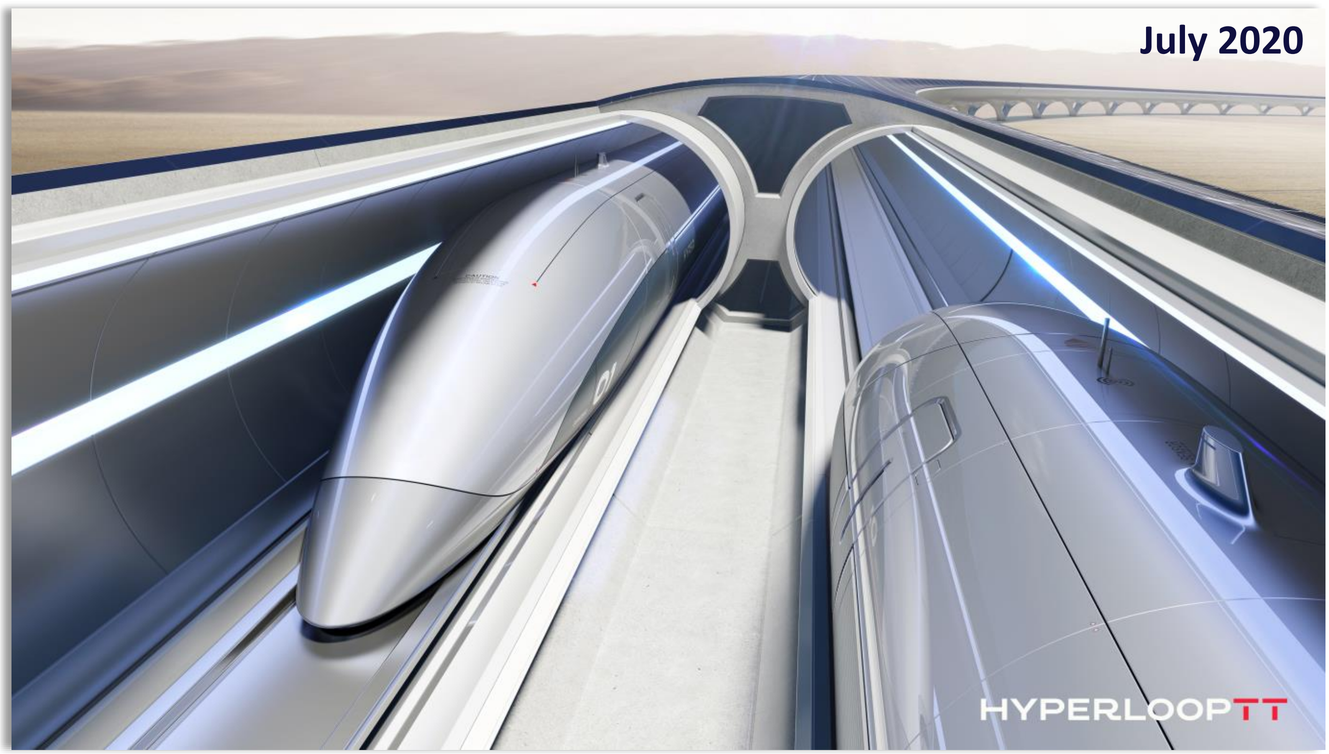
Prepared for

Northeast Ohio Areawide Coordinating Agency

Great Lakes Hyperloop Feasibility Report
Peer Review Panel – Questions and Responses
Technical Report



Prepared by

TEMS

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Peer Review Panel

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- **Professor Dr. Michael Pagono,** Dean, College of Urban Planning and Public Affairs and Professor of Public Administration University of Illinois Chicago; Director, Government Finance Research Center
- **Professor Dr. Joe Schofer,** Professor of Civil and Environmental Engineering, and Associate Dean McCormick School of Engineering, Northwest University
- **Professor Dr. Roby Simons,** Professor of Urban Studies, CSU
- **Dr. P. S. Sriraj,** Urban Transportation Center, Chicago Director, UTC; Adjunct Lecturer, UPP; Director of Metropolitan Transportation Support Initiative (METSI) and Research Programs
- **Contributor: Mr. Henry Posner**, serves as Chairman of RDC Deutschland, Chairman of Iowa Interstate Railroad, and adjunct Professor, Carnegie Mellon University, Dietrich College of Humanities

Study Team

- **Ms. Grace Gallucci,** Executive Director, Northeast Ohio Areawide Coordinating Agency (NOACA)
- **Ms. Kathleen Sarli, P.E.,** Associate Director of Operations/Chief Operating Officer, Northeast Ohio Areawide Coordinating Agency (NOACA)
- **Mr. Charles R. Michael, P.E.,** HyperloopTT, U.S. Infrastructure and Regulatory Affairs
- **Dr. Christopher Bobko,** HyperloopTT, Head of Engineering Integration
- **Dr. Alexander E. Metcalf,** President, Transportation Economics & Management Systems, Inc.
- **Dr. Edwin "Chip" Kraft,** Director of Operations, Transportation Economics & Management Systems, Inc.
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- **Mr. Stephen E. Schlickman,** President, Schlickman & Associates

Introduction

The Peer Review Panel was convened to review and assess the Great Lakes Hyperloop Feasibility Study. This included the Databases, Route Analysis, Operating Plans, Capital and Operating Costs, Market Analysis of Passenger and Freight Traffic and Revenues, and Financial and Economic Analysis.

The aim of the Peer Review was to assess areas of strengths and weakness in the Feasibility Study and to provide guidance on factors that may need to be added to the analysis, alternative approaches that might be considered, and the effectiveness of the analysis in meeting the requirements of both state and federal governments -- specifically in terms of meeting funding requirements such as Benefit Cost Ratio's, and potential Wall Street requirements for public-private partnership and private sector finance.

The Peer Review Panel's expertise was primarily in transportation planning, transportation and traffic operations, and economic impacts and decision making for major infrastructure projects, so a detailed review of the HyperloopTT technology was not a focus. The Peer Review Panel appreciated the overview of major technology elements, including a presentation of the full-scale prototyping work underway. The Peer Review Panel's attention was largely focused on broader issues of demand, market share, security, emergency, and risk, rather than technical elements of the HyperloopTT system performance.

Given the assumption of the technology capabilities, the Peer Review Panel focused on the planning methods and sought to identify the likely planning issues and risks associated with assessing the feasibility of implementing the system in the Cleveland-Chicago-Pittsburgh corridor, from a planning and marketing perspective.

Finally, the Peer Review Panel comments were not limited to Scope of Work of the Feasibility Study given to the Study Team, but rather took the broadest view and raised issues that would be relevant to the implementation of a revolutionary ground transportation system. Some of the comments will need to be addressed in future work and will require additional research into many of the demand, integrated land use and transportation issues that will need to be considered in more advanced planning phases.

The following comments from the Peer Review Panel were received and the Study Team has provided responses about how the issues, concerns and questions will be assessed as the project moves forward.

Overall, no single "fatal flaw" issues arose with the project analysis, although it is clear that there are some issues that will need further research in the future planning work to minimize financial risk and ensure that a practical and realistic approach is being developed.

Peer Panel Questions and Study Team Responses

Session 1: Technology (HyperloopTT)

1. Have cyber security risks been considered during planning and design?

Response: Cybersecurity risks are a key criterion during system and subsystem design and operational planning. HyperloopTT's cyber mitigation strategies are considered best in class and are considered to be proprietary and confidential.

2. What kind of redundancy will the system have and how autonomous will the vehicles be?

Response: System redundancies, communications modules and command systems are integral to the overall HyperloopTT system and subsystem design. Critical systems subscribe to N Modular Redundancy with synchronized inputs providing bumpless crossovers. The Inductrack™ passive levitation system has achieved fail-safe status in full-scale testing. The capsules will be fully autonomous, controlled by the Operations Control Center.

3. Is the Toulouse, France test track long enough? Are there any plans to lengthen the test facility beyond 1,000 feet?

Response: A 320m/1050 ft test track and R&D Center has been constructed by HyperloopTT in Toulouse, France, with construction completed in 2019. The testing of various systems and subsystems is ongoing. There are no plans to expand this center however research and development will continue at the site.

4. When will the 5 kilometers prototype in Abu Dhabi be up and running, and will it be extended to Dubai?

Response: A full-scale 5km HyperloopTT commercial prototype is currently under development in Abu Dhabi, UAE, with completion anticipated in 2023. Extensions to this project are being considered.

5. What is the optimal speed or time to get to the top speed of 760 mph?

Response: There are no optimal speeds or time to distance criteria as each route or corridor is configured to maximize passenger safety and comfort, maximize efficiency, and minimize travel time. Average speeds along corridors would be in the range of 400 to 600 mph.

6. How many miles would it take to get up to speed?

Response: HyperloopTT capsules accelerate and decelerate at a comfortable rate of 0.1g to maximize passenger safety and comfort. To achieve a maximum speed of 760 mph at a constant rate of acceleration 0.1g would take approximately 58 km. However, travel times can be greatly reduced without reliance on maximum speeds but rather maintaining high average speeds.

7. We understand there is a vacuum tube entry/exit location at 2,000-foot intervals, how does this compare to current public transportation systems such as subways?

Response: Passenger safety is the highest priority of HyperloopTT. Public transportation systems such as subways do not employ vacuum tube enclosures and therefore subway emergency exit procedures do not mirror hyperloop emergency exit procedures. If an unforeseen situation arises, the capsule design allows self-propulsion to the next station for passenger exit. If the capsule is disabled, isolation gates fore and aft of the capsule are closed, and the tube is pressurized to ambient pressure (1 atm). The passengers would then exit the capsule and move to the nearest emergency exit.

8. What is the distance between hyperloop capsules if one capsule is slowed down? Would there be an underground escape hatch?

Response: Provisions for emergency exits are designed into the complete system to accommodate unforeseen conditions. When capsule speed is decreased, a minimum distance or headway is always maintained between capsules to maintain passenger safety and system integrity, managed by the Operation Control Center. For all HyperloopTT installations, including in tunnels, provisions for emergency exits are designed into the capsules and tube enclosures allowing for passenger evacuation in the event of unforeseen conditions.

9. Is the right-of-way 50 feet total with the two tubes in the middle?

Response: The minimum right-of-way width would require a nominal easement width of 50 feet for a dual tube system.

10. How long will it take to get comfortable with the risks at operating at very high speed?

Response: Prior to commercial deployment, a technology readiness assessment will examine system and subsystem requirements and capabilities leading to a Technology Readiness Level (TRL) range of between 1 and 9. Passenger-ready programs will require a TRL of 9 - the maximum readiness level - prior to deployment.

11. How are passengers kept safe from the perspective of g-forces? What kind of technology and design is incorporated to account for variations of the g- forces?

Response: The HyperloopTT design criteria limits the g-forces on passengers for longitudinal acceleration and deceleration, positive and negative vertical acceleration, and lateral acceleration, managed by the Operations Control Center, to maximize passenger safety and comfort. Passengers will not experience forces beyond a normal airplane flight.

12. Are hyperloop projects by the various hyperloop companies around the globe at the same state, and do they inform each other? Is the Great Lakes Hyperloop as presented generic to all the hyperloops around the globe, or is it a different construct between Chicago and Pittsburgh than it is someplace else?

Response: The Great Lakes Hyperloop technology presented by HyperloopTT is unique to HyperloopTT. This feasibility study did not evaluate or compare other technologies under development by other companies.

13. How convertible are the vehicles from freight to people, if the market changes? Can the vehicle be lengthened, or can the interior be retrofit?

Response: HyperloopTT capsules can be configured for either passenger or freight application with varying interior configurations. The capsule length and diameter are held constant.

14. Regarding the Federal approval of this system for its operation, how is that proceeding?

Response: The development of the HyperloopTT regulatory framework is proceeding with USDOT working through the Non-Traditional and Emerging Transportation Technologies (NETT) Council and other agencies as required.

15. What is going to be the security checking situation and has that been taken into account in terms of demand for ridership? Seems that will slow down the door to door process.

Response: Passenger and freight security screening is being developed as a passive, non-intrusive method that will be unlike current airport security systems. Passengers and their luggage or carry-ons would proceed through security screening to their departure gates without delay, therefore the security screening process will be independent from travel demand.

16. Is data privacy for passengers an issue, if they are checked up on without their knowledge?

Response: Data privacy provisions would be similar to that information acquired by existing airline operations, using advanced data acquisition and security best practices.

17. If the system needs to be shutdown abruptly for whatever reason (emergency situation, system failure, etc.), what happens to the vehicles as they slow down, the safety of the passengers, the deceleration, communicating with the vehicle in front, how far apart in distance, and getting the passengers out to the surface. What would be the notification system for an emergency evacuation?

Response: Passenger safety is first and foremost in the HyperloopTT operations plan, with system and subsystem design strictly adhering to this priority. All capsules will maintain constant communications with the Operations Control Center, and a safe, minimum headway is always maintained between capsules. For all HyperloopTT installations, provisions for system shutdowns, passenger safety, capsule communications and emergency exits are designed into the capsules and the tube enclosures allowing for evacuation in the event of unforeseen conditions.

18. How quickly can the hyperloop capsule be slowed down? How quickly can it be stopped?

Response: Capsules will accelerate and decelerate at a comfortable rate to maximize passenger comfort. During unforeseen conditions, the rate of deceleration can be increased by the Operation Control System to a practical maximum that considers passenger safety.

19. Are there switches?

Response: Route configurations that include off-ramps, wyes or bypass guideways will include either high-speed or low-speed switches, depending on the specific requirement. The technology behind the switches is proprietary and was therefore not available to the Peer Review Panel.

Peer Panel Questions and Study Team Responses

Session 2: Routes and Operations Analysis

1. What percentage of the Hybrid and Toll Routes is tunnel, cut and cover, elevated in the Feasibility Study?

Response:

MILEAGE	CHI-CLE Toll Rd	CHI-CLE Hybrid	CLE-PIT Toll Rd	CLE-PIT Hybrid
Deep Tunnel	103.1	79.0	80.0	100.1
Cut and Cover	227.0	258.0	58.7	41.8
Total Miles	330.0	337.0	138.7	141.9

PERCENTAGE	CHI-CLE Toll Rd	CHI-CLE Hybrid	CLE-PIT Toll Rd	CLE-PIT Hybrid
Deep Tunnel	31.2%	23.4%	57.7%	70.5%
Cut and Cover	68.8%	76.6%	42.3%	29.5%
Total Miles	100.0%	100.0%	100.0%	100.0%

It should be noted that since TEMS has not carried out any detailed engineering, it was decided to use the slightly less expensive deep tunnel, rather than the elevated infrastructure to approach downtown areas in cities along the route. It may be that elevated infrastructure would be used to enter cities, where effective alignment in the form of say, rail or electric utility lines are available.

2. Is Hyperloop intended to compete with railroads?

Response: Hyperloop is not designed to compete with railroads. The freight railroads move large volumes of low-value goods compared to hyperloop that moves small volumes of high-value express goods. Hyperloop like any passenger rail alternative will pay the freight railroads for access to their rights of way. Freight railroads have typically been interested in such deals as long as their core business is not compromised and they are insulated from liability.

3. Right-of-way acquisition is a critical factor; how will this be achieved?

Response: Right-of-way requirements will mostly be addressed by acquiring easements rather than by outright land purchase. The price paid for easements is intended to compensate landowners for the costs of any direct impacts, loss of property value, use or development rights. For elevated or shallow tunnel easements, usually surface development within the easement ROW is not allowed. Deep tunnels usually do not impose any surface use restrictions.
(See https://www.ccj.com/blog/2020/02/19/what-is-a-fair-payment-for-a-pipeline-easement)

Pipelines easements across rural land have typically been selling for $200-800 per rod (16.5-foot length) for a 50’ wide easement. 50’ is more than wide enough to accommodate the installation of two HyperloopTT tubes which are only 4 meters or 13.1 feet wide. As a result, the right-of-way is expected to cost $64-$254 thousand per mile, which is less than 1% of the construction cost. (See: https://winbladlaw.com/rodprice/#:~:text=If%20an%20easement%20is%2050,of%20the%20owner%20to%20negotiate.)

Deep tunnel easements cost even less due to the lack of surface impact. A recent appraisal of residential property values in the Seattle area found no measurable impact on property values due to the presence of a deep tunnel underneath the property. Sound Transit has been paying 0.1¢ per cubic foot of acquired easement area for residentially zoned property, and 1.0¢ per cubic foot for properties with less restrictive zoning. A twin-bore 4-meter HyperloopTT tunnel has a volume of 1.42 million cubic feet per mile, so the cost of the deep tunnel easements would range between $1,400 and $14,000 per mile. As a result, tunnel easement costs have a negligible impact on a system whose cost averages $50-75 million per mile.

(See: http://www.msreal.com/sites/msreal/files/research/impact_of_deep_tunnels_on_property_value.pdf
and
http://www.millernash.com/files/Uploads/Documents/Z%20201.1%20%20smith_beaver_white_hiatt_dec2005.pdf

4. How will the station locations be decided? Is this still subject to further work and field surveys? Will Stated Preference Surveys be completed in further work?

Response: For the purpose of the feasibility study, all the major free-standing urban areas in the corridor were connected to improve regional accessibility and to create economic growth in as many urban centers as possible. If a suburban stop is required for South Chicago for example, it could be at Midway Airport which serves over 11 million passengers per year. This offers much more significant ridership and freight potential. However, in the proposed environmental review process the stations and route selections will all be revisited and analyzed in much greater detail.

5. How deep will tunnels be in urban areas?

Response: Deep bored tunnels will be deep enough to avoid impacts on building foundations and on shallow utilities. They would be engineered to miss water, sewage and drainage tunnels and other existing deep underground utilities. The intent of deep boring the tunnels would specifically be to avoid surface and subsurface impacts on urban structures and the costs for utility relocation that would be needed if a shallow cut and cover approach were recommended.

6. How will land use patterns be impacted by hyperloop and what will happen to commuter patterns?

Response: It should be noted that the general impact of rail and fixed guideway modes like hyperloop is to promote high-density development around its stations, whereas highway investment tends to promote low density "sprawl" development. Hyperloop will provide very fast connection time between smaller urban areas like South Bend, Youngstown, Toledo and major cities[1]. The improved

[1] Reference: Technical Report: Passenger Transportation Strategy for Southern Ontario, 1990-2020 (Section 3, page 18 to page 31). TEMS, 1992

access time will result in increased growth in both the smaller communities and the major urban areas. The regional economy will become more integrated and the improved accessibility will generate growth in urban areas of all sizes when they are connected to the Hyperloop system. Commuter patterns will be extended between the city centers, and as with high-speed rail, new commuter flows will be from small urban communities with stations to the larger cities.

7. How will Covid-19 impact the demand between cities?

Response: Note that this study was performed before Covid-19 was known to exist in the U.S. The concern that without an effective vaccine, the economy may have to perform at a lower level is real, and we should know more in 2021. Ridership may lower with the preference for telecommuting, but freight demand is sure to increase with the preference for home delivery. Air cargo and less-than-truckload express trucking demand along the corridor is growing at 4 to 5% per year. With lower costs and significantly shorter travel times, hyperloop can not only transform the freight industry but absorb the estimated growth in the line-haul segments of freight movements. An investment-grade ridership, freight and financial projection will be developed as part of the planned environmental review process of the corridor. By that time, it will be possible to reflect on the impact of this variable.

8. Will urban sprawl be increased by hyperloop?

Response: The impact of hyperloop will be to integrate urban areas and give smaller urban areas improved access to larger cities. As a result, it will provide increased opportunity, income, job accessibility, and social mobility through expanded and improved access to larger urban areas. Since fixed guideway transportation systems are well known for promoting densification around their stations, rather than sprawl, it is unlikely that hyperloop will promote sprawl patterns of development. Further work will be required as the project progresses on the extent and size of the development potential in large and small cities where stations are proposed.

9. What is the stopping distance of the HyperloopTT system?

Response: The average speed of hyperloop is between 400 to 500 mph, so the typical stopping distance for an emergency will be four to five miles. Continuous monitoring and control of all capsules at all times allows advance notice of circumstances that may require a speed adjustment. Normal stops would need 20 miles or more. Braking distances are given in the Report, Exhibit 2-12.

10. What is the level of service for Hyperloop?

Response: Capsules traveling directly between major cities will make no intermediate stops. For travel between intermediate smaller locations, direct capsules will operate generally to the next major city in either direction. For example, direct capsules would run from South Bend and Toledo, directly to both Chicago and to Cleveland.

- Between major cities, capsules would operate on 6-10-minute peak hour headways, depending on demand. For heavy peak hour demands between major cities, Hyperloop capsules might be coupled together to increase guideway capacity. At other times, the capsules would run individually so that high frequency and short headways can be maintained during the off-peak period.
- Off-peak headways, and service to intermediate smaller locations would generally operate at 15-30-minute headways depending on the level of demand.

11. How will the MORPC Hyperloop study impact results?

Response: This is unknown. This study assumed only one hyperloop corridor between Pittsburgh and Chicago and that is the route via Cleveland. Today the freight movement between Chicago and Pittsburgh is dominated by the route through Cleveland using the Toll Road route in Pennsylvania and Ohio.

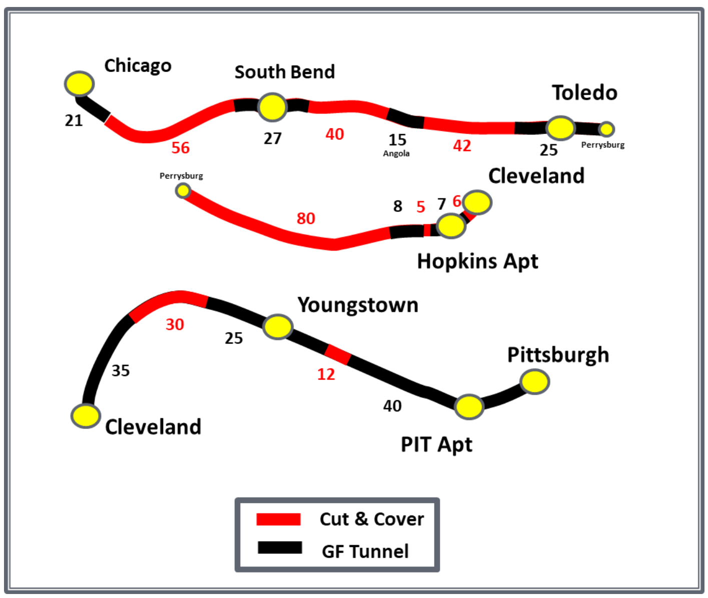
Peer Panel Questions and Study Team Responses

Session 3: Capital Costs

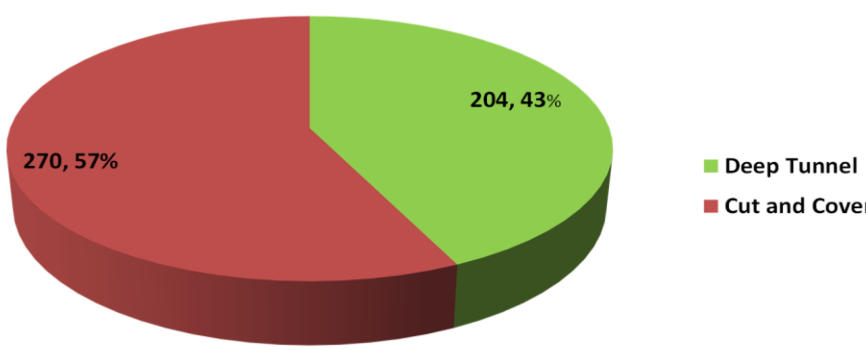
1. Can a map be produced showing the percent of infrastructure by each type (i.e., elevated, cut and cover, deep tunnel) for the Feasibility Study?

Response: The breakdown of Cut & Cover and Deep Tunnel is provided for the Preferred Option. In the analysis it was discovered that elevated structure would be slightly more expensive than deep tunnel for a 4-meter tube, and as such deep tunnel was used for most city approaches. It is possible that elevated structure may be preferred where effective rail or utility alignments are available.

Schematic:
Chicago to Pittsburgh



Mileage by Type of Construction Chicago to Pittsburgh



Overall Length = 474 miles

2. What is the contingency for the capital costs? How does it relate to high-speed rail projects?

Response: The capital costs for hyperloop are similar in character to those for a high-speed rail project. The bulk of these costs are for infrastructure that is well understood, e.g., tunnels, bridges, guideways. As a result, we were able to use the capital cost experience associated with 40 years of building high-speed rail systems. The main difference in the capital cost is the fact that hyperloop uses a 4-meter tunnel or tube, rather than the 8-12-meter tube required for high-speed rail. As such, tunnel costs are much cheaper for hyperloop than for high-speed rail. Furthermore, there is a considerable experience with 4-meter tubes and tunnels since these are extensively used for water, oil, and gas pipelines across the US. As such, the same contingency was adopted for hyperloop as for high-speed rail projects. The typical contingency for high-speed rail infrastructure is 30% contingency and 28% soft costs. See page 7-4 of the Feasibility Study. TEMS expects to do considerable sensitivity analysis as part of the next stage of work, such as the EIS study.

3. Were the tunneling costs estimated based on any actual tunnel projects?

Response: The tunneling costs for the study were provided by the Robbins Company[2], which is a highly experienced tunneling company with major projects in the Midwest, e.g., 135-mile mainline water pipe system for Chicago, as well as high-speed rail projects like the Channel Tunnel. There is a significant amount of experience in tunneling in the Midwest for smaller tunnels such as the 4-meter tunnels proposed by HyperloopTT.

4. Is the six-year implementation period for building the system long enough?

Response: Yes, this is sufficient for construction once the environmental review process has been completed. Construction of California High-Speed Rail was started as an economic stimulus measure before all the right-of-way had been secured, partially mitigated by the ability to operate on the existing rail network as the high-speed core is built out (like the French LGV network). As a result, many of the delays to that project have been attributed to difficulties in buying property and legal challenges. For cut-and-cover construction, however, hyperloop will not need to permanently bisect property parcels (the main complaint of landowners) and for many miles, it will have no surface impacts at all. It is important to secure the easements to a substantial share of the right-of-way before starting construction. If this is done, there is no reason why the six-year implementation cannot be achieved. A detailed Implementation Plan will be developed in the environmental review process of the project.

5. What is the life cycle of the infrastructure equipment?

Response: The estimated design life of HyperloopTT's technology is approximately 50 years considering a structured maintenance, repair and replacement program. The estimated design life of the structural tube enclosure, pylons and foundations is approximately 100 years. The estimated design life of tunnels and underground infrastructure is approximately 100 years. In addition, TEMS followed the standard economic framework of the 1997 Commercial Feasibility Study for High-Speed Ground Transportation (CFS) and for US TIGER/BUILD Grant which does not include inclusion of scrap/salvage value.

[2] Robbins Company provided to HTT.

Peer Panel Questions and Study Team Responses

Session 4: Operating Costs

1. What is the difference between Operating and Capital Costs? What is the cyclical maintenance cost? Should cyclical maintenance be in Capital Costs?

Response: Operating costs are for day-to-day operations of the hyperloop system. Capital costs are for construction of the system and initial acquisition of capsules. According to Generally Accepted Accounting Principles (GAAP) certain types of maintenance activities that have a life expectancy greater than one year, such as periodical infrastructure renewals and replacements, are to be capitalized rather than expensed. These types of maintenance expenditures are identified as cyclic maintenance. All three types of expenses are treated on a cash-flow basis in the Net Present Value (NPV) discounting analysis. See Page 9-1 of the Feasibility Report.

2. Are taxes included?

Response: Taxes are not included in the USDOT Benefit-Cost Analysis because taxes are considered a transfer payment and not a real cost or benefit of the project. They are an economic impact to the communities rather than a benefit, and this has been assessed separately from the Benefit-Cost Analysis.

3. How reliable is the electric power supply? What if the grid goes down? What happens to the operation? Do capsules just stop?

Response: The Feasibility Study assumes that the electric power supply is reliable and will have appropriate back-up capacity, with utility interconnections sufficient to provide continuous electric service redundancy. Each capsule is equipped with battery power sufficient to advance the capsules to the next station if needed.

4. How is liability handled? How do risks compare with other modes (e.g., air or high-speed rail)?

Response: HyperloopTT's design and completely controlled environment inherently reduces or eliminates many of the risks associated with the operation of many of today's transport systems.

- Weather-related risks associated with today's aviation system will be completely eliminated.
- Collision-related risks associated with the grade crossing of today's surface transportation systems will also be eliminated.

Hyperloop Transportation Technologies (HyperloopTT) and leading global insurer Munich Re have carried out a comprehensive risk analysis of HyperloopTT's technology and have declared it feasible and insurable. On this basis it is considered that the insurance cost will be comparable to or lower than the costs of today's High-Speed Ground transportation modes. Because of the considerable safety improvement associated with the HyperloopTT system, using rail insurance costs is considered conservative for this analysis.

5. When would the system become operational? Is it after six years of construction?

Response: It is considered that following the completion of the environmental review process and acquisition of a substantial share of the necessary right-of-way access, there would be a six-year construction and training period. The operation of the system could then occur. A more detailed development schedule will be prepared during the environmental review process.

Peer Panel Questions and Study Team Responses

Session 5: Passenger Markets

1. The model calibration is very good, in terms of coefficients and statistical measures, but there should be more explanation of the model and its performance.

Response: See detailed model description below.

(A) Database: The current model was developed using existing data sources (see pages 4-3 to 4-9 in the Report). These vary in quality.

- Socioeconomic Data – This was developed using a variety of data sources including US Census Bureau, MPO data, Woods & Poole data, and American Community 5-year Estimates. This data is regarded as being very good in providing population, income and employment data at a zone (TAZ) level.

- Network Data – This is derived from base year schedules for in-vehicle time, frequency, fares, terminal times, access-egress time, and so reflect actual performance in the base year. For forecast years, transport strategy assumptions are made for oil prices (US EIA forecasts), congestion (MPO forecasts), auto efficiency (Oakridge forecast). These forecasts are based on US government and local MPO forecasts and need to be tested in sensitivity forecasts at the next stage of work.

    - This data is regarded as being a very good description of base and forecast year travel times and costs, and typically accepted by USDOT.

- Origin/Destination (O/D) Data – This is derived for the base year from state and MPO data for auto travel, Amtrak passenger statistics for rail, FAA airline 10 percent survey, Bus line schedules and counts, and US Bureau of Transport Statistics. This data is regarded as good at a feasibility level but must be reinforced with direct survey and counts for Investment Grade work. The analysis is done on a zone to zone basis with local access and egress time being estimated for each zone.

- Stated Preference (SP) Data – The data for the study was derived from various high-speed rail studies completed in the Chicago-Detroit, Chicago-St. Louis, Chicago-Milwaukee corridors. Hyperloop data had to be estimated. It was assumed to be equivalent to air values of time. At the next stage of work a full Stated Preference Survey will be completed specific to hyperloop. This will give hyperloop values of time.

    - **A Full SP Survey will be needed for Investment Grade Study**

(B) Model: The forecasting model is a Discrete Choice model as recommended by academics MIT, US Transportation Research Center, Volpe, and USDOT. The model is based on three components –

- Total Demand. This forecast is based on growth in the total travel market due to growth in socioeconomic factors, population, income and employment.

- Induced Demand. This forecast is based on the change in traffic volume due to improved or worsening quality of travel as measured by the time and cost of travel. The quality of travel is measured in a single metric that includes all aspects of an origin to destination trip in terms of time and cost. See page 4-8 of the Feasibility Report. The assumption of the model is that the demand for travel expands or contracts based on the quality of travel available for a specific trip. As such, travel is being treated as a normal good subject to normal economic price theory, lower price more demand, higher price less demand.

- Modal Choice. This forecast is based on the relative quality of travel provided by each mode considering the time and cost of travel, which are turned into a single value by converting time to money using values of time. Values of time estimates used in the study are given on a mode and purpose basis on page 4-9 of the Feasibility Report.

(C) Calibration: Each of the three model components are calibrated using the data gathered in the development of the database.

- The Total Demand is regressed against the socioeconomics using combinations of population, income, and employment. See Appendix A, page A2.

- The Total Demand is also impacted by the quality of travel service offered between zones, so the impact of the improvement is estimated for each year once hyperloop is put into service. Since HyperloopTT is offering competitive fares with Amtrak, while saving significant amounts of time and a much higher level of reliability, the quality of service is significantly improved. At the same time, the highway network is facing increased gas prices and congestion over time according to the USDOT EIA forecasts for gas, and MPO forecasts for highway delays. Bus travel is impacted by oil and congestion forecasts, while air faces capacity issues, terminal access issues, and rising oil prices. As such, the quality of service is falling for the competitive modes.

- The Modal Split model merely compares the quality of service offered by the different modes and estimates the changing market shares, using logistic regression analysis calibration as shown in Appendix A, page A5 and A6. The modal split form, hierarchy, and structure is the Degenerate nested logit that is recommended by academics and USDOT, Volpe Center. See "Stated Choice Methods: Analysis and Applications" JJ. Louviere, D. Hensher, and J. Swait, Cambridge 2000

2. The model should provide an explanation of the importance of different variables and the role of the variables in explaining the growth of Total Demand and the Mode Choice selection.

Response: The role of the different variables is defined in the component models. For the Total Demand model, the two key factors are Socioeconomic growth and the Quality of the Transportation network. See Equation 1, page A1 in Appendix A.

The Total Demand model is behavioral and so considers different socioeconomic factors and different Quality of Service elements for each purpose of travel. This is because different factors and elements motivate different behavior, i.e., an individual's rational changes for the different types of trips made. The socioeconomic factors used for increased travel demand are shown on page A2 of Appendix A. For

Business Travel, Employment and Income factors are used. As a result, the proposition is that higher levels of Employment and Income generate increased business travel and are the drivers of Business Travel. Analysis shows that Commuting is driven by Population, Employment, and Income, while Social Travel is driven by Population and Income.

For each purpose of travel, different combinations of variables are tested to see which set gives the most reasonable and statistically stable relationship. See Appendix A, page A2.

For Quality of Transportation of Service, Travel Utility (as defined by travel times and costs and defined by Equation 3 on page A3 of Appendix A) is used. If Travel Utility improves i.e., travel time and costs are reduced, so the volume of travel increases. As Travel Utility diminishes, so the volume of travel diminishes.

The regression model for Total Travel Demand is shown in Equation 4 of Appendix A, page A3. This calibrates the trips between corridor zones for each of the three purposes of travel. The equations derived are shown in Exhibit A1 on page A4. It can be seen that Business Travel is the most sensitive to Socioeconomic Growth (0.4230) while Social Travel (0.2430) is half as sensitive and Commuting is the least sensitive (0.1055). In terms of the Quality of Travel Service, Commuting (0.8786) is the most sensitive, while Business and Social Travel are somewhat less sensitive at (60 to 70 percent). See Appendix A, page A4.

The Mode Split Analysis compares the Quality of Service offered by each mode in a bi-modal analysis that compares Auto with Public Modes, Air and Guideway (Rail/Hyperloop) with initially Bus, then Air and Hyperloop with Rail, and finally Hyperloop and Air. The equations are all statistically valid for each purpose of travel with hyperloop being highly competitive with air, rail, and bus, but less competitive with auto, particularly for business and social trips with short distance movements. For longer trips over 200 miles hyperloop becomes very competitive and is dominant over 300 miles. See Appendix A, page A9, Exhibit A-7.

3. *What is the interaction between smaller communities such as South Bend and the large cities like Chicago and Cleveland? Can the Origin/Destination (O/D) flows between cities be shown to support the concept of the interaction between the different cities?*

   Response: See O/D Matrix

OD Matrix

From	To	2030 Toll Road Option (million trips)	2030 Hybrid Option (million trips)
Chicago, IL	South Bend, IN	0.74	-
Chicago, IL	Toledo, OH	0.72	0.72
Chicago, IL	Hopkins Airport, OH	0.55	0.56
Chicago, IL	Cleveland, OH	1.98	2.00
Chicago, IL	Youngstown, OH	0.53	0.53
South Bend, IN	Toledo, OH	0.17	-
South Bend, IN	Hopkins Airport, OH	0.42	-
South Bend, IN	Cleveland, OH	0.68	-
South Bend, IN	Youngstown, OH	0.09	-
Toledo, OH	Hopkins Airport, OH	0.34	0.34
Toledo, OH	Cleveland, OH	0.66	0.66
Toledo, OH	Youngstown, OH	0.06	0.06
Hopkins Airport, OH	Cleveland, OH	0.25	0.25
Hopkins Airport, OH	Youngstown, OH	0.05	0.05
Cleveland, OH	Youngstown, OH	0.25	0.25
Chicago, IL	Pittsburgh, PA	2.28	2.31
South Bend, IN	Pittsburgh, PA	1.01	-
Toledo, OH	Pittsburgh, PA	0.85	0.85
Hopkins Airport, OH	Pittsburgh, PA	0.50	0.50
Cleveland, OH	Pittsburgh, PA	1.32	1.32
Youngstown, OH	Pittsburgh, PA	0.28	0.28

The table shows the station-to-station hyperloop O/D trip table for 2030. It can be seen that South Bend will contribute 2.4 million trips to large cities of Chicago, Cleveland, and Pittsburgh in 2030. The trips from South Bend will be more than 3 million if Toledo, Hopkins Airport, and Youngstown are included. Therefore, South Bend is an important trip generator in the corridor, which accounts for 17 percent of total ridership for interaction with large cities of Chicago, Cleveland, and Pittsburgh, and 22 percent of total ridership if other places in the corridor are also included.

4. Examples of trips using Hyperloop

Response:

- Business Trip – Chicago-Cleveland: Home to Hyperloop Station by auto or transit (30 mins to 60 mins), Station in Chicago to station in Cleveland by hyperloop (40 mins), walk, taxi, transit or auto to destination in Cleveland (10 to 40 mins).
- Commuter Trip – Toledo-Cleveland: Home to Hyperloop Station by auto or transit (10 to 30 mins). Station in Toledo to Station in Toledo to Station in Cleveland (25 mins), walk, taxi, transit to workplace in Cleveland (10 to 20 mins).
- Social Trip – Cleveland-Chicago. Home to Hyperloop Station by auto or transit (10 to 60 mins), Station in Cleveland to Station in Chicago (40 mins), Station in Chicago to shops, sports, family by transit, taxi, rental car (10 to 60 mins).

5. Can station-to-station volumes be provided to show train loadings?

Response:

Station to Station Volumes

	2030 Toll Road Option (million trips)	2030 Hybrid Option (million trips)
Chicago, IL-South Bend, IN	6.81	6.13
South Bend, IN-Toledo, OH	8.43	6.13
Toledo, OH-Hopkins Airport, OH	8.74	6.60
Hopkins Airport, OH-Cleveland, OH	9.19	7.46
Cleveland, OH-Youngstown, OH	6.94	5.87
Youngstown, OH-Pittsburgh, PA	6.25	5.26

The table shows the station-to-station segment loadings for Toll Road and Hybrid Options in 2030. It can be seen that the segment loading for the Toll Road option is from 6.25 million to 9.19 million. The segment loading for the Hybrid Option is from 5.26 million to 7.46 million in 2030.

6. How does the model measure Induced Demand, and how does it estimate diversion from existing modes to hyperloop?

Response: Induced Demand is the change in demand as a result of the travel between cities becoming cheaper in terms of time and cost. Travel, like any other normal product, responds to price (in this case the generalized costs of travel.) See Appendix A, Equation 3, page A3. Also, Appendix A, page A10.

7. Value of Frequency?

Response: The Stated Preference (SP) Surveys offer choices between options of waiting more time for a train or paying more money. This will be an element of the SP Survey to be done as part of the next stage of work. Current values used in the Feasibility Study were derived from previous SP Surveys done for higher speed passenger rail surveys in Midwest Corridors (e.g., Chicago-Detroit).

8. Economist view of Values of Time?

Response: The November 2013 Economist raised concerns about the Values of Time being applied to Business Travel and whether or not it took into account the ability of business travelers to work on trains. The Ministry of Transport in the United Kingdom (UK MOT) had used old data collected before Wi-Fi and laptops/smartphones. The UK MOT then did Stated Preference (SP) surveys and modified the Values of Time for Business to a lower level. The Values of Time were still regarded as a benefit in the Benefit-Cost Analysis, it was just the relative level of value that was slightly reduced. The Economist view did not challenge the use of Values of Time as a benefit, which is the current “practice” of Transport Economics. The same approach is used by USDOT procedures and of course, the UK Ministry of Transport procedures. Working on a train is productive, but that is not to say it is as productive as being in the office, and it is worth noting that the time to and from business meetings is frequently personal time. The personal time can often mean getting up early in the morning and going to bed late at night. Since the 1960’s when SP Surveys were introduced, they have consistently shown that individuals value time, and business travelers’ value it more than commuters and social travelers. In the February 2020 edition, Economist changed its view to support the HS2 high speed project. This included accepting significant Values of Time savings associated with the project.

9. Travel time value for different modes.

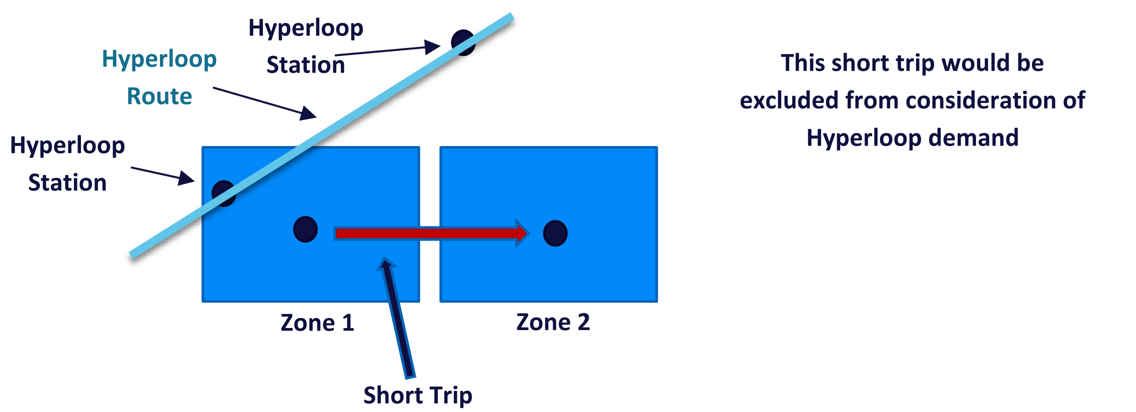
Response: Stated Preference (SP) Surveys consistently show that travelers on different modes and purposes have different time values. Business Air travelers have the highest Values of Time, Social Bus travelers (often students) have the lowest.

10. COMPASS™ modeling of traffic flows.

Response: The COMPASS™ model will review the character of a trip and consider if the trip should be included. Trips are excluded if –

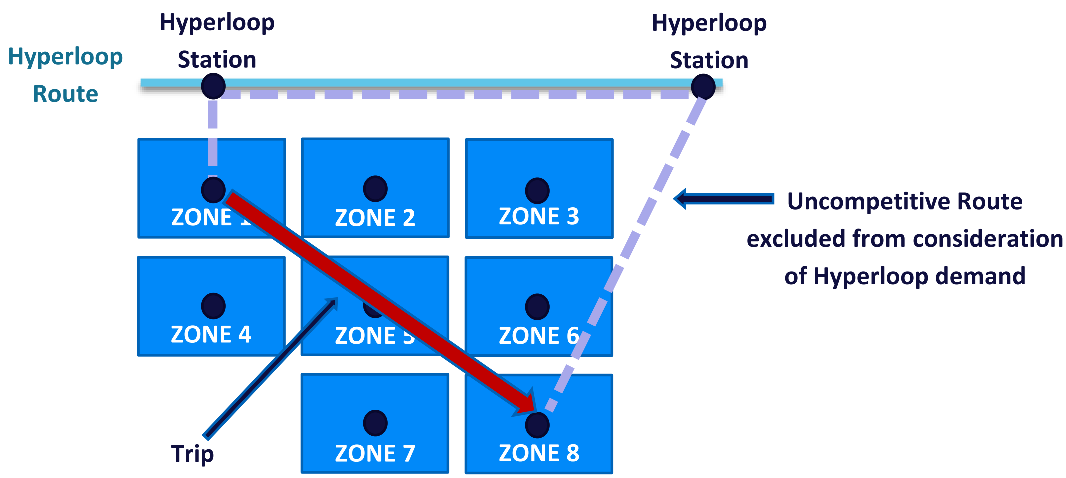
- The trip is too short to be made by hyperloop. Trip excluded. See Diagram 1

Diagram 1: Excluded Short Trip



- The trip can be made by hyperloop but is not economically competitive. In this case the trip is excluded. See Diagram 2

Diagram 2: Excluded Uncompetitive Trip



COMPASS™ eliminates trips that are unreasonable.

11. How would COMPASS™ model a trip to the airport from a Pittsburgh suburb?

Response: In Pittsburgh, COMPASS™ would not permit driving to the city to park and then take hyperloop to the airport. However, the model would consider walking to the station to take hyperloop to the airport.

12. Revenue sources for hyperloop.

Response: Hyperloop revenues include three sources –

- Passenger fare box
- Express freight revenues
- Property Development at Stations

13. What will be the impact of Driverless cars in the future?

Response: At this time, the analysis has not addressed Driverless Cars. This is an evolving technology and in future studies consideration can be given to how it might impact the competitiveness of auto versus hyperloop.

14. What is the potential for "onboard marketing" by video system?

Response: There is considerable potential for using HyperloopTT's onboard video system for marketing. Should this technology mature as intended, it would allow a different financial model to be developed. However, further research is needed to allow such financing to be considered in developing a funding program.

15. How will the Stated Preference (SP) Surveys be incorporated in the modelling process?

Response: SP Surveys for hyperloop are needed as the project progresses to Investment Grade Analysis. The SP data would be used to derive Values of Time, Frequency, Wait Time, Access and Egress Times, on a purpose basis. The derived Values of Time would be used directly in the modeling process. See Appendix A, page A3, Equation 3.

16. Can Benchmarking be used to compare results?

Response: TEMS typically uses Benchmarking to compare forecast results in its Investment Grade Studies. In developing benchmarks, TEMS will identify similar projects, infrastructure, technology, and operations, and landuse impacts. Hyperloop is a fixed guideway system like High Speed Rail and Maglev, both of which are used for intercity passenger transportation. Hyperloop is much faster than both. The nearest benchmarks would be for the Japanese 300 mph SC Maglev. In future work, TEMS would benchmark against forecasts for the SC Maglev. However, many high-speed rail projects have some similar features and can be used as well.

17. Have the COMPASS™ model forecasts been compared to the actual performance of high-speed rail?

Response: Yes, COMPASS™ model forecasts have been extensively tested in 34 Before and After studies for High Speed Rail. The error range on the 34 studies is less than ±20 percent. TEMS promises a plus or minus 20 percent range for Investment Grade Studies. (See the following page.)

TEMS' Forecasts

Exhibit 1 provides a validation of the 34 Investment Grade "Before and After" forecasts that TEMS has completed.

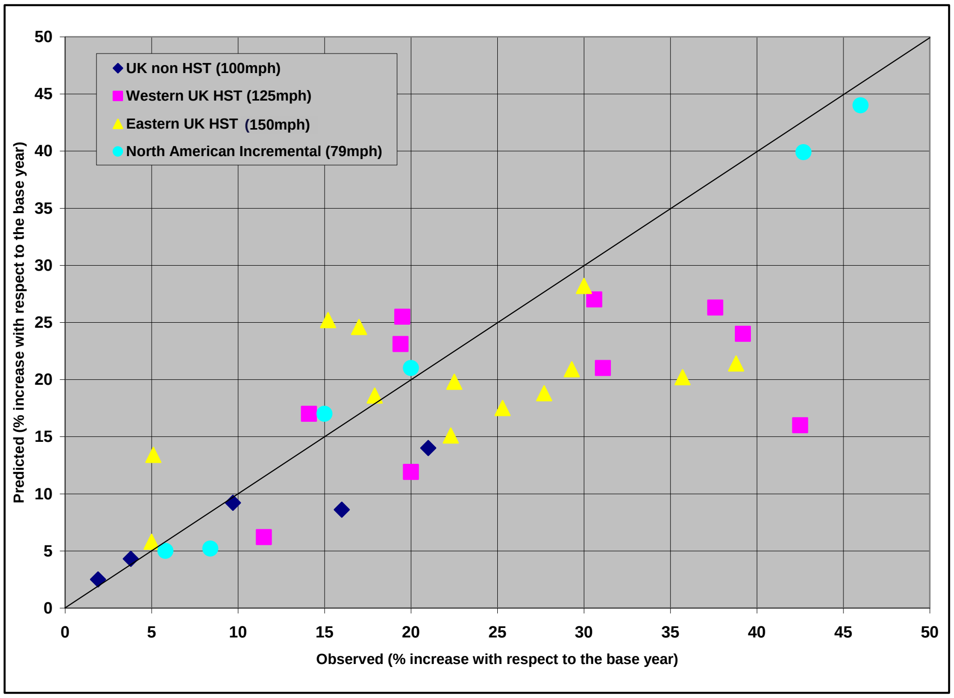


EXHIBIT 1: OBSERVED VS. PREDICTED IN TEMS' RAIL PROJECTS

Exhibit 2 shows the "Distribution of Forecast Error", all of which are within the 20 percent error range allowed by Investment Grade Forecasts.

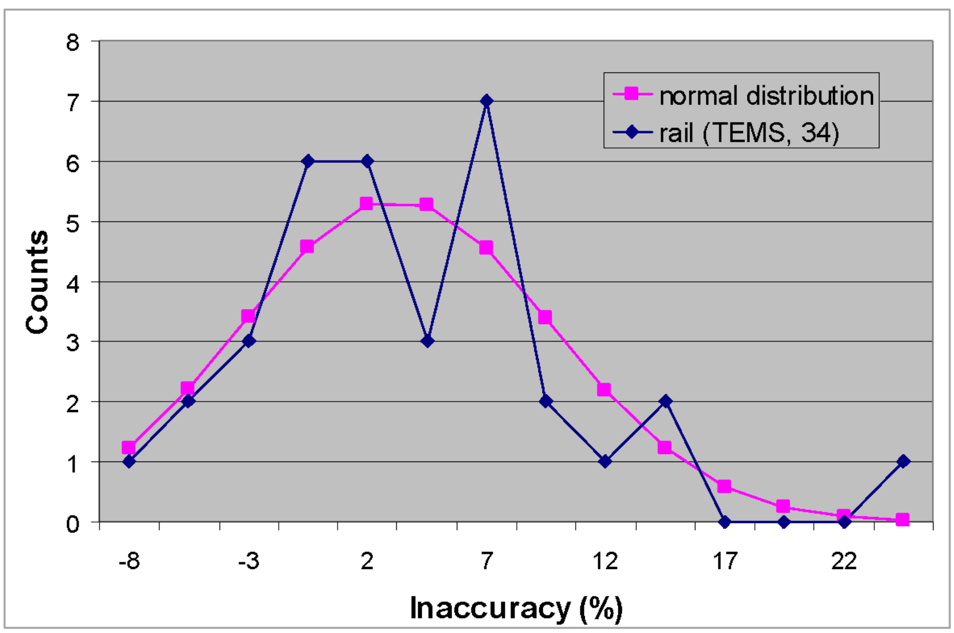


EXHIBIT 2: DISTRIBUTION OF TEMS' FORECAST ERROR FOR 34 PASSENGER RAIL STUDIES

Peer Panel Questions and Study Team Responses

Session 6: Freight Markets

1. How would the freight terminals be connected with hyperloop?

Response: In the short-term, express parcel, LTL freight terminals are clustered at urban gateways and airports. For this reason, Hyperloop can provide short connections to major terminal centers. For the long term, additional site-specific planning will be required, but it is likely that major Hyperloop terminals will be co-located with the first and last mile delivery terminals of the express parcel carriers (FedEx).

2. Characterize the Less than Truckload (LTL) and Air Cargo Markets.

Response: As shown in the Feasibility Study, LTL and Air Cargo operates through three distinct elements.

- Pick up – done by vans to bring goods to terminals
- Terminal to Terminal – movement done today by truck or air
- Delivery – done by vans from terminals

Hyperloop would compete for Terminal to Terminal movement only, not Door to Door Pick up or Delivery, which is done by vans. Terminals are clustered together at airports and urban gateways as shown in the Feasibility Study, see Exhibit 6-10, page 6-8. Exhibit 6-9 of the Feasibility report shows the typical networks used by express parcel carriers (i.e., FedEx, UPS, XPO, YRC, and ABF). It can be seen that first and last mile delivery is by van, terminal to terminal movements by truck and air. It is truck and air that hyperloop will compete against. Hyperloop is cost and time effective against air and truck competitors and will simply take market share from those modes in the express parcel markets.

3. What is the Value of Time for Parcels and Packages?

Response: In the Express Parcel market, people are clearly willing to pay money to have parcels and packages moved faster and quicker. The "Just-In-Time" supply chains that drive the supply of goods have done away with local warehousing in favor of an overnight delivery system (e.g., car parts, computer equipment, pharmaceuticals) which are all supplied by supply chains that pay premiums for fast delivery from national and regional warehousing, and repackaging facilities. Recent estimates from Stated Preference Surveys for Finished Goods and Express Parcels is $0.5 per ton per hour. See Great Lakes and St. Lawrence Seaway New Cargoes/New Vessels Market Assessment for USDOT [3], TEMS, Inc. and Rand Corporation.

4. In the Toll Road Corridor, how competitive is hyperloop?

Response: The express freight tonnage amounts in the corridor given in the Feasibility Study are from USDOT Freight Analysis Framework (FAF4). The tonnage is given as 1.72 million tons in 2012 growing

[3]Reference: Great Lakes and St. Lawrence Seaway New Cargoes/New Vessels Market Assessment Report for USDOT, TEMS/RAND Corp, 2007 see: https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB2009106672.xhtml

to 2.75 million tons in 2040. The value rises from $17.3 Billion in 2012 to $43.3 Billion in 2040, a 250 percent increase over 28 years. This is because the market is expanding so fast. The predicted hyperloop share is 28 percent of this market.

One of the advantages of the hyperloop service is that it can be competitive in corridors that are 300 to 1,000 miles in length. So, Amazon, FedEx and UPS can use them in a corridor like Pittsburgh to Chicago, without them needing to have a national network. First individual corridors are built and then expanded to a Regional network (e.g. Pittsburgh to Chicago), then Inter-regional (e.g. Chicago-New York), and finally a National network can be built.

5. Are the freight and passenger services compatible?

Response: Freight and passengers use the same capsules and can be run together. It may be that peak hours are largely passenger, with freight running at night, and both services offered during off-peak daytime.

6. What would be the impact of Driverless Trucks?

Response: The evaluation of future technology offerings such as driverless trucks was beyond the scope of this feasibility study. Research in this area is beginning and should be done so that a sensitivity analysis can be included in the Investment Grade Study.

7. What is the headway for freight?

Response: The headway for freight capsules is the same as for passenger capsules. However, freight may largely move during off peak periods, while passengers move during peak periods, but both can operate any time during the day or night.

8. Does the study propose a connection to Midway Airport in Chicago?

Response: The connection to Midway is for both passenger and freight service that can reduce short haul air service, and allow terminal gates to be used for long haul passenger service. Both passenger and freight terminals were proposed. Midway Airport is on the route to downtown Chicago. At the time O'Hare was being considered for a downtown connection. In the future O'Hare can be considered. O'Hare is strong for passenger traffic less strong for freight.

9. Given the changes in modal costs, what sensitivity are you doing for say Driverless trucks?

Response: A sensitivity and risk analysis will be completed as part of the Investment Grade Study, as suggested by Peer Review Panel.

10. Trucking is heavily subsidized in terms of infrastructure. Could hyperloop be equally subsidized?

Response: While the trucking industry is heavily subsidized with regard to highway maintenance costs, the evaluation of hyperloop for the Chicago-Cleveland-Pittsburgh corridor indicates that revenues would be sufficient to not require any operating subsidy from the government.

Peer Panel Questions and Study Team Responses

Session 7: Financial and Economic Benefit-Cost

1. Operating Ratio

Response: The Operating Ratio is the Net Present Value of the Revenues divided by the Net Present Value of the Operating Costs. See Report, Page 9-2. It should be noted that this is the operating ratio used for transit and passenger rail, which is different to that used by freight rail.

2. Revenue Sources

Response: Revenues include passenger fare box, freight revenues and net real estate revenues. The role of onboard advertising has not yet been defined. This should be considered in the Investment Grade Study, but considerable research is needed to establish the level and types of advertising.

3. Residual Value

Response: There is no need to exclude Residual Value from the analysis. However, it is still not yet defined exactly what the condition and materials would be after 25 years. This should be considered in the Investment Grade Study.

4. US Funding Support

Response: The project is proposed as a public-private partnership. The funding plan has not yet been developed but may seek to take advantage of USDOT funding programs like Transportation Infrastructure Finance and Innovation Act (TIFIA), Railroad Rehabilitation and Improvement Finance (RRIF), and Grant Anticipation Notes (GANS). TEMS uses the term funding to describe the raising of money and financing to describe the overall approach to overall program of cost and revenues that pay for the system.

5. User and Non-User Benefits

Response: USDOT has largely defined the User and Non-User benefits to be included in the Benefit-Cost Analysis e.g., Consumer Surplus Benefits includes benefits to users, but also benefits to highway and air users who face less traffic congestion and can drive faster. The SP Values of Time are used in the modeled Utility function (generalized cost) to identify the importance of time to different types of travelers.

6. Have Cash Flows been developed?

Response: Yes, the Cash Flows are developed. The sum of the cash flows appropriately discounted are given in exhibits 9.1 and 9.7. However, the annual Cash Flows and Economic Cost and Benefit Flows are proprietary.

7. Error Range

Response: For the Feasibility Study, we have an error range of ±30 to 40 percent and as such any benefit cost of greater than 1.3 – 1.4 is very significant and positive for the corridor and US economy. Our results show very significant net benefits at 3 percent discount and a breakeven to positive at 7 percent discount. The 7 percent discount rate itself is discriminatory and punitive, designed to eliminate weak projects. The interpretation at USDOT is to have a greater than 1.0 Benefit-Cost ratio, at a 7 percent discount rate. This is less punitive. This project is one of the very few really large projects that reaches comfortably both hurdle rates.

Peer Panel Questions and Study Team Responses

Session 8: Supply-Side Economic Analysis

1. Is the Transfer Payment Analysis not in the report?

Response: The Transfer Payment Analysis is given on pages 9-27 and 9-28 of the draft Feasibility Report. The analysis applied local, federal, and state rates to income and property values.

2. Accessibility

Response: This is defined in the same way as it is in the Travel Demand models. The definition is given as Generalized Cost. See page 4-8 of the Report.

3. Property Values

Response: The property values are provided by American Community Survey (ACS). The American Community Survey (ACS) is a continuous survey conducted by the U.S. Census Bureau which takes efforts in gathering information previously available only in the long form of the decennial census, such as income, employment, and property values. The U.S. Census Bureau sends surveys to almost 300,000 addresses monthly. TEMS used the ACS 2018 Data Releases that include the latest releases of the new 2014-2018 ACS 5-year Variance Replicate Estimates to get property values at census tract level. Then the property value data was aggregated to the TEMS zone level. Therefore, property value improvement can be estimated for each zone that is compatible with the COMPASS™ Ridership and Revenue Forecast Model.

4. Transit Oriented Development (TOD) Impact

Response: The TOD Impact Analysis for the corridor has been completed using the RENTS™ model. The model based on Prof. E. Mishan Cost Benefit book estimates the likely increase in economic wealth by assessing the likely increase in Economic Rent. Economic Rent is defined as the long-term increase in wealth (income, property values) due to the improvement in the economic productivity of the economy due to new investment in the factors of production. A key factor is transportation accessibility to markets. An investment in transportation systems improves market reach and accessibility. This results in increased economic performance and growth of regional and national gross domestic product (GDP). Hyperloop will provide such a transport improvement, particularly for the growth sectors of the New Economy such as Finance, Software, Health, Industry, Logistics, Consumer Products, Education, and Administration.

5. Station Property Values

Response: The values provided are theoretical and will vary with the proposed build out of the station. Perkins and Will proposals for Chicago could well give higher values, see page 9-41 of the draft Feasibility study. This is because the values we provide are for hyperloop alone and do not capture how the value can be impacted by local factors, amenities, location, and services (e.g., connecting transit). This local impact will be measured in future studies.

6. What percent of the tax base is for the station and lines themselves?

Response: The tax expansion identified is for the hyperloop system at a favorable location downtown and at airports. It is not broken down into component parts at this stage. That can be done for local station planning purposes, at a later date.

7. Do the system operating costs include property tax?

Response: The system has not included tax payments as that is not a USDOT requirement. They would be included in a Financial Prospectus for the Private Sector Financial Analysis. Property tax is a transfer payment and would be included in a private sector financing plan.

8. Calculation of Economic Rent Impacts

Response: Economic Rent Impacts are calculated by assessing how improved accessibility will increase economic value of assets. The methodology is described in the draft Feasibility Study on pages 9-21 to 9-23. Essentially the process identifies how much increase occurs from measuring the elasticity of accessibility on the economic rent factors (employment, income, property values) and then identifying how the improved transportation system reduces accessibility (generalized cost) to markets. Ideally future Economic Rent curves for 2030 to 2050 should be estimated, but that is complex as one moves from discussing 2019 dollars to 2030 or 2050 dollars that are not typically well understood. As such, the current estimate is conservative since it misses out on the economic growth from 2019 to 2030 and 2050.

9. How does the hyperloop impact different areas of cities?

Response: Hyperloop's impact depends on where it has its stations and terminals. We recognize that benefits will be different across the city as the Economic Rent curve forms a "Rent Tent" that is higher in some areas than others. The analysis to date has not estimated those "Rent Tents" but can do so for a more refined analysis of how each part of the city is impacted. The analysis can be done to a sector level or to a zone level. Typically, a sector level analysis is done.

10. Economic Rent of impacted industries (e.g., trucking)

Response: The Economic Rent analysis is an aggregate analysis showing overall level of benefit. As such, if there are negative impacts (e.g., lost trucking jobs) there is also a more positive impact that is greater to get the increase in Economic Rent.

In this case hyperloop is only absorbing the future growth of the express parcel markets so no existing jobs in trucking are lost. Hyperloop is absorbing the growth in the market and creating jobs (possibly with higher levels of productivity than existing trucking jobs) moving parcels and LTL by hyperloop.

11. Social Equity

Response: Social Equity has not been measured to date, but hyperloop serves both passenger and freight markets, so it creates benefits for high income and low-income workers. To measure Social Equity, an analysis of the distribution of benefits across different types of workers and the income ranges of workers is needed.

12. Loss of population, how does it get impacted by hyperloop?

Response: The Economic Rent Analysis allows the estimation of the likely changes in population, as well as employment over and above current trends. This will allow the analysis to show how hyperloop will improve the overall potential of population growth in the corridor cities.

13. What are the critical Risk Factors?

Response: The key planning risk factors that will need to be assessed include –

- Socioeconomic growth rates
- Energy prices
- Highway congestion
- Highway vehicle technology – driverless cars and electric trucks
- First mile/last mile assumptions for freight competition
- Climate Change
- Market Volatility

Current scope of work did not include Risk Analysis, but this could be added, rather than wait for Investment Grade Study.

14. How will hyperloop change land use?

Response: Hyperloop will strengthen regional and city to city ties. It can energize downtown areas in cities and expand airport and urban gateway freight growth. It will support the New Economy industries of Finance, Administration, Software, Computer, Logistics, Transportation, Warehousing, Health and Education. It will also create greater social and economic integration of the region as smaller cities integrate with larger cities through different land use patterns.

15. What role can onboard advertising play?

Response: While the financial model has not yet been developed, the potential exists for hyperloop to use its at seat video system to create a significant advertising revenue. This could be far greater than that used in high-speed trains, even trains like the London Heathrow Express service, which have video in each car.

This is outside the existing scope of work for the Feasibility Study and requires direct research into the level and value of advertising that might be developed.

16. Induced Demand

Response: Induced demand is relatively new in transportation planning as the early forecasting models (developed largely by engineers) such as BPR, used a fixed demand matrix and so had no induced demand. The advent of high-speed rail produced large induced demand impacts that were named “Nose Cone Effect”, and the BPR model simply could not model the impact. The development of the Discrete Choice models like COMPASS™, allowed induced demand that is really associated with a significant reduction in the time or price of travel to be modeled. It has now been successfully modeled for the last 30-years.