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Intelligent Transportation System (ITS)

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Abstract:- The research efforts focused on enhancing transportation systems have revealed numerous possibilities for improvement. However, there are still unexplored avenues in terms of implementing software or automation within the transportation system. Automation in transportation could refer a feasible solution to reduce accident and save human lives. Consequently, ensuring safer journey for passengers remains a primary objective for transportation companies. Findings revealed that population of Nigerian is figured to be at about 225.604 million and GDP of $493.50 billion in present years. The country is blessed with a lot of mineral resources and also being one among the six largest producer of oil. Nigeria is also refer to as biggest in Africa with evidence of Oil and Gas reserves worth 37.12 billion barrels and 207.0 Trillion cubic feet. It also seated on over 922 square kilometers in land size and large deposit of hidden mineral resources.

However, it is alarming and disturbing why my country is lacking modern transportation system technology, which can boost our economy and bring relief to our people. The city of Abuja and other states cannot fulfill its essence without making provision of new system solution for transportation. Influence of technology on transportation management, the system encompass a productive group of automation with potential to enhance the management of transportation systems, public transit and various aspect of travel decisions. This technology include cutting-edge technology receivers and automated solutions, all designed to boost the welfare in Transportation System. While decision using less energy is not the central focus of ITS.

- ***Project Title***

Progress in Intelligent Transportation Systems: Investigation of ITS Keywords: Intelligent Transportation System (ITS), communal details, transportation, Swift bus fleet, environmentally conscious driving, efficient routing for fuel economy, digital toll gathering, human aspects, managing incidents, services with shared vehicles, shared transport, management of traffic and transit, interconnected vehicles, self-driving vehicles SUMMARY (maximum 100 words):

- ***Intelligent Transportation System (ITS)***

Encompass an assortment of new innovation intended to enrich the management of transportation systems, public transit, and individual travel decisions. These technologies, encompassing state-of-the-art wireless, electronic, and mechanized solutions, strive to enhance safety, efficiency, and convenience in terrestrial transportation. While energy preservation isn't the principal focus of ITS, certain circumstances showcase its energy-related advantages. This article delivers a comprehensive outline of crucial energy-related benefits associated with varied ITS technologies, drawing from models, preliminary programs/field trials, and comprehensive deployments.

I. INTRODUCTION

The inception of ITS in 1991 marked a significant milestone in improving transportation efficiency. The multifaceted capabilities of ITS include managing traffic centers, regulating traffic signals, providing travelers documents, overseeing communal vehicle operations, advancing transportation systems that are public enabling electronically, fees are collected, also, facilitating ridesharing and car sharing services.

Public Transportation system is best (Observed) described as means or medium by which movement of goods in large or small quantity is achieved by means of transportation and economical way. It enables consumer to access goods and services through the aid of different alternative means, such as train system, commercial buses and subways. Intelligent Transportation system, is a tool that aid easy flow due electronic configuration and data base management.

I. Presentation of ITS II. Defining Intelligent Transportation Systems (ITS) III. Evaluation of Energy Impact of ITS IV. Predicted and Observed Results V. Integration within the System and Concluding Remarks VI. Bibliography.

GLOSSARY Active Transportation and Demand Management (ATDM): ATDM constitutes a strategy for operational enhancement in transportation, aiming to bolster reliability, efficiency, and safety. It encompasses Active Traffic Management, Active Demand Management, and Active Parking Management. ATDM leverages varied sources of information and methods of dissemination to elevate travel experiences and minimize delays. The outcome of increased throughput and decreased delays directly contributes to heightened energy efficiency and the promotion of a more streamlined mode of travel.

Bus Rapid Transit (BRT): BRT is designed to amplify bus services by reducing travel time and furnishing enhanced rider information. Strategies such as designated rights-of-way, bus lanes, optimized stop placements, wider entrances, pre-boarding payments, and supportive land-use regulations contribute to BRT enhancements. BRT also relies on ITS technologies like automatic vehicle location (AVL) a computer-based real-time vehicle tracking system using global positioning systems and radio frequency communications. Additional improvements to BRT services are realized through signal management and prioritization, smart card fare collection, and real-time bus status data.

Commercial Vehicle Operations (CVO): Commercial vehicle operations entail the use of electronic and wireless ITS technologies to address various challenges in the trucking sector. CVO approaches encompass electronic clearance and manifesting for efficient border crossings and safety, AVL, communication between vehicles and fleet management centers, on-board safety diagnostics for more effective roadside inspections, and responding to incidents involving hazardous materials.

Connected Vehicle: Connected vehicles employ multiple wireless technologies to communicate with other vehicles, infrastructure, and the Internet/cloud computing resources. Connected vehicles encompass autonomous and non-autonomous technologies that can enhance safety, fuel efficiency, and mobility by providing real-time connectivity across the transportation network.

Eco driving: Eco driving refers to behavioral adjustments made by drivers to enhance fuel economy. Static Eco driving involves practices like ensuring proper maintenance of inflated tires, by removing excessive weight on the vehicle, and avoiding idling. Dynamic Eco driving employs real-time feedback to inform drivers about vehicle performance.

Eco-routing: Eco-routing is a modern technics aiding and enabling drivers in fuel economy idea, to enable them passes through a short distance route, in traffic congested area. By the technic, easy route, less traffic and fuel saving is achieved.

Electronic Toll Collection (ETC): ETC are modern technics which enable vehicle's payment at the tolls. By this, an electronic devices are mounted at a designated on the road, which charged by the weight of the moving vehicle. A radio system often mounted on the windshield. Toll tag transponders transmit signal to radio frequencies to the reader, this enable automatically deduction of the charges. ETC also make use of the license number plate at a glance to register the vehicle.

Incident Management (IM): This are traffic surveillance innovation of radar and image dictator which aid in incident detection, clearance, and traveler information. Incident management includes traffic surveillance, emergency response coordination, and optimizing traffic signals for emergency vehicles.

In Intelligent Transportation Systems: ITS encompass a broad array of innovation such as computers, data processing, Bluetooth, communications, wifi and control system, all targeting at enhancing security on commuter, road users and efficient rendered services.

ITS User Services: ITS user services classify technologies from the user's viewpoint, addressing needs like route guidance and electronic payment.

Ramp Metering: Ramp meters are traffic signals at freeway on-ramps controlling the rate of vehicles entering the freeway to optimize flow and minimize congestion.

Shared Mobility: Shared mobility services provide short-term vehicle access without ownership costs. This includes car sharing, public bike sharing, ridesharing, and for-hire vehicle services.

Smart Parking Management: Smart parking management employs information technology and wireless communications to relay parking availability to drivers and may include dynamic pricing.

Traffic Signal Control: Traffic signal controls integrate freeway and surface street systems for improved traffic flow and safety, including priority services for transit.

Traffic Management and Surveillance: ITS-based traffic management includes incident management, ramp metering, traffic signal control, traveler information, and traffic surveillance, which employs various tools for roadway management.

Transportation Management Center (TMC): A hub for amalgamating and distributing transportation data, the Transportation Management Center (TMC) oversees the transportation network, including emergencies and incidents, while also offering traveler information.

The TMC relies on diverse ITS tools like electronic toll collection, radar, closed circuit video equipment, and loop detectors to gather data.

➢ *Transit Management*

Transit management comprises four essential domains:

- Tracking transit vehicles
- Managing fare payments
- Providing traveler information
- Offering personalized public transportation options.

✓ Tracking transit vehicles involves vehicle communication with transit centers. AVL systems, GPS, and radio frequency communication aid in scheduling and vehicle tracking.
✓ Fare payment involves electronic methods to facilitate cashless operations, reducing boarding times and fare handling.
✓ Transit traveler information is provided through vehicle tracking, the Internet, and changeable message signs at transit stops. Personalized public transportation includes

on-demand services like dial-a-ride, taxi, shuttle, and short-term vehicle access.

- ✓ Traveler Information: ITS-based traveler information systems utilize traffic surveillance and transit management systems to collect, process, and disseminate real-time travel information. The aim is to offer the public information on available modes, optimal routes, and costs in real time via in vehicle systems and signs.

Vehicle Control Technologies for Public Transit: Advanced sensing, communication, and computing technologies in ITS can prevent collisions, reduce injuries, and potentially lead to full vehicle automation. Existing technologies include adaptive cruise control, anti-lock brakes, and electronic system malfunction indicators.

II. PRESENTATION

Energy consumption in the transportation sector has shown a consistent upward trajectory, projected to continue. Data from the International Energy Agency (2015) indicates that between 1973 and 2013, the transportation sector's share of global oil consumption rose from 45.4% to 63.8%. Similarly, natural gas consumption in transportation increased from 2.7% to 6.9%, while electricity consumption decreased from 2.4% to 1.5%. Forecasts by Dulac (2012) suggest that without energy-efficient policies, alternative fuels, and mode shifts, transportation energy use could surge by up to 70% by 2050. Dulac emphasizes that this growth would primarily originate from light-duty passenger vehicles in developing nations.

The World Energy Council (2011) anticipates a potential rise of up to 430% in the number of cars in developing countries from 2010 to 2050. While this growth signifies progress, mobility improvement, and better quality of life, it underscores the need for alternative fuels, modes, and enhanced system efficiency. This article explores how Intelligent Transportation Systems (ITS), encompassing Advanced Transportation and Demand Management (ATDM), Advanced Traffic Management (ATMS), Advanced Traveler Information (ATIS), and Advanced Vehicle Control and Safety (AVCSS), could enhance system efficiency. ITS employs modern wireless, electronic, and automated technologies to elevate safety, efficiency, and convenience in surface transportation. These technologies have the potential to integrate vehicles, users, and infrastructure.

ITS encompasses precision docking for buses, automated guide ways, collision avoidance systems, and real-time driver information for efficiency and current roadway conditions. Various ITS technologies contribute to trip optimization, congestion reduction, alternative mode promotion, fuel consumption decrease, and air quality improvement. Integrating ITS into system management and vehicle design can further reduce fuel consumption.

Numerous ITS technologies have already showcased the potential to reduce energy consumption.

Over the last decade, there has been an examination of the impact of various ITS technologies on fuel consumption, including:

- Regulation of traffic signals
- Oversight and monitoring of traffic (e.g., ramp metering)
- Management of incidents
- Implementation of toll collection electronically
- Influence on behavior of drivers (e.g., eco-driving and eco-routing)
- Provision of commuter’s information and network behaviors
- Implementation of smart street parking management
- Administration of public transit (e.g., bus rapid transit)
- Operations concerning commercial vehicles
- Integration of vehicle system control technologies
- Shared transportation (such as car sharing and public bike sharing) Human factors also exert a significant influence on the energy implications of ITS, influenced by factors like latent demand and price responses.

While this analysis addresses these aspects, it's important to recognize that the broader impacts and unintended consequences of ITS technologies are not yet comprehensively understood. This article examines the realm of intelligent transportation systems, their energy effects, measurement methodologies, and documented outcomes.

III. DEFINITION OF INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

The concept of Intelligent Transportation Systems emerged in 1991 when transportation experts identified the potential of electronic technologies to optimize surface transportation. This recognition led to the inception of the U.S. Congress' national ITS program. Subsequently, significant advancements in computer, communication, and sensor technologies have given rise to ITS technologies across global highway and public transit systems. The deployment of ITS unfolds in three stages: • Stage One: Testing and Implementing Early ITS Technologies (foundation) • Stage Two: Linking Early ITS Technologies • Stage Three: Developing an Integrated System of ITS Technologies The initial stage largely involves the public sector's research and development of early ITS technologies to enhance conventional operations. This phase has yielded achievements like traffic management centers, traffic signal control, enhanced traveler information, toll collection electronically, satellite distributing systems in public transit, in-vehicle navigation systems, eco-driving and eco-routing, ridesharing services, car sharing, and public bike sharing. Stage Two involves the interconnection of these early ITS technologies and is an ongoing process. Efforts are directed toward integrating ITS with conventional capital improvement projects, fostering a customer centric approach by offering technology and service packages. This phase involves improvements in public transportation systems, coordination among different freight modes, real-time data are managed through a good system management, and in-vehicle collision avoidance systems. Ultimately, Stage Three envisions the realization of an interwoven ITS system, necessitating a system of technologies functioning cohesively within critical corridors of and urban centers. Challenges persist in implementing a comprehensive technology network that efficiently manages and disseminates information. A. Categorization and Planning for ITS To guide the development and deployment of ITS technology, the U.S. Department of Transportation introduced the National ITS Architecture. This framework facilitates the integration of functions and geography, ensuring interoperability across locations. The architecture encompasses not fewer than 33 user services in ITS are grouped to be eight sections, including prediction of travel time, prioritizing public transit, road payment electronically, commercial vehicle assistance, controlled signal system, advanced incident vehicle system, advanced intelligent parking, and road maintenance and rescheduling routing check on vehicles. Innovations and support for sharing transportation system information align with strategic objectives aimed at mitigating environmental impacts and reducing energy consumption. The U.S. Department of Transportation's Applications for the Environment Real-Time Information Synthesis (AERIS) Program explores interoperable technologies for mitigating transportation's environmental effects. AERIS encompasses operational scenarios like Eco-Signals, Eco-Lanes, Low Emission Zones, Eco-Traveler Information, and Eco-Integrated Corridor Management.

IV. TOOLS FOR EVALUATING ITS AND ENERGY IMPACT IN 1998, THE U.S. ENVIRONMENTAL PROTECTION

Agency (U.S. EPA) released a report exploring methodologies to assess energy and environmental impacts of ITS. Subsequent research, including studies by Barth and Boriboonsomsin (2009) and Cambridge Systematics, Inc. (2009), has applied these methodologies. Challenges arise due to the intricate relationship among ITS, travel behavior, and transportation system management, making the assessment of ITS fuel consumption and emission impacts complex. Models and data from traffic simulation and travel demand contribute to understanding this relationship, yet further work is needed. The U.S. Department of Transportation AERIS Program advances modeling capabilities through scenario analysis, encompassing energy benefits from Low Emission Zones, Eco-Lanes, and micro-simulation tools. Modeling serves as a valuable tool for predicting real-world impacts of ITS deployment. Additionally, data from field tests and pilot projects contribute to simulation studies, offering insights at various deployment levels. Results presented in the following sections draw from modeling studies, field test and pilot project data, and actual deployments.

V. PREDICTED AND EMPIRICAL FINDINGS

Enhanced understanding of the influence of Intelligent Transportation Systems (ITS) on fuel consumption has seen substantial progress in recent years. An overview encompassing eleven distinct ITS categories, in which fuel consumption has been studied over the past 17 years, highlights the growing insight into the energy impacts of ITS. By mitigating stop-and-go traffic, optimizing route direction and managing vehicle usage, ITS has the potential to positively affect the consumption of fuel. The ensuing sections quantify energy consumption outcomes through modeling, field tests/pilot projects, and full-scale implementations whenever relevant. While this analysis provides comprehensive coverage of diverse ITS technologies, it does not serve as an exhaustive review of the entirety of ITS and its effects on fuel consumption. Additionally, a brief discussion is included regarding the complexities and potential implications of understanding latent demand, which can arise from strategies enhancing ITS capacity.

Traffic Signal Control: Traffic signals fulfill multiple functions, including managing traffic speeds, vehicle merging, corridor crossings, and interactions involving vehicles and low-speed or non-motorized modes at intersections. Utilizing ITS microsimulation models enables the assessment of how different traffic signal controls impact emissions, travel durations, and fuel consumption. These controls can be configured to optimize specific objectives such as time savings and energy reduction. To enhance fuel efficiency, traffic signal controls can be set to minimize vehicle accelerations, decelerations, and idle periods, all of which contribute to increased fuel consumption. Balancing multiple, sometimes conflicting, goals is pivotal in traffic management. The application of traffic signal controls to reduce energy consumption is not new, with studies quantifying energy impacts in this domain predating the emergence of ITS. For instance, during the energy crises of the 1970s (1973-74 and 1979), researchers identified that synchronizing traffic signals to reduce stop-and-go traffic could lower energy usage. More recently, traffic signal control has become integral to ITS, and its effects have been evaluated through simulations and real-world scenarios. ITS applications related to traffic signals encompass communication systems, adaptive control systems, and real-time data collection and analysis. Recent assessments indicate potential fuel savings of 8 to 9% along with corresponding reductions in travel time of 8 to 10% (USDOT, 2007b). Another study underscores an overall 22% improvement in fuel economy due to infrastructure-to-vehicle (I2V) communication (Caminiti, Cunningham, and Lovell, 2010).

Standard estimated savings arises in some factors such as the essential rate of time planning, internet configuration, traffic modes and signage equipment. The U.S. DOT AERIS Program (2014b) has reported initial findings from an eco-signal timing scenario/modeling involving varying levels of connected vehicle market penetration. These findings suggest that partial linked vehicle market penetration could lead to a 2-4% reduction in emissions and fuel consumption, while full market penetration might result in reductions of 4-6%. For public transit and freight scenarios (2014b), signal priority for transit and freight vehicles under partial connected vehicle penetration could achieve emissions and fuel savings of 1-2%, rising to 2-4% under full connected vehicle penetration. Eco-freight signal priority could also yield fuel savings for freight trucks, ranging from 1% to 4%, depending on the penetration rate of connected vehicle technology and other factors.

Incorporating traffic signal control within ITS frameworks offers a range of benefits, including optimized route planning, reduced fuel consumption, decreased transport-related air pollution, and improved overall traffic efficiency. Additionally, predicting traffic flow significantly contributes to congestion reduction. Inputs for the algorithm include historical traffic flow matrices derived from past traffic flow data.

- *Transportation Sector's Carbon Emissions and Sustainable Policies among human generated carbon dioxide (CO2) emissions, the transportation sector holds the second position. The key aim of the U.S.*

Department of Transportation centers on adopting sustainable strategies to curtail carbon emissions stemming from transportation origins. The integration of smart growth principles, encompassing compact, mixed-use zones, improved network interconnectivity, and environmentally conscious surroundings, plays a pivotal role in alleviating emissions.

- *Greenhouse Gas Emissions and Eco-Driving Techniques*

Even with progress in engine and fuel technologies, the transportation sector remains a noteworthy contributor to greenhouse gas (GHG) emissions. To further mitigate GHG emissions, eco-driving techniques, inclusive of driving behaviors, present an auxiliary approach. The majority of eco-driving research has primarily concentrated on metropolitan areas dealing with persistent congestion concerns. This research aims, however, seeks to ascertain the most environmentally responsible routes for urban movement in a smaller city. In such settings, distances might be short but dependence on cars is pronounced. The research undertook a comprehensive citywide survey in Abuja, Nigeria, involving nearly 10,000 residents. The analysis encompassed alternative routes, traffic flow patterns, time variations, and atmospheric conditions.

VI. CONCLUSION

In this modern day of technologies intelligent transportation, system is introduction into a system of our daily activities to ease movement of goods and services without delay, its provide real time information to safety and intelligent transportation system keywords also gives proper details on transportation, swift bus fleet, communal details, environmentally conscious driving, efficient routing gathering, human aspects, shared transport, management of traffic and transit, interconnected vehicles self-driving vehicles in summary. Intelligent Transportation system provides real-time information to guide motorists information via 12 electronic message signs to manage road congestion, safety is also very essential in ITS. Study found a possibility of 10%to 15% reduction in fuel consumption and there is a beneficial network effect because surrounding vehicles that where not receiving signal communication also improved fuel efficiency, even with lower penetration rates of vehicles receiving the signal information.

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