is very small, a railway system can connect it to its neighboring countries. For example, even though Monaco's size is only 2.2 km², it has a railway system that connects to France and other countries in Europe [4].

There are also some railways on islands adjacent to mainlands, like Long Island in New York, United States [5], Sicily in Italy [6], and Hainan in China [7]. On such islands, the railways are usually connected via bridges [8], tunnels [9], or ferries [10] to the mainland, and they can be considered as undivided portions of the mainlands.

However, isolated territories like islands will have no economic viability for a railway system (even if their size is larger than Monaco). Railway systems may only succeed in a large territory where there is a necessity to

transport a significant number of people, as will be explained in this article.

Cases of Islands Without Active Railways

Cyprus is an island that is surrounded by the Mediterranean Sea from all sides. Therefore, there is no railway system in the country. There was previously a 122-km railway in Cyprus, but it was closed in 1951 since it was unprofitable, and currently, no railway systems exist in Cyprus [11]. There are still railway remnants in some locations in the country [12], such as the abandoned railway crossing lights presented in Figure 1.

The Republic of Trinidad and Tobago has a similar railway history to Cyprus. There too was a railway of 173 km there, but since it was unprofitable, the railway system was closed in 1968, and currently no railway systems exist in The Republic of Trinidad and Tobago [13].

Crete railways were shut down even earlier. Although there has never been a passenger train in Crete, an industrial railway, designed to facilitate the building of the harbor in Iraklion, was constructed in 1922. However, when the harbor's construction was over, the train was pointless and unprofitable. So, in 1937, the train was closed, and there has been no train in Crete since then [14]. An old and inoperative locomotive dumped in a field in Crete can be seen in Figure 2.

A similar story to Crete is that of Negros Island in the Philippines, which has never had a passenger railway. Negros Island is a large sugar producer and exporter. Sugar is the largest industry on the island, and the railway was constructed to transport freights of sugar. In 1985, the price of sugar in the international market crashed. Most of the sugar factories in Negros Island went bankrupt, and there was no good reason to keep the railway, so it was closed. Currently, there is no sugar railway in



FIG 1 Abandoned railway crossing lights in Cyprus.



FIG 2 An old and inoperative locomotive in Crete.



FIG 3 A defunct train station in Jamaica.

Negros Island, nor is there any other kind of railway [15]. A new bridge to the island is planned by the Philippines government; however, it will be a bridge with a road and no railway [16].

Like the failure of the railways in the Philippines, those in Jamaica were an unsuccessful business as well. The railway system of Jamaica was opened in 1845, and this system was the first outside of Europe and North America. The British government built railways in many of its colonies, and Jamaica was the second British colony to have one [17]. The railway system of Jamaica was built only 20 years after the United Kingdom government started to build the first railway system on the main island of Great Britain [18].

The railway system of Jamaica was intermittent for more than a century until its closure in 2012. Sometimes the railway system was opened only for freight, like bananas or bauxite, while other times it was opened for passengers. There were also times the railway system was opened for both freight and passengers. In each of these openings, the trains operated at a loss, so the railway system went out of business. Any attempt to revive the railway system was followed by insolvency [19]. A defunct train station with some defunct rolling stock in Jamaica is displayed in Figure 3.

Another railway system in a British colony was one built by the British government on the island of Salsette. This island is currently under Indian sovereignty. However, the railway system was already shut down by the British governor to make way for an airport [20]. The airport was for military flights, but when India gained independence, its government decided to convert the airport to a civilian one and keep the railway closed. Although rails are prevalent in India's mainland, the government did not believe that a railway on this island was capable of being cost-effective. So, until this day, there is no railway on the island of Salsette [21].

Railroads were not only built in British colonies but also in German colonies. During the time of German sovereignty on the island of New Guinea, many railways were built on the German part of the island [22]. At the beginning of the 20th century, Germany decided to give a boost to New Guinea's economy by building a railroad system. The railroads were an extensive failure. Some dozens of millions of German marks were invested with little return. In the First World War, Germany lost its part of the island of New Guinea to Australia. The Australians did not want to go on with this unproductive rail project, so the railroads fell into poor condition. There has never been a railroad system on the other parts of the island. So, as a result, there currently is no active railroad on the entire island of Papua New Guinea [25].

The conclusion of this survey about cases of islands without active railways is that even before the COVID-19 outbreak and the emergence of autonomous vehicles, rail

systems on islands were not a lucrative business, so many governments preferred to relinquish such services.

Cases of Islands With Unsuccessful Rail Systems

Ireland is a country within an island in the northeast Atlantic Ocean. Even though Ireland is isolated, the government owns a lengthy railway system of 1,200 mi. The Irish railway infrastructure is poorly developed and functions ineffectively [24]. In addition, the Irish railways have the lowest rail-electrification rate in the European Union (2.7% in 2016).

In contrast to the poor railway infrastructure, the subsidy for the railway company is high-priced. US\$887 million are annually paid to the Irish rail company, Iarnród Éireann, by the Irish government as a subsidy. However, only 1.7 billion passenger-kilometers are traveled annually in Ireland—that is to say, the subsidy cost is US\$0.52 for each passenger-kilometer [25].

Even when comparing this subsidy price tag to China, which provides an excessive subsidy to its rail system, the numbers are thought-provoking. China annually subsidizes its sizable rail systems with US\$128 billion [26], and the train usage of China’s rail system is 1,470.664 billion passenger-kilometers [27]—that is to say, the subsidy cost is US\$0.087. China’s economy leans toward a planned economy and heavy intervention in the market [28], whereas Ireland leans toward a free market [29]. Nevertheless, Ireland’s rail subsidy is significantly higher.

When the COVID-19 pandemic began to spread in Ireland, many of the rail routes were closed, like the routes from Waterford to Limerick and Ballybrophy to Limerick. The other routes’ frequency of service was significantly lowered [30]. As a result, the inefficiency of the Irish rail company, Iarnród Éireann, has been becoming much worse lately.

Another territory with an unsuccessful rail system is Puerto Rico. Puerto Rico is an unincorporated territory of the United States, located on an island in the Caribbean Sea. There is an unsuccessful train in Puerto Rico, called “Tren Urbano,” that received a lot of negative criticism [31]. The train consists of 16 stations, operating on only 10.7 mi, all owned by the Government of Puerto Rico. Puerto Rico’s Highways and Transportation Authority, which manages this train, complains on a regular basis about the financial difficulties of this train and declares that it is completely running at a loss. The trains are 90.45% empty on average [32]. Figure 4 presents a train before the COVID-19 crisis with only a single passenger in a railroad car of Tren Urbano.

The expected ridership of a minimum of 115,000 passengers per day [33] seems to be absolutely overstated when, in 2018, the average weekday daily ridership was only 18,600 [34]. In a hearing before the Subcommittee on Regulatory Reform, Commercial and Antitrust Law in 2015, The Puerto Rico’s Highways and Transportation Authority gave this disapproving statement: “There are rising operating subsidy requirements to the Tren Urbano light rail, an underperforming and underutilized asset, which has long been a burden on the overall system. Recent reports also indicate that the system has stopped paying third-party vendors amid mounting cash flow pressures” [35]. Therefore, the future of this railway was unclear, even before the outbreak of COVID-19.

The COVID-19 epidemic induced the Puerto Rican government to immediately stop all of the services of Tren Urbano until further notice [36]. At this time, passengers can get used to the absence of the train as it is undecided as to whether the service will reopen.

Unsuccessful Rail Systems

The information previously given is gathered in Table 1. The statistics in this table indicate that the potential of



FIG 4 An almost empty railroad car of Tren Urbano.

Table 1. The practicability of rail systems on islands.

Name	Population (Million)	Sovereignty	Area (Square Miles)	Does Railway Exist?	Profitability
Salsette	15.1	India	239	No	No rail
New Guinea	12.6	Papua New Guinea, Indonesia	303,381	No	No rail
Ireland	6.8	Ireland, United Kingdom	32,595	Yes	No
Negros	4.5	The Philippines	5,048	No	No rail
Puerto Rico	3.5	United States	3,500	Yes	No
Jamaica	3	Jamaica	4,320	No	No rail
Cyprus	1.5	Cyprus, Turkey	3,565	No	No rail
Trinidad	1.4	Trinidad and Tobago	1,934	No	No rail
Crete	0.63	Greece	3,220	No	No rail

a railway system succeeding on an island is improbable. Only in large territories, where there is a necessity to convey a large number of people, can a rail system have the possibility of being effective.

In the United States, only the Amtrak routes in the northeast region, which is the densest region in the United States, are money making [37]. In the northeast region (Massachusetts, Connecticut, New Hampshire, Maine, Rhode Island, Vermont, New York, Pennsylvania, New Jersey, Virginia, Maryland, West Virginia, Delaware, and the District of Columbia) live 74,035,662 people [38], and the region is connected to the rest of the United States and Canada, so this is the opposite set of circumstances of an island. All of the other Amtrak routes run at a loss, and even some of the routes within the northeast region, like Amtrak's Hartford Line from New Haven to Springfield, run at a loss.

From this review, it can be realized that rail systems on islands were not profitable in the 21st century and a fortiori when the COVID-19 broke out and autonomous vehicles emerged, the rail systems' future has been doomed, as will be explained in the coming sections.

Autonomous Vehicles Renounce the Need for Rail Systems

In [39], the authors provide evidence that public buses in the near future will remain economically competitive only in dense and large urban areas. Rails have separated and dedicated pathways so their construction costs are higher. Moreover, rails endeavor to stop near more passengers' destinations. So, all the more, rails will not be economically competitive [40].

Furthermore, drivers do not drive the same way. They take turns differently and accelerate and apply the brakes in their own way. This variety in driving styles is one of the key reasons for traffic jams and traffic congestion, as has been explained in various research [41], [42].

Much unexplained traffic congestion is generated when a vehicle goes on a dense road. When it slows down, even slightly, the vehicle behind it will slow down even more, and the slowing down propagates backward through the vehicle line, getting severer the farther the slowing down

propagates. Sooner or later, there might be vehicles that are forced to completely stop to avoid hitting the vehicles ahead, engendering a traffic jam [43].

In contrast, autonomous vehicles of even competing companies fulfill the driving assignments almost in the same way. Moreover, they can drive in a platoon [44], which means all of the vehicles on the road will go like a long train, keeping the same distance from the vehicle ahead and also the same speed [45]. Such a platoon can be seen in Figure 5. When such platoons are the everyday site on the roads, the railroads will be of no use because a train takes many passengers from one central station to another, whereas an autonomous car can take each passenger from a different location and give a ride to anywhere a road is present, which is a much better service than a train can offer [46].

A connection of two or more means of transportation can become a nuisance for passengers if the connection is poorly implemented. Such poor connections can discourage potential passengers from using connected means of transportation, like a train plus a bus. Nevertheless, it is very problematic to implement all of the connections well, and there are many conflict requirements that make a perfect implementation for all connections impossible [47].

Autonomous vehicles will make these connections unnecessary. Therefore, they will have a significant advantage over the rail services. In several states in the United States, like Arizona, California, Michigan, and Ohio, autonomous vehicles are permissible, even without the necessity of a driver [48], and such vehicles are impending in other locations [49].

When it comes to COVID-19, a platoon of autonomous vehicles is much safer for passengers than a conventional train. In autonomous vehicles, each passenger is surrounded by metallic barriers that thoroughly keep the passenger safe from COVID-19 infection. Obviously, such a platoon of vehicles can protect the passengers much more than a cloth mask [50].

In [51], the authors propose measures that should be implemented in public transportation to eliminate the spread of a virus. A key measure is separating people from each other, for example, by Plexiglas barriers. However, using a platoon of autonomous vehicles and putting each passenger in a separated vehicle is even better than a barrier because, in separated cars, people absolutely cannot infect each other. A virus cannot pass through the cars. In addition to cars protecting passengers from weather phenomena and accident injuries, they also protect passengers from viruses, including COVID-19.

It is uncertain how much time the COVID-19 pandemic and its ramifications will last. The pandemic itself could even last until 2025 [52]. The pandemic will not disappear in one day, and the vaccination of the entire world will take time. By the same token, the worries and fears of many people from COVID-19 will not disappear in one day and



FIG 5 A platoon of cars.

will deter travelers from entering a crowded railroad car for an unknown time, even after the pandemic itself ends, as we still cannot fully anticipate the long-lasting effects of this pandemic on our societies [53].

The year 2025 was also mentioned by the U.S. Secretary of Transportation who anticipated that autonomous cars will have a global presence by 2025 [54]. Yet again, this transportation-market change will not take place in one day; rather it will take some time to be adopted by more authorities and customers.

The COVID-19 pandemic and autonomous vehicles will affect our lives in the foreseeable future. Both will make rail systems in isolated territories redundant, and gradually these rail systems will fade away.

Conclusion

Rails were invented more than 200 years ago [55]. The model of rail systems is to convey many passengers from one central station to another. On islands, such a model cannot do well economically. As shown by this article's review of various rail systems on islands in a variety of locations in the world, no rail system can be successful or profitable.

In the coming years, autonomous vehicles will be prevalent, and they will be able to travel in platoons, which means vehicles will keep an invariable distance from the vehicle ahead. These platoons will be similar to trains, but with the ability to take each passenger to an individual destination rather than a central station. For that reason, people will prefer to go in autonomous vehicles, and there will be no financial justification for rail systems anymore [56].

The current COVID-19 pandemic has discouraged many people from traveling by trains [57]. It is unclear how much time this pandemic will last. However, even when the pandemic is over, passengers will not come suddenly flooding back as train services are resumed.

A substantial portion of the population will still avoid traveling in crowded trains, even when a vaccine for COVID-19 is available. Some people will worry about the efficiency of the vaccine, and others will worry about other viruses [58]. Furthermore, a poll in the United States maintains that about 30% of people do not want to take any vaccine for COVID-19 and about 50% do not want to take a vaccine for COVID-19 that was not produced in the United States [59]. According to this poll, traveling in crowded trains will be a worrisome choice for a substantial portion of the population, even when a COVID-19 vaccine is available, and they will prefer autonomous vehicles.

It will take a long period until these COVID-19 worries will be diminished to the minimal level they were at before the COVID-19 outbreak. During this period, autonomous vehicles will be able to establish themselves as an accomplished means of transportation, capable of dealing with transportation challenges. The looming technology of autonomous vehicles, along with the current unsuccessful

and ineffective functioning of rail systems on islands, should discourage the transportation authorities of islands from investing in rail systems in their territories.

About the Author



Yair Wiseman (wiseman@cs.biu.ac.il) earned his M.Sc. (summa cum laude) and Ph.D. degrees in computer science from Bar-Ilan University. He carried out his first postdoctoral research at the Hebrew University of Jerusalem, and the second at the Georgia Institute of Technology, Atlanta, USA. He is on the editorial board of several journals, a member of various conference committees, and a reviewer of many scholarly journals. He has collaborated with other partners and received research grants to run an active laboratory from inter alia Sun Microsystems, Intel, and Polak Foundation. He is an international expert who has reviewed and evaluated several large projects of the European Union, Israel Science Foundation, Marie Skłodowska-Curie actions in Ireland, Ministry of Education, and Science of Kazakhstan. His more than 50 journal papers have been published in many venues around the world.

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