Transportation problem with current & future Transportation models

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Abstract: *The term 'operation research' was coined in 1940 by McCloskey and Trefthen in a small town of Bawdsey in England. It is a science that came into existence in a military context. During World War II, The military management of UK called on scientists from various disciplines and organized them into teams to assist it in solving strategic and tactical problems relating to air and land defense of the country. They were required to formulate specific proposals and plans for aiding the military commands to arrive at decisions on optimal utilization of scarce military resources and efforts and also to implement the decisions effectively. This new approach to the systematic and scientific study of the operations of the system was called operation research (OR). And they use many applications of OR. One of the most important successful applications of optimization is transportation problem (TP), which is a subclass of a linear programming (LP) in operation research (OR). Its goal to find shipping routes between supply and demand centers that will meet the demand for a given quantity of goods or services at each destination center while incurring the fewest transportation cost. In addition, we must know the costs that the result from transporting one unit of commodity from various origins to various destinations. By these transportation problem methods uses in the future trending transportation systems the following transportation methods are very accruing with optimum cost and optimum time. In new world time should be optimum and get good results by these innovative transport models.*

Introduction:

Transportation problem is a particular class of linear programming, which is associated with day-to-day activities in our real life and mainly deals with logistics. It helps in solving problems on distribution and transportation of resources from one place to another. The goods are transported from a set of sources (e.g., factory) to a set of destinations (e.g., warehouse) to meet the specific requirements. In other words, transportation problems deal with the transportation of a single product manufactured at different plants *(supply origins)* to a number of different warehouses *(demand destinations)*. The objective is to satisfy the demand at destinations from the supply constraints at the minimum transportation cost possible. To achieve this objective, we must know the quantity of available supplies and the quantities demanded. In addition, we must also know the location, to find the cost of transporting one unit of commodity from the place of origin to the destination. The model is useful for making strategic decisions involved in selecting optimum transportation routes so as to allocate the production of various plants to several warehouses or distribution centers. Suppose there are more than one centers, called **'origins'** , from where the goods need to be transported to more than one places called **'destinations'** and the costs of transporting or shipping from each of the origin to each of the destination being different and known. The problem is to transport the goods from various origins to different destinations in such a manner that the cost of shipping or transportation is minimum. Thus, the transportation problem is to transport various amounts of a single homogeneous commodity, which are initially stored at various origins, to different destinations in such a way that the transportation cost is minimum. The objective of the transportation model is to determine the amount to be shipped from each source to each destination so as to maintain the supply and demand requirements at the lowest transportation cost.

History of transportation problem:

The origin of transportation was first presented by F.L. Hitchcock in 1941. He presented a study entitled "The Distribution of a Product from Several sources to numerous Localities". This presentation is considered to be the first important contribution to the solution of transportation problems. In 1947 T.C. Koopmans presented in independent study, not related to Hitchcock's, and called "Optimum Utilization of the Transportation System". These two contributions helped in the development of transportation methods which involve a number of shipping sources and a number of destinations. The transportation problem, received this name because many of its applications involve determining how to optimally transport goods. Transportation networks are complex, large-scale systems, and come in a variety of forms, such as road, rail, air, and waterway networks. Transportation networks provide the foundation for the functioning of our economies and societies through the movement of people, goods, and services. From an economic perspective, the supply in such network systems is represented by the underlying network topology and the cost characteristics whereas the demand is represented by the users of the transportation system. An equilibrium occurs when the number of trips between an origin (e.g., residence/ place of employment) and destination (place of employment/ residence) equals the travel demand given by the market price, typically, represented by the travel time for the trips (Nagurney (2004)). The study of transportation networks and their efficient management dates to ancient times. It is known, for example, that Romans imposed controls over chariot traffic during different times of day in order to deal with the congestion (Banister and Button (1993)). From an economic perspective, some of the earliest contributions to the subject date to Kohl (1841) and to Pigou (1920), who considered a two-node, two-link transportation network, identified congestion as a problem, and recognized that distinct behavioral concepts regarding route selection may prevail (see also Knight (1924)). The formal study of transportation networks has challenged transportation scientists, economists, operations researchers, engineers, and physicists for reasons, including: the size and scope of the systems involved; the behavior of the users of the network which may vary according to the application setting, thereby leading to different optimality/ equilibrium concepts; distinct classes of users may perceive the cost of utilizing the network in an individual fashion, and congestion, which is playing an increasing role in numerous transportation networks.

Future transportation: These emerging technology trends will transform our roads and skies

What will the future of transportation look like? As technology advances, dramatic changes to urban transportation are coming to our roads and skies. While some of these ideas seem light-years away, such as flying taxis and pods that transport passengers at 350 miles per hour, many of these transformative ideas are already in design, in testing, or just a few regulatory steps away from reality.

As the transportation world evolves, we're faced with big questions. Who would be responsible for paying for a collision involving a driverless vehicles? Would it be the driver's vehicles insurance company or the manufacturer's insurance? As of now, vehicles companies have been footing the bill for crashes so research and development isn't slowed down, but that will likely change once driverless cars become mainstream.

Below, we look at these emerging technology trends and the societal changes they may bring. Jump to the infographic or take a deep dive into the issues these technologies are trying to solve by making transportation safer and more secure.

Key words: : Classical Transportation Problems, Maglev trains,Flying taxis,Driverless cars,Delivery drones,Underground roads,Hyperloop.

Classical Transportation Problem (CTP):

Many scientific disciplines, including operations research, economics, engineering, geographic information science, and geography, have contributed to the analysis of TPs. To proceed with a minimal total cost solution technique to the TP, an IFS is required. As a result, IFS serves as a foundation for a minimum total cost solution technique to this problem. When the cost coefficients, as well as the demand and supply quantities, are known, efficient algorithms for solving TPs have been developed. The mathematical model of the TP was provided by Hitchcock [1]. The stepping stone method, developed by Charnes and Cooper [2], provided an alternative method for determining the simplex method information. As for the primal simplex transportation method, Dantzig [3] applied the simplex method to TPs. In his book LP, Hadley [4] also included the transporta Upper bounded transportation problem. Several heuristic solutions approaches, such as Goyal's [5], looked into the IFS and degeneracy resolution in the TP. Arsha [6] studied a general TP algorithm of the Simplex type. Krzysztof Goczyla [7], a transportation network expert, spoke about optimal routing. For a specific TP, Adlakha and Kowalski [8] proposed an alternative solution algorithm based on absolute point theory. Sharma and Sharma [9] proposed a new dualbased procedure based on heuristics for the TP. In their Determination of Degeneracy in TPs, Sultan [10] and Goyal [11] Ekanayake [12] investigated the TP and maximum flows. Okunbor [86] employed goal programming to address TPs. Putcha [13] devised a method for arriving at an initial basic feasible solution for engineering optimization problems. Adlakha and Kowalski [14] proposed an analysis of alternate solutions for TPs. Immam et al. [15] used an Object-Oriented Model to solve the TP. For example, Klibi et al. [16], for example, looked into the stochastic multi-period location TP. Pandian and Natarajan [17] proposed a novel method for dealing with TPs and Ahamed et al. [18] proposed a new approach to solve TPs. Many heuristic solution techniques have been presented in the literature to obtain an IFS for the TP. The Northwest Corner Method and the Minimum Cost Method Taha [19] are well-known. Furthermore, Sharma and Prasad [20] presented a heuristic that provided a very efficient initial feasible solution to the proposed VAM-TOC approach. Because of the impracticality of performing enormous calculations in the northwest corner method, minimum cost method, row minimum cost method, column minimum cost method, and VAM for finding an IFS to the TP, Imam et al. [21] and Sen et al. [22] implemented them in C++. Kulkarni and Datar [23] created a heuristic-based algorithm to arrive at an initial feasible solution in order to obtain the modified unbalanced TP with a low total cost. Vasko and Storozhyshina [24] investigated the role of the dummy column (row) in the VAM, the Greedy heuristic [26], the Northwest Corner method, Pargar et al. [25] proposed a heuristic for obtaining an initial solution for the TP with experimental analysis, and Hillier and Lieberman [29] in solving unbalanced TPs. Shimshak et al. [27] and Balakrishnan [28] proposed changes to VAM in order to obtain preliminary solutions to the unbalanced TP. Schrenk et al. [30] investigated degeneracy characterizations for two classical problems: the transportation paradox in linear TPs and pure constant fixed charge TPs (there is no variable cost and the fixed charge is the same on all routes). In 2013 and 2014, Juman et al. proposed a sensitivity analysis and an implementation of the well-known Vogel's approximation method for solving an unbalanced transportation problem and a heuristic solution technique to achieve the minimal total cost bounds of transporting a homogeneous product with varying demands and supplies. Liu [31] investigated the TP with varying demands and supplies within their respective ranges. Following these variations, the minimal total cost was also varied within an interval. So he created a pair of mathematical programs in which at least one of the supply or demand variables changed to calculate the lower and upper bounds of the total transportation cost. Korukolu and Balli [32] proposed an improvement to the well-known VAM by accounting for total opportunity cost. Using computational experiments, they claimed that this improved VAM provided a more efficient and feasible initial solution to a large scale TP. Singh et al. [33] improved optimization and analysis of some variants through Vogel's approximation method [VAM]. To provide an initial feasible solution to the TP, Deshmukh [34] proposed a new method called the innovative method. However, among the existing heuristics for obtaining an IFS, VAM is one of the most efficient heuristics for TPs because it allows for a very good IFS (often an optimal solution). Furthermore, Sudhakar et al. [35] recently proposed a new approach for finding an optimal solution for TPs. Winston [36], Operations Research: Applications and Algorithms, Mathirajan, [37], Experimental analysis of some variants of Vogel's approximation method [38], Srinivasan and Thompson [39], The Red-Blue TP, and Cost Operator Algorithms for the TP. Adlakha [40] and Das et al. [41] investigated the Logical Development of Vogel's Approximation Method (LD-VAM): a method for determining a basic viable solution to the TP. Gen, at el. [42], Samuel [43], and Zangiabadi [44] proposed improvements and a new model for TPs with qualitative data, respectively. Gupta [45] investigated paradoxical situations in TPs, as well as the identification of vanishing variables in TPs and their potential applications. Mathirajan [46] also proposed an experimental analysis of some variants. Ramadan [47] and Ramadoss [48] proposed a hybrid two-stage algorithm for solving the TP and an evolutionary heuristic algorithm for solving the assignment problem, which Kowalski et al. [49] also investigated. Pradipkundu [50] investigated some solid transportation models with crisp and rough costs, while Aizemberg's [51] Formulations for a Problem of Petroleum Transportation investigated the initial basic feasible solution and the resolution of degeneracy in TPs. Arsham and Khan [52] investigated a Simplex-type algorithm for the general TP, while Kirca and Statir [67] proposed obtaining an initial solution to the TP. Bertsekas and Castanon [53] worked on an auction algorithm for the transportation problem. Kleinschmidt [54] suggested a strongly polynomial algorithm for

the transportation problem and Reinfeld and Vogel, Math [44], proposed mathematical programming. Ekanayake at el. [5,6] recently proposed using the Ant Colony algorithm (ACA) in the first stage to find an improved initial basic solution and an Effective Alternative New Approach in Solving TPs. Mathematical Model of the Transportation Problem: The TP can be formulated as an LP model and usually represented in a tabular form. Let us assume that in general that a particular product is manufactured in m production plants known as supply denoted by $S_1, S_2, S_3 \ldots\ldots S_n$ with respective capacities a,a,a,a…a and distributed to n distribution centers known as demands denoted by D,D,D…,D with respective demands b,b,b,….b Also, assume that the transportation cost from i^{th} supply to the j^{th} demand is C_{ij} (unit transportation cost) and the amount of product shipped is x_{ij} where i = 1, 2,..., m and j = 1, 2,..., n. The following table is known as the transportation cost:

Table 1. *Tran*

Supply / Demand	D_1	D_2
S_1	c_{11}	c_{12}
S_2	c_{21}	c_{22}
⋮	⋮	⋮
S_m	c_{m1}	c_{m2}
Demand	b_1	b_2

The mathematical model of TP can be formulated as given below:

Minimize $z = \sum_{i=1}^{m}\sum_{j=1}^{n} x_{i,j}c_{i,j}$ (Total transportation cost)

Subject to the constraints

$\sum_{j=1}^{n} x_{i,j} = a_i, i = 1,2,3\ldots m\ (supply\ constraints)$

$\sum_{j=1}^{n} x_{i,j} = b_j, j = 1,2,3\ldots m\ (demand\ constraints\ )$, and $x_{ij} \geq 0\ for\ all\ i = 1,2\ldots m\ and\ j = 1,2,..n$

In the above model, if the total supply is equal to total demand, then the TP is known as a balanced TP and otherwise, it is known as unbalanced TP. These balanced and unbalanced TPs can be mathematically stated as below $\sum_{i=1}^{m} a_i \sum_{j=1}^{n} b_j$ and $\sum_{i=1}^{m} a_i > \sum_{i=1}^{n} b_j\ or\ \sum_{i=1}^{m} a_i < \sum_{j=1}^{n} b_j$.

The future of transportation look like:

Innovations in transportation can lead to improvements in our lives by reducing stress, anxiety, costs, and death. Here are six transportation innovations that are already being engineered:

Maglev trains

These high-speed trains use magnetic levitation from powerful electromagnets to travel high speeds with less noise and vibration than traditional trains. They are also less likely to encounter delays due to weather and mechanics because of the dip in vibration and friction.

Because maglev trains are not powered by fossil fuels, they are better for the environment too. The "engine" is the magnetic field that is created by combining electrified coils in the guideway walls and the track, which causes the train to push forward.

As of 2018, there are six maglev lines operating for public use. All of these lines operate out of Asia but expect to see maglev trains expand into the U.S. as early as 2020. The first U.S. maglev train will connect Washington D.C. and Baltimore and then expand its route to New York.

Flying taxis

This aerial transportation method is already being prototyped by at least 20 companies. The flying taxis would move passengers above cities in small planes. The hope is that these flying taxis would provide safe, reasonably priced rides (such as $70 from Manhattan to Kennedy International Airport) that aren't a nuisance to people on the ground below.

The biggest challenges facing flying taxis are the costs and regulations. Building safe, durable aircraft at a reasonable cost isn't possible given the market trends as they are now and a long regulatory process still awaits with the Federal Aviation Authority.

Driverless cars

Currently in testing phases, the future of driverless cars seems inevitable despite some consumer hesitation. The pushback comes from questions around safety and regulations. Tesla's autopilot system is already live but it has had several accidents reported, although Tesla has stated that "crash-like events" are still way more likely with the autopilot disengaged. Audi, Uber, and Volkswagen are also on the road and making headlines for their driverless vehicles.

Distracted driving is a leading cause of death on U.S. roads, and driverless cars hope to eliminate this entirely by using robots rather than humans to operate vehicles. Driverless cars will also be designed to take less risks and reduce speeding incidents. But these cars come with a hefty price tag – the anticipated costs exceed $100,000. Some other setbacks include privacy concerns, ethical questions, legal ramifications, and more.

Delivery drones

The first UPS drone delivered prescription medications to U.S. homes in October after receiving certifications from the Federal Aviation Administration. This is the fewest restrictions delivery drones have received to date, which means that the FAA is likely warming up to the idea of full-scale commercial deliveries.

While the technology is already here, drones still have a way to go in terms of regulatory phases before they are rolled out for full-scale commercial delivery. Currently, UPS is limited to delivery in rural areas and hospital campuses. Since drones do pose a risk to life and property, they will need to prove long-term reliability before they become "type certified" by the FAA and similar international regulators.

Underground roads

Elon Musk is reimagining traditional road design with his idea of underground roadways. This futuristic vision aims to solve city infrastructure issues by making roads 3D. Musk believes taking cars underground — which he believes is more weather-proof than taking cars to the skies — will alleviate congestion and speed up transportation.

The Boring Company is working on figuring out how to create a system of tunnels that will be needed to support the underground roadways. The plan is to lower cars underground via a metal elevator and then transport them at high speeds to other destinations. The underground tunnel will run on a metal trolley-like platform that Musk hopes is both cost-effective and quick.

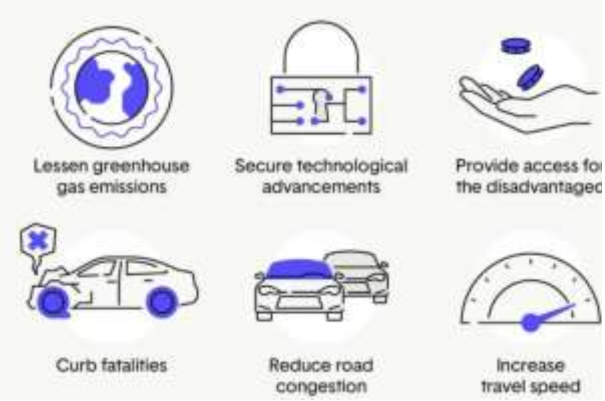
Hyperloop

Elon Musk conceived another transportation concept called hyperloop, which is a transportation tube that would run groups of passengers or freight through a pressurized track. The hyperloop would run at a high speed of 600 mph or more.

Multiple companies are working to bring this vision to reality, and we could be seeing passenger service hyperloops as early as 2021.

Ttransportation evolving?

Humanitarian challenges and advances in technology are leading a wave of transportation innovation across the globe. Issues such as overcrowding, climate change, and wealth inequality make these advancements especially attractive to cities and companies, despite the many regulatory and logistical challenges these new ideas bring to the table.



Here are some of the issues the future of transportation hopes to tackle:

- **Greenhouse gas emissions**. The transportation industry is betting on climate change and its role in a changing world. Expect engineers to emphasize cleaner solutions that limit carbon emissions and gasoline, instead utilizing renewable energy alternatives.

- **Preventable fatalities**. Annually, nearly 37,133 people die in car crashes in the U.S. Speeding and distracted driving play a major role in these crashes. New technology hopes to devise safer ways for drivers to travel.

- **Road congestion**. Many cities have already maxed out their infrastructure. Transportation technology looks to reduce congestion by looking for alternatives to traditional roads.

- **Security**. With new technologies come new security risks. Creators will have to learn how new technology, such as flying drones, can not only be invented but secure from hackers. Because terrorists have targeted transportation vessels, the security risk is especially great.

- **Poverty**. Affordable transportation technology that is eco-friendly and inventive will be necessary to address income equality throughout the world. Whether someone makes $10,000 or $200,000, they still need to be able to get to work efficiently and safely.

- **Speed**. The amount of time spent commuting — due to miles traveled or traffic congestion — comprise years of our lives that could be put to more productive use. Transportation technology hopes to make travel quicker and more efficient by traveling at high speeds.

Top 10 Transportation Trends & Innovations in 2023

1. Autonomous Vehicles:

Transport vehicles account for significant pollution and traffic congestion, especially in big cities. One solution to these issues is the adoption of autonomous vehicles and systems. Self-driving cars use sensors, LIDAR, and automated safety features to navigate roads. They deploy camera technology to read road signs and see in high resolution. AI algorithms recognize objects on roads, guiding the vehicles on how to perceive their environment. Autonomous vehicles increase road safety and reduce harmful emissions. Another major transportation trend includes the commercialization of delivery drones, which are useful to transport medical supplies, food packets, and more, directly to even remote locations. Robotic or drone deliveries also assist the elderly and enable rapid emergency response. Further, driverless trucks bring greater efficiency to the trucking market and directly address driver shortage challenges.

Minus Zero manufactures Self-driving Cars

Indian startup Minus Zero develops fully autonomous cars for tricky roads. It uses nature-inspired AI algorithms for image recognition on roads. The algorithms predict the behavior of surrounding objects in real-time and accordingly plan suitable routes. Intuitive decision-making ensures vehicular safety and reduces accidents due to negligence. Further, the startup deploys computer vision for object detection instead of expensive LIDARs. This makes the vehicle more economical and allows higher frame rates for faster perception. Moreover, its driverless technology does not rely on lane marking for road mapping, ensuring accurate detentions even on poor road infrastructure.

NuPort Robotics develops Autonomous Trucks

Canadian startup NuPort Robotics automates trucking via its proprietary navigation system. It equips trucks with high-tech sensors that prevent accidents and enable fuel monitoring. The retrofit robot-as-a-service (RaaS) system enables truck automation for middle-mile transportation. It incorporates an autopilot feature for conventional trucks, which increases driver and vehicle safety on roads. The startup's technology enables the autonomy of level four and level five, allowing the movement of trucks between distribution centers and warehouses.

2. Green Energy

Green energy in transport includes all transport modes, alternative fuels, and technologies that reduce the negative impact on the environment. Eco-friendly vessels have precedence over conventional vessels because of reduced emissions of greenhouse gases. Ships are incorporated with energy-efficient propulsion systems and a streamlined hull design to reduce friction during navigation. Further, alternative fuels such as hydrogen, liquefied gas, synthetic fuels, and more, are used in marine and aerial transport to reduce harmful emissions and pollution. Moreover, electric vehicles transport goods in a sustainable mode without requiring any fuel. Trains also provide a green alternative by carrying huge volumes of goods over long distances, thereby reducing the number of vehicles on the road.

Unleash Future Boats designs Zero Emission Electric Catamarans

German startup Unleash Future Boats develops *CargoOne*, a zero-emission electric truck on water. The truck solves the problems of transport with low water levels and allows the transportation of large quantities of goods without harmful emissions. CargoOne allows digital communication not only between boats, but also between the land and water infrastructure. It automatically loads products on docks, which eases operations and improves efficiency. Further, the startup builds FutureOne, an electric boat for the transport of people and products. It is powered by green hydrogen and fuel cell technology. Using such fuel alternatives, Unleash ensures sustainability by eliminating the emissions of polluting gases for maritime vessels.

Tracks offers a Carbon Visibility Platform

German startup Tracks offers digital tracking of vehicular fuel consumption using AI. It creates a digital twin of trucks that analyzes and predicts their fuel consumption. It ensures accuracy while calculating emissions by tracking consumption-based data directly from the transport vehicle. Accurate predictions facilitate effective decarbonization in freight, dispatch, and procurement. Moreover, it measures Scope 3 emissions, which are a business's indirect emissions such as those from suppliers or business trips. These contribute to the majority of a business's carbon footprint but are difficult to measure. This way, the startup ensures carbon visibility in the supply chain.

3. Electric Transportation

Large-scale electrification is a major trend in the transportation industry. Electric vehicles (EVs) emit fewer greenhouse gases (GHGs) and air pollutants as compared to petrol or diesel cars. As EVs require electricity to recharge batteries, they eliminate dependence on conventional fossil fuels. Moreover, EVs offer better performance due to electric motor efficiency with less noise production. With the increased adoption of electric cars, startups work on improving the charging infrastructure. Vehicle-to-grid (V2G), fast-charging, mobile charging, new battery innovations, and many more such solutions facilitate wider acceptance of EVs in everyday commute and delivery operations. Air transport also witnesses an increase in electrification via electric vertical take-off and landing (eVTOL) aircraft, electric air taxis, and drones. Startups are working towards reducing the negative impact of air travel on the environment.

Faction builds Autonomous Electric Vehicles

US-based startup Faction makes driverless electric vehicles for micro-delivery and micro-mobility. Its EVs are compact, making them suitable for traffic-congested urban roads. Their small size not only makes them more economical but also reduces emissions and energy consumption. It also enables riders to drop off where needed without having to worry about parking space availability. Moreover, Faction utilizes clean energy for manufacturing, thereby adding to sustainability.

Infinite Mobility makes Solar-powered Electric Vehicles

Norwegian startup Infinite Mobility manufactures solar-powered electric vehicles for urban mobility and last-mile delivery. It designs right-sized vehicles to tackle traffic congestion. It ensures a minimal space footprint and offers a sustainable alternative to larger vehicles that cause excessive noise and air pollution. The vehicle's body is integrated with solar photovoltaic cells that generate electricity to power the EV. The EV also enables charging when stuck in traffic, thereby enhancing passenger convenience.

4. Artificial Intelligence

Artificial intelligence makes transportation more efficient by predicting delays in traffic flows. AI algorithms enable object detection and recognition for the navigation of autonomous vehicles. Machine learning is utilized in driver behavior analysis to determine driver drowsiness and improve road safety. AI-powered route optimization speeds up the delivery of goods. It digitally matches the demand and supply of stocks, thus automating freight operations. It also reduces traffic congestion and accidents. In the shipping industry, AI improves navigation safety and facilitates autonomous vessels. Additionally, it ensures the safety of commodities via real-time tracking and theft detection.

Coros enables AI-powered Cargo Tracking

US-based startup Coros tracks cargo based on AI. It deploys advanced optics and computer vision to facilitate visibility in cargo transport. It automates cargo scanning for easy and hands-free operations. Based on machine learning algorithms, it alerts operators in case of misloads and logistical errors. This way, the startup prevents late deliveries and loss of packages. It also leverages AI to audit warehouse facility plans, thus giving a comprehensive evaluation of the facility's assets.

Trucksters optimizes Trucking via AI

Spanish startup Trucksters provides an AI-based long-distance full truckload (FTL) transport service. It equips FTL trucks with sensors for real-time monitoring and visibility. Based on its proprietary relay system, the startup reduces the transit time of fleet transport. Its AI-powered technology identifies and plans safer routes for trucks. It also interchanges truck heads in a way that allows drivers to sleep comfortably at home, instead of in trucks. This improves the work safety and quality for the driver. The startup also reduces carbon emissions and operational costs.

5. Internet of Things

The Internet of things (IoT) makes the transportation industry smarter. IoT, along with embedded sensors, gathers vehicular data to track the condition or performance of transport vehicles. IoT devices in traffic congestion systems predict and redirect vehicles to alternate faster routes, speeding up the delivery. This reduces congestion resulting in less energy consumption. Moreover, the use of IoT in vehicles allows monitoring of fuel levels, driver safety, vehicular health, and more. Connected cars impose speed limits depending upon the nature of the traffic, which assists in preventing accidents. This ensures a smooth flow of transport vehicles and improved road safety.

Eranext develops a Fleet Telematics Device

Indian startup Eranext develops a telematics device for fleet vehicles. The device diagnoses engine and vehicular health for predictive maintenance. It provides real-time updates of the temperature, speed, and fuel levels of the vehicle. This enables cost analysis and resource optimization. The solution uses machine learning to monitor driver behavior and detect accidents. Additionally, it provides a prior intimation of traffic conditions and plans routes accordingly to ensure vehicular safety on roads.

Soar Robotics advances Vehicular Connectivity

US-based startup Soar Robotics builds vehicle-to-everything (V2X) connectivity technology for autonomous vehicles and robots. It works on an AI-enabled cellular modem that is integrable into the existing vehicular communication infrastructure.

Using deep neural networking, the startup enables vehicles to connect to other vehicles via vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-network (V2N), and more. It also facilitates integration with various protocols such as 4G, 5G, wi-fi, or LTE. This optimizes latency, throughput, range, and reliability of the connected network. Another solution, nodeConnect, simulates the performance of wireless networks to determine the coverage and capacity needs of vehicles on the road, ensuring the safe operation of autonomous vehicles.

6. Mobility as a Service

Like other industries, the transportation industry is also working towards improving consumer comfort and convenience. The use of mobility-as-a-service (MaaS) ensures an on-demand provision of transport services. It consolidates different digital channels to enable users to plan and book for multiple modes of mobility through a single platform. It simplifies payments by offering a subscription model and pay-as-you-go model. Moreover, MaaS facilitates users to combine public and private transportation, thereby giving them the flexibility to choose optimum transport modes. It discourages private ownership of vehicles by offering services like carpooling, on-demand cabs, bookable intercity travel, and more. Fewer vehicles on roads cause lesser emissions, lesser pollution, and reduced accidents.

7. Blockchain

Blockchain is still a developing technology that improves visibility in the transport sector. It allows real-time asset tracking for precise planning of operations. Its decentralized structure enables transparency and prevents deceitful transactions from taking place. Block chain-based smart contracts facilitate the successful exchange and settlement of goods. Moreover, blockchain ensures payment safety. Besides, it efficiently integrates various documents involved in the transport or logistics processes.

ChainGO Tech empowers Block chain-based freight

Spanish startup ChainGO Tech creates block chain-based software for inter modal freight transportation. The software collects necessary logistical documents in one place. It automates documentation using optical character recognition (OCR) technology, which in turn reduces time delays and errors. Furthermore, blockchain technology introduces transaction transparency and document immutability. This ensures the document's safety for accurate transport operations. The collaborative structure of the software also improves information flow between stakeholders.

8. Transportation Management Systems

Goods transportation has planning and execution challenges. A transport management system (TMS) helps businesses save time by automating workflows and optimizing asset utilization. It offers solutions for moving all sizes of freight in various modes, including intermodal and international routes. TMS allows real-time tracking of drivers, goods, and inventory to enable visibility in the supply chain and address inefficiencies. Moreover, a TMS provides analytic s and data insights that enable cutting unnecessary expenses. Another trending software is the fleet management system (FMS). FMS enables remote monitoring and control of fleet vehicles, allowing fleet operators to ensure the right protocols are being followed in the delivery operations.

ASIA ONE TMS provides Transport Management Software

Malaysian startup ASIA ONE TMS (AoT) provides a transport management system to digitalize transport operations by enabling current trucks and drivers' status visibility and pickup, shipment, and real-time delivery status tracking using loading and unloading times. AoT's software includes the electronic proof of delivery (e-POD) feature optimizes on-site efficiency by reducing paperwork and improving data accuracy and customer communication. The startup's TMS analyzes costs incurred in bookings, trips, or assignment of drivers, and suggests methods of cost optimization. This allows businesses to plan their expenses in a budget-friendly manner.

Track stride creates Fleet Management System

UK-based startup Trackstride offers fleet management software. It tracks the fleet in real-time to provide insights into the route operations, driver behavior, and idle time. These metrics allow users to determine the efficiency of their fleet and plan operational strategy. The platform alerts in case of inadequate engine performance and oil temperature fluctuations for timely remediation. It also allows fleet owners to define vehicle routes and notifies them if the vehicle goes off track. This way, they have full control over the fleet, giving them more time to focus on other important aspects of the business.

9. Smart Shipping

The shipping industry has safety challenges, ranging from avoidable human errors to unavoidable natural hazards. The emergence of unmanned or low-manned smart ships has reduced the number of people at risk at sea. Smart shipping automates ship operations, ensures crew safety, and increases fuel efficiency by providing greater insights into ship performance. It incorporates advanced digital sensors to navigate ships accurately while adapting the speed with respect to the water flow. Moreover, automated shipping reduces labor costs and errors for improved efficiency.

NepTech facilitates Autonomous Vessel Navigation

French startup NepTech designs autonomous catamarans for carrying passengers and freight. It enables zero-emission propulsion by replacing diesel-powered vessels with polymer electrolyte membrane (PEM) hydrogen fuel cells. It uses an air injection system optimized by computational fluid dynamics (CFD) in its catamarans, which reduces friction while navigating. The ship's design includes hydrofoils and an innovative hull shape that lowers the hydrodynamics drag in the water. The startup also incorporates recyclable and bio-sourced materials in manufacturing to address sustainability concerns. These features, together, minimize ship fuel consumption and thereby lowers maritime transport costs.

10. Last-mile Delivery

Last-mile delivery, also known as last-mile logistics, comprises all operations required to move goods to the end consumer. With the widespread use of e-commerce platforms, delivery services are improving day by day. Startups develop innovative last-mile delivery solutions to transport an item to its recipient in the quickest way possible. Advances in analytic s and GPS track shipments in real-time to update the order status to stakeholders. Autonomous drones deliver products quickly to any location and are increasingly deployed to deliver medicines and grocery items. Robots automate the delivery and provide a way for contact less transport of products. They also reduce GHG emissions and pollution, thus offering a sustainable alternative to delivery vehicles.

BringAuto enables Robotic Delivery

Czech startup BringAuto makes a last-mile delivery autonomous robot. The robot optimizes routes for faster deliveries and notifies customers of the expected arrival time. It continuously navigates from one address to another to improve time efficiency during the delivery process. Being autonomous, it ensures contactless and safer delivery. Moreover, it is electric, ensuring emission-free transportation. The startup also enables real-time tracking of the shipment via its mobile app for customer satisfaction.

Carriyo innovates Retail Last-mile Operations

UAE-based startup Carriyo automates last-mile delivery operations for retail brands. The startup's solution collects the order information via the brand's e-commerce or online platforms. It then assigns shipments to the available carrier after verifying delivery addresses. It automates tasks like bulk label generation and printing for faster operations. Moreover, it tracks the shipments in real-time to offer order visibility, which enables brands to predict delays and plan necessary actions. This way, the startup facilitates retail brands to increase customer satisfaction and retention.

Discover all Transportation Trends, Technologies & Startups

Transportation, being one of the largest existing industries, is experiencing disruptive technological advancements. The transition to fully autonomous vehicles and ships has already begun and will dominantly prevail in the near future. Apart from autonomous navigation, autonomous transport operations are replacing manual handling to improve efficiency and reduce errors. The industry witnesses widespread adoption of technologies like AI, IoT, and blockchain. Businesses also pay attention to sustainability factors by designing zero-emission vehicles and processes.

The Transportation Trends & Startups outlined in this report only scratch the surface of trends that we identified during our data-driven innovation and startup scouting process. Among others, autonomous vehicles, connected vehicles, and electric mobility will transform the sector as we know it today. Identifying new opportunities and emerging technologies to implement into your business goes a long way in gaining a competitive advantage. Get in touch to easily and exhaustively scout startups, technologies & trends that matter to you!

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