الجمهورية الجزائرية الديمقراطية الشعبية
Ministry of Higher Education and Scientific Research
وزارة التعليم العالي والبحث العلمي
People's Democratic Republic of Algeria

HIGHER SCHOOL OF MANAGEMENT AND DIGITAL ECONOMY

H.S.M.D.E

المدرسة العليا للتسيير والاقتصاد الرقمي

Master thesis submitted in partial fulfillment of the requirements for the degree of Master's startup degree

Speciality :E-business

Digitalization of the algerian urban public transport

Study case : SETRAM, SEMA,ETUSA

Project :

YALLARIDE

Submitted by :

-Ms TIDAFI NOUR EL-HOUDA DJAMILA

-Ms BECHANE ASMA

Supervised by :

- Ms CHIBANE ASSIA

- Ms MERABTI MANAL

Academic year

2024-2025

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Dedication

We dedicate this Master thesis, not only to the past few months of hard work, but to the five years of dreams, doubts, laughter, tears, and growth we've lived through together.

To my dear project partner this work carries both our names, but also our shared courage, sleepless nights, endless calls, and mutual trust. This thesis is as much yours as mine, and I wouldn't have wanted to walk this journey with anyone else.

To our loving parents, brothers, and sisters, thank you for your patience, prayers, and unwavering belief in us, even when we doubt ourselves.

To our friends the ones who cried with us, laughed with us, and never let us feel alone. Your presence made the weight lighter and the joy brighter.

And finally, to the kind-hearted teachers who supported us, guided us, and left a lasting impact on our hearts. You were more than educators, you were light-bringers, shaping not only our minds, but our character.

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Thank you to every day that carried me here, to every moment, every soul, every lesson.This is not the end. It’s the beginning .

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LIST OF ABBREVIATIONS

Acronym	Full Term / Definition
AFC	Automated Fare Collection
AI	Artificial Intelligence
BRT	Bus Rapid Transit
CRM	Customer Relationship Management
DPI	Dots Per Inch / Deep Packet Inspection *(depending on context)*
ERP	Enterprise Resource Planning
ETUSA	Entreprise de Transport Urbain et Suburbain d'Alger
IBM	International Business Machines Corporation
ICT	Information and Communication Technology
IOT	Internet of Things
ITS	Intelligent Transport Systems

LRT	Light Rail Transit
PDM	Product Data Management
QR	Quick Response *(QR Code)*
RUL	Remaining Useful Life
SEMA	Société d'Exploitation du Métro d'Alger *(Algiers Metro Operating Company)*
SETRAM	Société d'Exploitation des Tramways *(Tramway Operating Company)*
TMS	Transport Management System

Summary :

This study explored the role of digital payment integration in public transport systems in Algeria, focusing on how it enhances operational efficiency for transport companies and improves passenger satisfaction. Using a mixed-method approach that combined user questionnaires and interviews with professionals from ETUSA, SETRAM, and SEMA, the research identified key barriers to digital adoption: infrastructure limitations, security concerns, and user resistance. Findings demonstrated that digital tools such as e-wallets, QR codes, and smart cards significantly improve user experience, reduce operational costs, optimize revenue management, and promote transparency. Digitalization in transport aligns with the vision of smart cities, where innovation, sustainability, and efficiency come together to meet both public expectations and institutional goals.

Keywords:

Digital Payment, Public Transport, Operational Efficiency, User Satisfaction, Smart Cities

Résumé :

Cette étude a examiné l'impact de l'intégration des moyens de paiement numériques dans les systèmes de transport public en Algérie, en mettant l'accent sur leur contribution à l'efficacité opérationnelle des entreprises de transport et à la satisfaction des passagers. À travers une approche mixte combinant une enquête quantitative auprès des usagers et des entretiens qualitatifs avec des professionnels du secteur (ETUSA, SETRAM, SEMA), l'étude a permis d'identifier les principaux défis liés à l'adoption du numérique : l'infrastructure, la sécurité et la réticence au changement. Les résultats ont confirmé que les outils numériques tels que les portefeuilles électroniques, les QR codes, et les cartes intelligentes peuvent considérablement améliorer l'expérience utilisateur, réduire les coûts d'exploitation, optimiser la gestion des revenus et renforcer la transparence. La numérisation dans le transport s'inscrit donc pleinement dans une dynamique de ville intelligente, où efficacité, durabilité et innovation se rejoignent pour répondre aux attentes des citoyens et aux objectifs des opérateurs.

Mots clès:

Paiement électronique, Transport public,Efficacité opérationnelle, Satisfaction des usagers, Villes intelligentes

الملخص :

تناولت هذه الدراسة دور دمج وسائل الدفع الرقمية في أنظمة النقل العام في الجزائر، مع التركيز على مساهمتها في تحسين الكفاءة التشغيلية لشركات النقل وتعزيز رضا الركاب. اعتمدت الدراسة على منهجية مزدوجة تجمع بين استبيان

موجه للمستخدمين ومقابلات مع مهنيين من مؤسسات النقل (إيتوزا، سيترام،سيما)، وقد أظهرت النتائج أن من بين التحديات الرئيسية: ضعف البنية التحتية، الأمان، ومقاومة المستخدمين للتغيير.

أكدت نتائج الدراسة أن الأدوات الرقمية مثل المحافظ الإلكترونية، رموز QR، والبطاقات الذكية تساهم بشكل كبير في تحسين تجربة المستخدم، تقليل التكاليف التشغيلية، وتحسين إدارة الإيرادات، وزيادة الشفافية. تندرج رقمنة قطاع النقل في إطار التحول نحو المدن الذكية التي تجمع بين الابتكار؛ الاستدامة والكفاءة لتلبية تطلعات المواطنين وتحقيق أهداف المؤسسات.

الكلمات المفتاحية

الدفع الرقمي, النقل العمومي ,الكفاءة التشغيلية, رضا المستخدم, المدن الذكية

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Part One : classical thesis

Digitalization of the Algerian urban public transport

Study case ; SETRAM, SEMA, ETUSA

General Introduction

The transport sector plays a crucial role in national development, acting as a key driver of economic growth and social cohesion. In both developed and developing countries, improving transportation infrastructure is widely recognized as essential for supporting sustainable urban development.

Urban mobility is particularly vital, especially in densely populated cities like Algiers, where public transport ensures access to jobs, education, and essential services. However, urban transport systems face growing challenges, such as congestion, pollution, and service inefficiencies, which negatively affect both citizens' quality of life and environmental sustainability.

In response, many cities are turning to digitalization as a strategy to modernize public services. Digital tools offer promising solutions for optimizing operations, improving accessibility, and encouraging a shift toward shared mobility. The global COVID-19 pandemic further highlighted the importance of digital platforms, particularly contactless services in ensuring continuity and enhancing user experience.

In Algeria, digital transformation in public transport is gradually gaining traction. In this context, our research focuses on the integration of digital payment systems and their potential to improve operational efficiency and passenger satisfaction in public transportation.

To address this issue, we conducted an extensive literature review encompassing various works related to urban mobility. We undertook an exhaustive literature review of the Master's thesis titled "Optimisation de la multimodalité pour une mobilité urbaine inclusive : le cas d'Hussein Dey" from the University of Blida 1 – OVAMUS Laboratory, which focused on promoting inclusive urban mobility. We also drew on the international perspective offered by the United Nations Commission on Science and Technology for Development's 2016 report "Smart Cities and Infrastructure", which outlines global challenges and strategies for implementing smart city technologies. Our work builds on and deepens these reflections, with a specific focus on the digitalization of urban transport in the Algerian context.

The purpose of this research is to analyze the impact of integrating modern digital payment solutions within Algeria's public transport systems. The study aims to assess how such technologies can improve both operational efficiency for companies and satisfaction for passengers.

- Evaluating the current state of digitalization in Algerian public transport services.

- Identifying passenger needs, expectations, and attitudes toward digital payment methods.

- Investigating the challenges and limitations faced by transport operators in adopting digital tools.

- Measuring the potential benefits of digitalization in terms of cost reduction, performance optimization, and enhanced service delivery

We selected this topic due to the critical role that public transport plays in the daily lives of citizens, especially in dense urban areas. Despite its importance, the sector continues to face challenges such as operational delays, inefficient paper-based systems, and limited payment flexibility. As graduate students in E-Business, we are particularly interested in how digital technologies can modernize this essential sector, offering added value both to users and to transport providers.

Thus, throughout this research work we will answer the following main question:

Does the integration of modern payment methods into public transport systems in Algeria significantly improve operational efficiency for companies and passenger satisfaction ?

Four secondary questions can be proposed to refine this problem:

- Does the diversity of modern payment methods have a positive effect on passenger satisfaction?
- Does simplifying payment processes improve operational efficiency?
- Does access to real-time payment and service information enhance user satisfaction?
- Does the use of digital payment tools reduce operational costs and improve productivity?

In order to answer our questions, we formulate the main hypothesis followed by the following four sub-hypotheses :
The integration of modern payment methods into public transport systems in Algeria significantly improves operational efficiency for transport companies and enhances passenger satisfaction.

To answer this hypothesis, we will examine several sub-hypotheses :

Sub-Hypotheses

- H1: The diversity of modern payment methods has a positive effect on passenger satisfaction.
- H2: Simplifying payment processes improves operational efficiency.
- H3: Access to real-time payment and service information enhances user satisfaction.
- H4: The use of digital payment tools reduces operational costs and improves productivity.

This study adopts a mixed-methods approach combining both quantitative and qualitative data:

- Quantitative Component:
  We conducted a structured survey targeting public transport users to collect data on travel behaviors, digital preferences, and overall satisfaction.

- Qualitative Component:
  We carried out semi-structured interviews with professionals from three major Algerian public transport operators: ETUSA, SETRAM, and SEMA. These discussions provided in-depth insights into internal practices, digital strategies, and operational challenges.

The collected data were analyzed using Jamovi software for statistical treatment and thematic content analysis for qualitative responses, allowing for a comprehensive interpretation of the results.

To address our central research problem, we conducted a comprehensive literature review covering a wide range of academic and professional works related to public transport, digital transformation, and user satisfaction. Our thesis is structured into two main chapters :

- The first chapter explores the Digital Transformation of Urban Public Transport: Concepts, Challenges, and Innovations, providing definitions, key concepts, and global practices related to digitalization in transport and smart cities.

- The second chapter presents the Empirical Study on Digitalization in Public Transport: Company Practices, User Experience, and Operational Efficiency in Algeria , including our empirical study, data collection, analysis, and findings based on the Algerian public transport context.

Chapter one

Digital Transformation of Urban Public Transport

Introduction

The rise of digital technologies has profoundly transformed urban life, giving birth to the concept of smart cities urban environments that leverage digital tools to optimize infrastructure, enhance services, and improve overall quality of life. One of the sectors most impacted by this transformation is public transport, which now incorporates innovations such as digital ticketing systems, real-time tracking, and mobile payment platforms. These tools aim not only to streamline operations and reduce costs but also to significantly enhance the passenger experience.

This theoretical chapter explores the foundations of digitalization and its role within smart urban ecosystems, with a particular focus on the transport sector. It aims to clarify the strategic and operational advantages for companies that integrate such technologies into their systems. Specifically, it will demonstrate how digital innovation can transform user experience and strengthen operational efficiency, laying the groundwork for more adaptive, inclusive, and sustainable mobility solutions.

Section 1: Smart Cities and Digitalization

This section explores the transition from analog systems to digital ecosystems, highlighting the importance of digital infrastructure in modern governance. It defines smart cities and their key components like mobility and energy, emphasizing the role of ICT in urban management. The section also covers the evolution of digital transformation across sectors and introduces various forms of digitalization, from general technologies (IoT, AI, Big Data) to sector-specific applications in health, transport, and education.

1.1 Digitization vs. Digitalization: Evolution of the Digital Shift :

Digitalization according to one of the simpler definitions to create and execute "changes associated with the application of digital technology in all aspects of human society[1]"

1.1.1-Conceptualisation of digitalization:

The process of leveraging digital technologies to transform a business model, creating new revenue streams and value-producing opportunities. This involves integrating digital tools and systems into various aspects of a business's operations, from management and communication to production and customer service.

Digital transformation is fundamentally based on digitization, which is a preliminary and necessary step. Indeed, digitization is the process of digitizing the physical aspects of business processes and workflows. When non-digital or physical objects are represented in a digital format, it means that the computer system can use this information. For example, paper forms filled out by customers are converted into digital models that they complete online. This digital data can then be used for analytics and business intelligence.[2]

There is often a confusion between digitalization and digitization , though they are different

[1] STOLTERMAN (Erik) et FORS (Anders), *The Philosophy of Technology and the Challenge of Digital Transformation*, 2004, p. 23.

[2] https://www.strategymission.org/en/the-difference-between-digitization-and-digital-transformation/ , consulted at 19:30 , 11/05/2025

Table 01:Digitalization vs. Digitization

Aspect	Digitization	Digitalization
Definition	The process of converting hard/paper files and documents into digital formats.	The strategic use of digital technologies to transform business operations and models.
Example	Scanning a picture, uploading documents, converting a report to PDF and storing it on a computer.	Using cloud platforms, data analytics, or automation tools to redesign business processes.
Impact on Data	Data and information remain unchanged—only format, accessibility, and storage are affected.	Leads to transformation in how data is used and integrated across business activities.
Purpose	Improves accessibility and convenience in storing/retrieving information.	Enables innovation, efficiency, and revenue growth through digital transformation.
Business Benefit	Fast and easy access to key information.	Enhances operations, creates new value, and may disrupt traditional business models.

Resource: Brennen, S., and Kreiss, D. (2016). Digitalization. In B. Peters (Ed.), The International Encyclopedia of Communication Theory and Philosophy (pp. 556–566). Wiley-Blackwell.

1.1.2.Historical Evolution of Digitalization

The concept of digitalization has its roots in the mid-20th century, evolving through several key phases that reflect broader technological, economic, and societal transformations.

A. The Pre-Digital Era (Before 1940s):[1]

The foundation for digitalization began with early developments in mathematics, logic, and mechanical computation. Charles Babbage's Analytical Engine (1830s) and Alan Turing's theoretical work in the 1930s laid the groundwork for the concept of programmable machines. However, this era was dominated by analog technologies and manual processes.

[1] Tapscott, D. (1995). *The Digital Economy: Promise and Peril in the Age of Networked Intelligence*. McGraw-Hill.P 50

B. The Advent of Digital Computing (1940s–1960s):
The invention of the electronic digital computer during World War II (e.g., ENIAC in 1945) marked the beginning of digital technology. During this period, digitalization primarily referred to the digitization of analog information converting physical data (e.g., text, images) into digital form. This was a technical development limited largely to research, military, and large institutional contexts.

C. The Expansion of Digital Infrastructure (1970s–1980s):
With the emergence of microprocessors and personal computers in the 1970s, digital technologies became more accessible. Key innovations included the development of operating systems, databases, and networking technologies. Businesses began to digitize internal processes (e.g., payroll, inventory management), laying the foundation for enterprise information systems.

E. The Rise of the Internet and Global Connectivity (1990s–2000s):[1]
This period saw the transition from digitization to digitalization, the integration of digital technologies into business models and value creation. The internet revolutionized communication and commerce, enabling e-business, digital media, and online services. Books like The Digital Economy by Don Tapscott (1995) describe this transformation as a shift in the logic of value creation and competition.[2]

F. The Era of Digital Transformation (2010s–Present):[3]
Digitalization has become deeply embedded in all aspects of life and economy. This phase is marked by the convergence of cloud computing, big data, artificial intelligence, and mobile technologies. Organizations no longer simply digitize processes but reconfigure entire business models and customer experiences. Digital transformation is now a strategic imperative across sectors, as discussed in works like Leading Digital .[4]

1.1.3-The role of digital public infrastructure in modern governance :

In the digital age, effective governance increasingly relies on strong digital public infrastructure (DPI). DPI serves as the backbone for delivering modern public services, enabling governments and institutions to operate more efficiently, inclusively, and resiliently. Through scalable, interoperable, and innovative systems, DPI transforms how public services are designed, delivered, and experienced.

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[1] Westerman, G., Bonnet, D., & McAfee, A. (2014). *Leading Digital: Turning Technology into Business Transformation*. Harvard Business Review Press, p. 44.
[2] Idem
[3] Manuel Castells, The Rise of the Network Society, Blackwell Publishers, Oxford, 1996, p. 62.
[4] Erik Brynjolfsson and Andrew McAfee, *The Second Machine Age*, W. W. Norton & Company, New York, 2014, p. 89.

A. Efficiency : When public sector institutions and private service providers can rely on established tools and platforms, they can redirect resources to more valuable tasks and create economies of scale, resulting in time savings and cost effectiveness.

B. Interoperability: DPI promotes interoperability by providing common components and facilitating standardised approaches and methods for designing and providing services, for sharing and accessing data, and for communication and collaboration between and across teams, departments, organisations, and borders.

C. User experience and inclusion: Robust and reliable DPI supports a better user experience with digital public services and can help make services more inclusive by providing a foundation of tools that assist public sector institutions and private service providers in tailoring the services more efficiently to user needs.

D. Scalability: As the volume and complexity of data and digital public services continue to grow; scalability becomes a critical consideration. Reusable digital building blocks are designed to scale up along with increased demand and to prevent lock-in effects, ensuring the ability to offer quality services can adapt to evolving needs rapidly without significant rework, investment or impact on service continuity.

E. Resilience: Countries with robust digital foundations are better equipped to navigate crises and deliver essential services. This was demonstrated during the COVID-19 pandemic, when some countries were able to implement key services and support more rapidly in response to emerging challenges by leveraging DPI.

F. Innovation: By providing a foundation of reusable digital tools and platforms, DPI allows public sector institutions and private service providers to focus their efforts on building upon existing solutions rather than starting from scratch, allowing them to experiment with new approaches and technologies more efficiently.[1]

1.2 Concepts and Constituent Elements of Smart Cities

A smart sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects[2]

[1]OECD (Organisation for Economic Co-operation and Development), Digital Public Infrastructure for Digital Governments, OECD Publishing, 2024, [en ligne] disponible sur : https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/12/digital-public-infrastructure-for-digital-governments_11fe17d9/ff525dc8-en.pdf

[2] UNCTAD (United Nations Conference on Trade and Development), Data Protection Regulations and International Data Flows: Implications for Trade and Development, Geneva, 2016, [en ligne] disponible sur : https://unctad.org/system/files/official-document/ecn162016d2_en.pdf

Smart infrastructure provides the foundation for all of the key themes related to a smart city, including smart people, smart mobility, smart economy, smart living, smart governance and smart environment. The core characteristic that underlies most of these components is that they are connected and that they generate data, which may be used intelligently to ensure the optimal use of resources and improve performance. This section introduces some key components of smart city infrastructure and concludes by highlighting the need for an integrated approach in dealing with such infrastructure.

1.2.1 Smart buildings :

A smart building integrates the different physical systems present in an intelligent way to ensure that all the systems act together in an optimized and efficient manner. Smart building management systems can improve building energy efficiency, reduce waste and ensure an optimum usage of water, with operational effectiveness and occupant satisfaction .[1]

1.2.2 Smart mobility :

Smart mobility is best described as approaches that reduce congestion and foster faster, greener and cheaper transportation options. Most smart mobility systems use data collected from a variety of sources about mobility patterns in order to help optimize traffic conditions in a holistic manner. Smart mobility systems include mass transit systems as well as individual mobility systems that feature bicycle sharing, ride sharing (or carpooling), vehicle sharing and, more recently, on-demand transportation.[2]

1.2.3 Smart energy :

Smart energy management systems use sensors, advanced meters, renewable energy sources, digital controls and analytic tools to automate, monitor and optimize energy distribution and usage.[3]

1.2.4 Smart water :

Cities are constantly trying to solve water scarcity problems with innovative technologies and better management of water. Improved metering and flow management are key to a good water distribution system. A smart water management system uses digital technology to help save water, reduce costs and increase the reliability and transparency of water distribution.[4]

1.2.5 Smart waste management :

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[1] Sinopoli, J. (2009). Smart buildings systems for architects, owners and builders. Butterworth-Heinemann,p. 14.
[2] Neckermann, L. (2015). *Smart mobility: Reducing congestion and fostering faster, greener, and cheaper transportation options*. Neckermann Strategic Advisors,p 23.
[3] Mobley, K., & Söder, L. Y. (2010). Energy management and operating costs in buildings. Elsevier,P. 36.
[4] Shahin, M. (2007). *Water resources and water management*. Springer,p.11

Waste generation is increasing at a rate faster than that of urbanization.18 Cities are increasingly finding it difficult to source, separate and use different kinds of waste that can potentially be returned to a consumer life cycle. Waste management typically includes the monitoring, collection, transport, processing, recycling and disposal of waste. Smart waste management systems reduce waste and categorize the type of waste at the source, and develop methods for the proper handling of waste.[1]

1.2.6.Smart health :

The health and well-being of urban residents are of particular concern with regard to the sustainability of urban areas and their supporting ecosystems. Smart cities can develop the capacity to use technology such as big data to develop predictions or identify hotspots of population health (such as epidemics or health impacts during extreme weather events).20 Smart health-care management converts health-related data into clinical and business insights, which include digital health records, home health services and remote diagnosis, treatment and patient monitoring systems.[2]

1.3.The Evolution of Digital Transformation :

Digital transformation has evolved significantly over the past few decades, driven by rapid advancements in technology and changing consumer expectations. Initially focused on digitizing internal processes and automating tasks, it has now become a strategic imperative that reshapes entire business models, customer experiences, and organizational cultures. From the early days of computerization and the internet to today's era of artificial intelligence, big data, and cloud computing, digital transformation continues to redefine how businesses create value and remain competitive in a constantly shifting landscape.

1.4.Types of Digitalization :

Digitalization manifests in multiple forms depending on the area it targets within an organization. It includes the transformation of internal processes for greater efficiency, the redesign of business models to create new value, the expansion into new markets through technological capabilities, and the shift in organizational culture to support innovation. Each type addresses specific strategic objectives and reflects a different level of digital maturity and impact.

1.4.1. Transformation Process :

The primary goal of process transformation is to make internal processes simpler and more efficient. Companies undergoing process transformation aim to reduce lead times, costs,

[1] Pichtel, J. (2014). *Waste management practices: Municipal, hazardous, and industrial* (2nd ed.). CRC Press,p. 62.

[2] UNCTAD (United Nations Conference on Trade and Development), *Data Protection Regulations and International Data Flows: Implications for Trade and Development*, Geneva, 2016, [en ligne], disponible sur : https://unctad.org/system/files/official-document/ecn162016d2_en.pdf

errors, and complexity by rethinking existing strategies. Possible results include streamlining or eliminating steps, improving reporting, and minimizing typos. An assessment of existing software is critical to a successful process transformation.

It may be tempting to introduce entirely new systems as part of a process transformation, but business leaders should consider several factors when introducing new software applications as part of a transformation. First, managers should review implementation plans, change management, and the urgency of the change. For example, implementing a new application may take more than a year and require temporary measures to address potential issues.

Second, SaaS application functionality is frequently updated, so a company's current vendor may offer functionality that was previously unavailable, eliminating the need to implement an entirely new software system.

Third, this transformation also affects external vendors and customers. For example, a change in the accounts payable process may change the invoicing process, so change management is critical for both internal employees and external stakeholders.

An example of a process transformation is the fast food industry. In the past, customers would walk into a restaurant and order food from an employee. Today, customers can place their own orders at a kiosk or use a restaurant app to pre-order food.

1.4.2.Business Model Transformation :[1]

This shift changes the way a company delivers value to its customers by digitizing products or services that were previously physically or manually produced. This is a deeper transformation than just improving internal processes.

For example, Peloton has evolved from a fitness equipment manufacturer to an immersive, connected fitness experience provider where users can attend live classes and interact virtually.

Companies take this approach to stay ahead of consumer behavior or to stay competitive in a changing market. However, this often requires new skills and changes in team structure.

1.4.3.Domain Transformation :

This is when a company leverages its technological capabilities to enter new industries or markets. This allows the company to diversify revenue or respond to threats in its current domain.

[1] OSTERWALDER (Alexander) et PIGNEUR (Yves), *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, Wiley, Hoboken (NJ), 2010, p 499

For example, IBM initially focused on computers and hardware but expanded its offerings to consulting and software solutions after the market became saturated.

Domain transformation can create entirely new revenue streams and business opportunities, but it often requires innovation and strategy.

1.4.4.Cultural and organizational change :

This is one of the most complex forms of digital transformation because it changes the mindsets, values, and work habits of employees and managers.

The trigger is often a major event such as an acquisition, leadership change, or a global crisis like COVID-19, which has forced many companies to move to remote work and rethink internal collaboration.

Successful cultural change often requires a strong internal communication and change management strategy.

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[1]George Westerman, Didier Bonnet and Andrew McAfee, *Leading Digital: Turning Technology into Business Transformation*, Harvard Business Review Press, Boston, 2014, p. 34.

Section 2: Public Transport in the Digital Era

This section reviews the historical development of public transport, from early tram systems to today's multimodal networks. It emphasizes the essential role public transport plays in ensuring accessibility, supporting urban development, and promoting sustainability. The section outlines key modes of transport: bus, underground , tramway and their integration. It also examines the economic impact of transport infrastructure, including job creation and improved city connectivity. Finally, it explores the digitalization of public transport, focusing on intelligent systems, smart traffic, and fleet management.

2.1.Historical Overview of Public Transport

Transportation has been a cornerstone of human civilization, shaping the development of societies, economies, and urban environments. From ancient methods like walking and animal-powered movement to modern systems such as trains, metros, and digital ride-sharing platforms, transport has continuously evolved to meet the growing needs of populations. In this section, we explore the foundational concepts of transport, its definitions, religious and cultural references, and the historical milestones that have marked its transformation particularly the transition from traditional forms to structured urban public transport systems.

2.1.1.Definition of Transport

Transport is the process of moving people, goods, or objects from one location to another using designated modes of transportation. It is a fundamental component of infrastructure, economic activity, and social development, facilitating trade, communication, and connectivity between different geographical areas.

-Transport refers to the physical movement of people and goods from one place to another using designated modes of transportation. It plays a vital role in infrastructure and economic activities.

In Islamic teachings, transport is mentioned in several Quranic verses, underscoring its importance in facilitating human endeavors and trade. For example:

﴿ اللَّهُ الَّذِي خَلَقَ السَّمَاوَاتِ وَالْأَرْضَ وَأَنزَلَ مِنَ السَّمَاءِ مَاءً فَأَخْرَجَ بِهِ مِنَ الثَّمَرَاتِ رِزْقًا لَّكُمْ ۖ وَسَخَّرَ لَكُمُ الْفُلْكَ لِتَجْرِيَ فِي الْبَحْرِ بِأَمْرِهِ وسَخَّرَ لَكُمُ الْأَنْهَارَ﴾ (الآية 32 من سورة إبراهيم) ﴿وَالْخَيْلَ وَالْبِغَالَ وَالْحَمِيرَ لِتَرْكَبُوهَا وَزِينَةً وَيَخْلُقُ مَا لَا تَعْلَمُونَ﴾ (الآية 8 من سورة النحل)

These verses highlight the essential role of transport in economic and social development.

- **Transport:** Madeleine Damien, in her transport dictionary, defines transport as **"the movement of objects, goods, or individuals from one place to another."** [1]These modes of transport include aviation, railways, road transport, maritime transport, cable transport, pipeline transport, and space transport. The mode of transport also depends on the type of vehicle or infrastructure used. Methods of transport can include automobiles, bicycles, buses, trains, trucks, walking, helicopters, or airplanes. Transport can be classified as either public or private.

  On the other hand, Michel Chesnais views the transport system as "a set of means whose fundamental purpose is to meet a need for movement or transport, or more generally, communication between distinct geographical locations**."**[2]

- **Movement:** The act of moving or going from one point to another.[3]
- **Mobility:** According to *Le Petit Larousse* (2009), "mobility is the ease of moving, being put in motion, changing, or relocating**."**[4]

  Mobility refers to the ability or property of people or objects to move within a space, or "the characteristic of something that can move or be moved, change position, or function**."** This space can be physical, such as the circulation of goods (referred to as freight or goods transport) and people.

  Mobility is the ability of individuals and goods to move or be transported from one place to another.

  Urban transport is defined as **"all public transport services that facilitate internal travel within urban areas."** These are typically public transport services that passengers can access by purchasing a ticket. They operate according to established schedules along designated routes with predetermined stops.

2.1.2.History of transport

For most of human history, transportation remained limited to walking, animal-powered travel, and wind-powered boats. It wasn't until the 19th and 20th centuries that transportation underwent revolutionary changes.

A. **Early Transport (Pre-1800s)**[1]

[1] Robert Cervero, *The Transit Metropolis: A Global Inquiry*, Island Press, Washington, D.C., 1998, p. 78.
[2] *Transports et Espace Français*, Masson, Paris, 1981, p. 20
[3] Madeleine Damien, *Le Transport et Logistique Fluviale*, Éditions Techniques, Paris, 2005, p. 331
[4] *Le Petit Larousse [CD-ROM], Larousse, France, 2009.*

a. People traveled on foot or used animals like horses, camels, and oxen.
b. Boats powered by wind or human effort were the main mode of water transport.
c. Roads were poorly maintained, making land travel slow and costly.

B. **Industrial Revolution & Steam Power[2] (1800s)**
   a. **Steam Engine (1769):** James Watt's steam engine led to significant advancements.
   b. **Steamboats (1807):** Robert Fulton's steamboat revolutionized river transport.
   c. **Railroads (1830s-1900s):** Railways, starting with the Baltimore and Ohio Railroad, rapidly expanded across the U.S., replacing canals as the main mode of land transport.
   d. **Canals (Early 1800s):** Canals like the Erie Canal (1825) connected waterways and facilitated trade.

C. **The Rise of Automobiles and Highways (1900s)**
   a. **Automobile Industry (1900s):** Henry Ford's mass production of affordable cars changed personal transportation.
   b. **Road Infrastructure (1920s-1950s):** The U.S. government invested heavily in road networks, culminating in the Interstate Highway System (1956), which connected the entire country.
   c. **Decline of Railroads:** With the rise of automobiles and trucks, railroads lost dominance, focusing mainly on freight.

D. **Air Travel and Global Connectivity (20th Century)**
   a. **First Powered Flight (1903):** The Wright Brothers introduced the airplane.
   b. **Commercial Aviation (1920s-1950s):** Air travel expanded rapidly with advancements in jet engines, making international travel faster and more accessible.
   c. **Containerization and Global Trade (1960s-2000s):** The development of **container ships** and intermodal transport (combining trains, trucks, and ships) revolutionized global logistics.

E. **Modern Transportation (21st Century & Future Trends)[3]**
   a. **High-Speed Rail and Electric Vehicles:** Growing focus on sustainability with bullet trains, electric cars, and hybrid transport systems.
   b. **Smart Transport Systems (ITS):** Intelligent Transportation Systems (ITS) use data, AI, and automation to improve efficiency.

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[1] McKay, J. P., Hill, B. D., Buckler, J., Crowston, C. H., Wiesner-Hanks, M. E., & Perry, J. (2014). *A history of Western society* (11th ed.). Bedford/St. Martin's.
[2] Shaw, R. (1990). *Canals for a nation: The canal era in the United States, 1790–1860*. University Press of Kentucky.
[3] Givoni, M., & Banister, D. (2013). *Moving towards low carbon mobility*. Edward Elgar Publishing.

c. **Space Travel and Hyperloop:** Innovations like Elon Musk's Hyperloop and commercial space travel are pushing the boundaries of transportation.

2.1.3.The role of public transport in modern societies

A.Economic and Social Impact

Transportation is a non-separable part of any society. It exhibits a very close relation to the style of life, the range and location of activities, and the goods and services which will be available for consumption.[1]

B.Environmental Benefits

Public transportation includes urban, rural, bus systems, paratransit, bus rapid transit (BRT), water-borne services, subways, light rail, streetcars, and other urban rail networks... Public transportation is available in every state across the United States, both in cities and more rural areas, providing mobility options that can lead to reduced traffic congestion and environmental benefits[2].

C.Social Inclusion and Accessibility

Public transportation plays an important role in creating an accessible society because it is critical for ensuring employment, completing activities of daily living, and participating in social activities[3].

D.Urban Structure and Development

Public transport is central to commuting in most cities. This paper studies the role of public transportation in shaping the urban structure.[4]

E.Sustainability Considerations

Public transportation is often framed as a key component of building sustainable cities. Conversely, the social, economic, and environmental dimensions of sustainability are deeply intertwined with the development and operation of public transit systems.[5]

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[1] *Report on Transportation and Society*, Federal Highway Administration, U.S. Department of Transportation, n.d., p.44

[2] *Public Transportation Fact Book*, American Public Transportation Association, Washington, D.C., 2023, p. 34.

[3] Victor Pineda (ed.), "The Importance of Public Transportation" in *Accessible Public Transportation: Designing Service for Riders with Disabilities*, Routledge, New York, 2018, p. 45

[4] *Public Transport and Urban Structure, Travel Behaviour and Society*, Elsevier, n.d., p. 90.

[5] The article "Public transportation and sustainability: A review

2.1.4.Modes of Public Transport [1]

Public transport systems consist of a variety of modes that differ by capacity, speed, infrastructure requirements, and operational models. According to Vuchic (2007), public transport modes can be broadly categorized into road-based, rail-based, and water- or air-based systems, with further distinctions based on service type (scheduled vs. demand-responsive).

Table 02 : Modes of Public Transport

Mode	Definition	Examples/Subtypes	Strengths	Weaknesses / Limitations
Bus Systems	Road-based vehicles operating on existing street infrastructure	Standard buses, articulated buses, trolleybuses, Bus Rapid Transit (BRT)	Low capital costs, flexible routes	Prone to congestion, lower capacity
Rail-Based Transit	Operate on dedicated rail infrastructure	LRT, Metro/Subway, Commuter Rail, Tram/Streetcar	High capacity (especially metro), efficient over long distances	High infrastructure cost, less flexible
Paratransit & Demand-Responsive	Non-scheduled, flexible services based on user demand	Shared taxis, minibuses, ride-hailing apps	Flexible routing, serves underserved areas	Less predictable, lower regulatory oversight

[1] *Report on Transportation and Society*, Federal Highway Administration, U.S. Department of Transportation,n.d., p. 33.

Water-Based Transport	Vessels operating on rivers, lakes, or coastal waters	Ferries, water taxis	Useful in cities with water bodies	Weather-dependent, limited routing
Aerial & Cable Transport	Cable-driven systems used in difficult terrain or congested areas	Cable cars, funiculars	Effective in hilly/urban areas	Limited capacity and geographic use
Emerging & Hybrid Modes	Innovative or integrated transport modes often using new technology	Autonomous shuttles, e-buses, bike-sharing, e-scooters, Mobility-as-a-Service (MaaS)	Promotes multimodal integration, eco-friendly options	Still evolving, dependent on digital access and regulation

Ressource; VUCHIC (Vukan R.), *Urban Transit Systems and Technology*, Wiley, Hoboken (NJ), 2007, p.39 .

2.1.5.Public Transport and the Economy

A-Impact on Economic Growth and Job Creation

Public transportation is a fundamental component of urban infrastructure, playing a significant role in economic development. It enhances mobility, supports job creation, and stimulates local businesses. As highlighted in The Geography of Urban Transportation , public transit systems are not only a means of transportation but also a catalyst for economic prosperity.[1]

-Cost Savings for Individuals: Public transportation provides a cost-effective alternative to private vehicle ownership. individuals who rely on public transit save significantly on expenses related to fuel, insurance, parking, and vehicle maintenance. These savings increase disposable income, improving financial stability for households.[2]

[1]Susan Hanson and Genevieve Giuliano (eds.), *The Geography of Urban Transportation* (4th ed.), Guilford Press, New York, 2017, p. 21.
[2] Kenneth A. Small, *Transportation Economics*, Routledge, New York, 2012, p 32

- Job Creation: The public transit sector directly and indirectly generates employment opportunities. It is noted that public transport systems employ a range of professionals, from operators and maintenance workers to administrative staff. Furthermore, accessible transit allows individuals to commute to job centers, increasing workforce participation and reducing unemployment.[1]

-Local Business Development

Public transportation fosters commercial activity by increasing foot traffic to retail centers, restaurants, and service providers; the author emphasizes that transit-oriented development can boost property values, encourage business investments, and revitalize urban districts. Efficient public transit makes cities more attractive for businesses, enhancing economic competitiveness.[2]

-Reducing Environmental Costs

Beyond economic benefits, public transportation reduces environmental costs by lowering carbon emissions, transit systems reduce reliance on personal vehicles, leading to improved air quality and public health. The long-term financial savings from decreased healthcare costs and environmental damage contribute to overall economic sustainability.[3]

[1] Kenneth J. Button, *Transport Economics* (3rd ed.), Edward Elgar Publishing, Cheltenham, 2010, p.13
[2] Harry T. Dimitriou, *Sustainable Transport: Mobility for Developing Cities*, Routledge, London, 2011, p.45.
[3] William R. Black, *Sustainable Transportation: Problems and Solutions*, Guilford Press, New York, 2010, p98

Section 3: User Experience and Digital Engagement

Public transport plays a crucial role in urban mobility, yet user satisfaction remains a key challenge. The experience of passengers is shaped by various factors, including reliability, comfort, and accessibility. improving the user experience can enhance ridership levels and overall system efficiency.[1]

3.1.Challenges Faced by Users

In today's dynamic urban environments, public transport plays a central role in ensuring mobility for all. However, the quality of user experience remains a persistent concern, often shaped by issues such as reliability, safety, accessibility, and comfort. As cities grow and mobility demands increase, identifying and addressing the everyday difficulties faced by passengers becomes essential. Improving the user journey from entry points to payment requires a clear understanding of their expectations, behaviors, and pain points in order to design services that are more inclusive, efficient, and aligned with modern lifestyles.

3.1.1. Overcrowding, Delays, and Safety Concerns

Overcrowding, unpredictable delays, and safety issues are common pain points in public transportation. In Public Transport Planning and Operation, it is noted that overcrowding leads to increased stress levels, reduced travel satisfaction, and a decline in perceived service quality. Delays, particularly during peak hours, disrupt commuting patterns and impact workforce productivity. Additionally, security concerns, especially in poorly monitored transit areas, contribute to passenger discomfort and hesitancy in using public transport.[2]

3.1.2. Accessibility Issues for People with Disabilities

Accessibility remains a major barrier for individuals with disabilities. Inclusive Transport: Fighting Inequality in Mobility highlights the importance of designing transit systems that accommodate all users, including those with mobility impairments. Many public transit networks lack adequate infrastructure, such as ramps, tactile paving, and auditory announcements, making travel difficult for individuals with disabilities.[3]

3.2-Expectations of Passengers

3.2.1. Reliability, Affordability, and Comfort

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[1] Margareta Friman, Dick Ettema and Lars E. Olsson, *The Passenger Experience of Public Transport*, Routledge, New York, 2018, p 67

[2] Stephen Ison and Corinne Mulley, *Public Transport Planning and Operation: Modeling, Practice and Behavior*, Routledge, Abingdon, 2017, p35

[3] *Karen Lucas, Inclusive Transport: Fighting Inequality in Mobility, Routledge, London, 2012, p 124*

Passengers expect public transport to be dependable, cost-effective, and comfortable. The Transport System and Transport Policy discusses how frequent service disruptions and high fares discourage ridership. Affordable and efficient transit systems contribute to urban sustainability and social equity by ensuring accessibility for lower-income populations.[1]

3.2.2. Digital Tools for Real-Time Tracking and Planning

The integration of digital solutions enhances user experience by providing real-time information on arrivals, departures, and disruptions. As stated in Smart Urban Mobility: Trends, Concepts, and Best Practices , mobile apps and intelligent transport systems (ITS) allow passengers to make informed travel decisions, improving efficiency and reducing uncertainty.[2]

3.3-Pain Points and Areas for Improvement

- **Service Frequency and Reliability :** Public transport agencies must optimize schedules and minimize delays to improve passenger satisfaction.
- **Safety Measures** : Enhanced surveillance, better lighting, and increased security presence can improve passenger confidence.
- **Accessibility Upgrades :** Investing in barrier-free infrastructure ensures equitable mobility for all users.
- **Comfort Enhancements :** Improved seating, better ventilation, and reduced overcrowding contribute to a more pleasant journey.

3.4-Digitalization of Transport and Passenger Experience

The integration of digital technologies in public transportation has revolutionized passenger experience, enhancing efficiency, accessibility, and convenience. According to Smart Urban Mobility: Trends, Concepts, and Best Practices (Geurs, Patuelli and Pineda, 2021), digitalization optimizes transport networks, reduces travel uncertainty, and improves overall system usability.[3]

3.4.1-How Technology Improves Usability

A-Mobile Apps for Route Tracking and Trip Planning

[1] Kenneth J. Button and David A. Hensher, Handbook of Transport Systems and Traffic Control, Pergamon, Oxford, 2001, p *45*

[2] *Karst T. Geurs, Roberto Patuelli and Antonio Pineda (eds.), Smart Urban Mobility: Trends, Concepts, and Best Practices, Elsevier, Amsterdam, 2021, p324*

[3] Karst T. Geurs, Roberto Patuelli and Antonio Pineda (eds.), *Smart Urban Mobility: Trends, Concepts, and Best Practices*, Elsevier, Amsterdam, 2021, p 210

Real-time journey planning tools have transformed urban mobility by providing passengers with live updates on routes, schedules, and delays. how mobile applications such as Google Maps, Citymapper, and proprietary transit apps help commuters make informed decisions. These technologies reduce waiting times and increase efficiency, leading to higher passenger satisfaction.[1]

B-Contactless Payments and Ticketing Systems

Digital payment solutions have streamlined fare collection, making transactions quicker and more secure.The adoption of contactless cards, mobile wallets, and QR code-based ticketing, which minimize physical interactions and reduce congestion at ticket counters. These innovations also enhance accessibility for tourists and occasional riders who may not have traditional fare cards.[2]

C-Smart Stations and Automated Scheduling

The implementation of smart infrastructure has improved the functionality and reliability of transit systems.Smart stations equipped with automated ticketing, digital displays, and AI-driven scheduling systems optimize passenger flow and reduce congestion. Automation also allows for predictive maintenance, preventing service disruptions and ensuring smooth operations.[3]

3.2.Challenges and Pain Points in Transport Usage :

3.2.1. New Digital Requirements :

IT can be a pain point for many transportation companies. Many still stick to traditional logs, records, and paperwork. This is a problem, and digital requirements on a government level are also putting pressure on transport companies that are stuck in the dark ages.

TMS platforms are simple and user-friendly enough to help companies that are still using outdated tracking practices get with the times.

3.2.2. Industry Demand for Digital Transformation :

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[1] *Luca Mora, Intelligent Transport Systems: Smart and Green Infrastructure Design, Elsevier, Amsterdam, 2020, p.54*

[2] Corinne Mulley and John D. Nelson, *Public Transport and Smart Mobility: Transitioning to a Mobility-as-a-Service Model*, Taylor & Francis, London, 2020, p78

[3] *David A. Hensher, The Digital Transformation of Transportation: Economic Perspectives, Edward Elgar Publishing, Cheltenham, 2021, p 47*

Digital transformation involves taking a company's traditional strategies and business models and examining what can be done to make them more competitive from a digital standpoint. This is a big reason why transportation management systems are such beneficial tools to implement into a transport business. Not only can a TMS present a number of tools that can replace old, outdated analog processes, but a TMS is also designed to be user-friendly across all departments for drivers, administration, management, and everyone in between.

3.2.3. Integrating the Supply Chain

It's no secret that trade has globalized on an incredible level. Products are purchased and sold to and from different entities around the world. For this to even work, the transportation industry has had to examine trade flows and international politics, as well as ever-changing supply and demand.

Integrating the supply chain isn't just about following trade policies. Transportation companies must also take into consideration the different points within the supply chain to prevent data silos. With transportation management systems, this can easily be managed.[1]

3.2.4. Transforming Core Systems :[2]

Transportation companies must know what their core systems look like. They also need to know this before trying to implement disruptive technology into their business at any level. This can be a challenge, as many transportation companies grow disparately and stakeholders may have difficulty understanding the business as a whole. Transportation management systems can revive a company and modernize how its supply chain administration operates.

3.2.5. The Rise of Automation :

Automation and AI are going to be big components of the transportation company of the future. From order fulfillment to driver tracking to product monitoring, automation can be a

[1] Martin Christopher, *Logistics and Supply Chain Management*, 5th ed. (Harlow, UK: Pearson Education, 2016).
[2] Amit Sinha et al., *Digital Supply Networks: Transform Your Supply Chain and Gain Competitive Advantage with Disruptive Technology and Reimagined Processes* (Hoboken, NJ: Wiley, 2020).

huge benefit to any transport company. Consumers and clients are pushing for these modern transport techniques as well. However, it can be difficult to pinpoint exactly what area of the company needs automation the most.

A TMS tackles and automates all of the relevant processes within a transport business. When you work closely with a vendor, they can determine what your real pain points are and what tedious tasks can be allocated to a TMS platform.

3.2.6. Improving Cybersecurity :

As we continue through a digitally evolving economy, businesses are using technology and evolving digital tools more than ever before. Unfortunately, so are hackers and other cybercriminals. Transportation companies are not strangers to hacking, either. And many cyber attacks come from within the organization.

Without a decent transportation management system, workers can accidentally provide internal vulnerabilities that could lead to serious cyber attacks. Just as well, without a decent protocol in place, many workers may not follow specific processes to prevent such attacks from happening. This is an age-old problem that the transport industry has dealt with for a long time.

While there is yet to be a permanent solution to this problem, a transport management system is an excellent and secure tool to implement into your operations. TMS platforms are designed to be accessed only by authorized personnel, and the platform itself can be customized based on a company's specific use cases and security needs.[1]

3.2.7. Changing Customer Expectations :

Consumer desires change with evolving technology. Just as well, consumers are more informed about transportation and relevant technology than ever before.This means that they have bigger expectations, especially when it comes to communication and transparency. In

[1] Luke Tuttle and Mykel J. Kochenderfer, eds., *Cybersecurity for Transportation Systems* (Cham, Switzerland: Springer, 2022).

order to offer the most value to consumers, transport companies will need to have a better grip on how new tech impacts the transportation industry and implement TMS platforms now.[1]

[1] https://www.transplus.io/blog/7-major-challenges-facing-the-transportation-industry-in-2022 consulted the 16/05/2025 at 12:34

Section 4: Operational Efficiency and Company Perspective

Operational efficiency refers to the ability of a company to deliver products or services in the most cost-effective manner possible without compromising on quality. It involves the optimal use of resources,such as time, labor, and capital to minimize waste, streamline workflows, and maximize productivity. In today's rapidly evolving digital landscape, operational efficiency has become a key strategic priority for organizations seeking to remain competitive and responsive to market demands.

With the rise of digital transformation, companies are increasingly adopting advanced technologies such as artificial intelligence, machine learning, Internet of Things (IoT), and automation to enhance their operational performance. These tools offer new possibilities for predictive maintenance, real-time monitoring, and intelligent decision-making, all of which contribute to smoother operations, better resource utilization, and improved customer satisfaction.

This section explores how digital tools can significantly enhance operational efficiency from the company's perspective. It focuses on three key areas: the deployment of predictive maintenance and automated scheduling systems, the modernization of revenue management through digital ticketing and analytics, and the integration of advanced security systems such as AI-based monitoring and biometric technologies to prevent fraud and enhance trust.

4.1.Enhancing Operational Efficiency Through Digital Tools

4.1.1.Predictive Maintenance

Predictive maintenance (PdM) utilizes data-driven techniques to anticipate equipment failures, allowing for timely interventions that minimize downtime and maintenance costs. By collecting and analyzing data over time, patterns and correlations can be identified to predict and prevent failures. This approach is particularly beneficial in manufacturing industries, where unplanned downtime can be costly. The implementation of PdM strategies has become increasingly feasible with the advent of Industry 4.0 and smart systems, which emphasize the use of predictive maintenance to reduce downtime costs and increase equipment availability.[1]

Advanced sensors installed on machinery enable constant monitoring of production activities, collecting vast amounts of data that describe equipment behavior and performance over time. Effective processing and analysis of this data facilitate informed decision-making processes within companies. Predictive maintenance strategies can be implemented through various data

[1]Archit P. Kane et al., "Predictive Maintenance Using Machine Learning", *arXiv preprint*, arXiv:2205.09402, 2022, p 76

analytics methodologies, including anomaly detection, predictive analytics, and Remaining Useful Life (RUL) estimation.[1]

4.1.2.Automated Scheduling Systems

Automated scheduling systems leverage machine learning algorithms to optimize maintenance plans and operational workflows. By analyzing historical data and real-time inputs, these systems can forecast equipment failures, identify safety hazards, and optimize maintenance schedules. Integrating machine learning into maintenance procedures involves generating dashboards or alerts for maintenance crews and automating maintenance scheduling, thereby enhancing operational efficiency.[2]

4.2.Revenue Management & Digital Ticketing

4.2.1.Digital Fare Collection and Analytics

Automated Fare Collection (AFC) systems have revolutionized public transportation by automating ticketing processes, leading to increased efficiency and reduced operational costs. These systems often utilize contactless smart cards, enabling seamless integration across various modes of transport. The implementation of AFC systems has been widespread, with notable examples including the OV-Chipkaart in the Netherlands and the Octopus card in Hong Kong. [3]

The integration of digital fare collection systems with Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP) systems allows businesses to gather valuable insights into customer behavior, sales trends, and event attendance. This data is crucial for making informed decisions that enhance customer satisfaction and optimize operations.[4]

4.2.2.Real-Time Revenue Tracking

Real-time revenue tracking enables businesses to monitor ticket sales instantaneously, identify peak purchasing periods, and adjust marketing efforts accordingly. The use of AI tools in ticketing platforms can analyze purchasing patterns and suggest optimal pricing strategies or promotional campaigns. By embracing digital ticketing, businesses can improve user

[1] Tania Cerquitelli, Nikolaos Nikolakis and Niamh O'Mahony, "Predictive Maintenance in Smart Factories: Architectures, Methodologies, and Use-Cases", 2023, p 311

[2] Smart Technologies for Improved Performance of Manufacturing Systems and Services", in *Advances in Intelligent Decision-Making, Systems Engineering, and Project Management*, Springer, 2023, p 122

[3] Automated Fare Collection", 2025, p5.

[4] ARED Group, *The Future of Digital Ticketing Systems,* ARED Group Publications, 2025, p.86

experiences and achieve significant cost savings and operational efficiencies driven by valuable real-time insights.[1]

4.3.Security and Fraud Prevention

4.3.1.AI-Based Monitoring

Artificial Intelligence (AI) has become a pivotal tool in enhancing security measures and combating fraud in digital transactions. AI-driven behavioral biometrics analyze user-specific behavioral patterns, such as keystroke dynamics and mouse movements, to identify deviations from normal behavior that may indicate fraudulent activities. This dynamic and adaptive approach offers a more accurate method for securing financial transactions and reducing fraud.[2]

Incorporating AI-based security solutions can detect and prevent fraudulent activities by analyzing patterns and identifying anomalies in user behavior. For instance, AI-powered systems can inspect incoming calls to ensure authenticity before the caller reaches an agent, enhancing the security of contact center interactions.[3]

4.3.2.Biometrics in Ticketing

Biometric authentication methods, such as fingerprint, facial, and iris recognition, have emerged as effective solutions for securing digital transactions and preventing fraud.[4] The integration of biometric systems with AI-driven analytics creates robust fraud prevention frameworks by enhancing identity verification and anomaly detection. This synergy not only strengthens security measures but also streamlines the user experience.[5]

4.4.Digital Payment Systems

The integration of digital payment systems such as e-wallets, QR codes, and smart cards has revolutionized the transportation sector by enhancing operational efficiency, reducing cash handling, and improving user convenience. However, the adoption of these technologies is accompanied by challenges related to infrastructure, security, and user adaptation.[6]

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[1] Idem

[2] Mei Song, "Financial Fraud Prevention with AI-Based Behavioral Biometrics", *ResearchGate*, 2022, https://www.researchgate.net/, [Accessed: 09/02/2025].

[3] AI-Based Security Solutions Can Detect & Prevent Fraudulent Activity", *Security Magazine*, 2025, https://www.securitymagazine.com/, [Accessed: 09/02/2025].

[4] Real-Time Fraud Mitigation in Digital Payments: Big Data and AI-Driven Biometric Authentication", n.d., p.45

[5] Iyanu Samuel Ayebo, "Biometric Authentication and AI in Fraud Prevention: A Deep Research Analysis", *ResearchGate*, 2024, https://www.researchgate.net/, [Accessed: 24/04/2025]

[6] S. L. Tripathi, *Digital Payment Technologies*, [Publisher not specified], 2021, p 231

4.4.1.E-Wallets

E-wallets, or mobile wallets, are digital applications that allow users to perform financial transactions via smartphones. They facilitate services like money transfers, bill payments, and purchases without the need for a traditional bank account. The convenience and accessibility of e-wallets have made them particularly valuable in promoting financial inclusion and streamlining fare collection in public transportation systems. Their adoption reduces reliance on physical cash, thereby minimizing transaction times and associated operational costs.

4.4.2.QR Code Payments

QR (Quick Response) codes have emerged as a cost-effective and flexible tool in digital payment ecosystems. They enable contactless transactions by allowing users to scan codes to initiate payments. In the transportation sector, QR codes facilitate quick fare payments and can be integrated into various platforms, enhancing the user experience and operational efficiency. Their low implementation cost and ease of use make them particularly attractive for small vendors and public transport systems.

4.4.3.Smart Cards

Smart cards are physical cards embedded with integrated circuit chips capable of securely storing and processing data. In transportation, they are widely used for fare collection, enabling users to load funds and access services seamlessly. Smart cards support both contact and contactless interactions, offering flexibility and speed in transactions. Their robust security features and ability to store multiple applications make them a reliable choice for public transport systems.[1]

4.5.Challenges in Adoption

4.5.1.Infrastructure Limitations: The successful implementation of digital payment systems requires robust infrastructure, including reliable internet connectivity and widespread availability of compatible devices. In regions with inadequate infrastructure, the adoption of these technologies can be hindered, affecting the efficiency and reliability of payment systems.[2]

4.5.2.Security Concerns: Digital payment systems are susceptible to security threats such as data breaches, unauthorized access, and fraud. Ensuring the security of transactions and protecting user data are paramount to maintaining trust and encouraging widespread adoption. Implementing advanced encryption methods and adhering to stringent security protocols are essential measures to mitigate these risks.

[1]Wolfgang Rankl and Wolfgang Effing, *Smart Card Handbook* (4th ed.), Wiley, Chichester, 2010, p 87.
[2]Debasis Mukhopadhyay, "Digital Payment Systems: Secure and Inclusive", *Future Internet*, Vol. 14, No. 9, 2022, Article 287, p 76

4.5.3.User Adaptation: The transition from traditional payment methods to digital systems requires users to adapt to new technologies. Factors such as digital literacy, trust in technology, and resistance to change can impede this transition. Comprehensive user education and awareness campaigns are necessary to facilitate smooth adoption and maximize the benefits of digital payment systems.[1]

[1]The Emerging Technologies of Digital Payments and Associated Challenges: A Systematic Literature Review", *Future Internet*, Vol. 15, 2023, Article 23, 984

Conclusion

This first chapter provided a foundational understanding of the digital transformation process within the context of urban public transport, with a particular focus on smart cities. Through an exploration of theoretical concepts, historical developments, and current innovations, we were able to grasp how digitalization is not only reshaping infrastructure and services but also redefining the relationship between cities, transport systems, and their users.

We learned that digitalization is a long-evolving process rooted in technological progress and urban planning trends, culminating in the development of smart cities. These cities rely on the integration of data, connectivity, and intelligent systems to create more efficient, livable, and sustainable urban environments. Understanding the components of smart cities such as mobility, governance, energy, and communication has helped frame public transport as a central pillar in achieving smart urban development.

Beyond merely moving people, public transport serves as a backbone for economic growth, social inclusion, and environmental sustainability. I also realized that different transport modes (bus, underground, tram, etc.) offer varying digitalization potentials, each requiring tailored strategies based on their operational structures and user expectations.

We explored the importance of user experience (UX) in the success of digital transformation. This part of the study made it clear that digital tools must be designed with the passenger in mind. Key pain points such as long waiting times, unclear information, and cash-only systems highlight the gap between current services and user needs. Digital engagement, therefore, becomes a way to build trust, increase usage, and deliver more inclusive mobility experiences.

And Finally,We understood how companies can use digital tools to enhance efficiency, reduce fraud, and improve revenue management through smart ticketing and payment systems. However, the section also revealed several challenges in adoption, including limited budgets, outdated infrastructure, and organizational resistance.

This chapter has shown that while the potential of digital transformation in urban public transport is immense, its success depends on strategic alignment between user needs, technological solutions, and institutional readiness. The knowledge gained here forms the theoretical foundation for the practical case studies and fieldwork explored in the following chapters.

Chapter two

Empirical Study on Digitalization in Public Transport in Algeria

Introduction

This second chapter aims to address our central research question, which is to assess the impact of integrating modern digital payment methods into public transport systems in Algeria, highlighting their influence on operational efficiency and passenger satisfaction.

In the previous chapter, we explored the fundamental concepts related to digital transformation, smart cities, user experience, and operational optimization mechanisms. This second chapter will be dedicated to the empirical study conducted in the Algerian context.

In the first section, we will present the transport companies studied namely ETUSA, SEMA (Algiers Metro), and SETRAM highlighting their missions, services, technological developments, and degree of digital integration. The second section will then detail the methodology adopted for our field study, combining both a quantitative approach (questionnaire survey of users) and a qualitative approach (semi-structured interviews with internal managers).

The third section will present the results of the quantitative survey, processed using the Jamovi software, through descriptive analysis, hypothesis testing, and cross-variable correlations. These results will help assess the real impact of digitalization on user experience and the performance of transport operators.

Finally, this study aims to outline the theoretical, practical, and managerial contributions of the work, while formulating concrete recommendations for stakeholders in the sector. These findings will be put into perspective with the insights drawn from the academic literature explored in the first chapter.

Section 01 : Transport Operators Presentation

In this section, we will present the field of our study, focusing on the three main public transport companies in Algeria: ETUSA, Métro El Djazaïr, and SETRAM. This overview aims to provide a clear understanding of the organizational and operational context in which our research was conducted.

1. Presentation of the Urban and Suburban Transport Company of Algiers[1]

The Entreprise de Transport Urbain et Suburbain d'Alger (ETUSA) is a public industrial and commercial establishment (Établissement Public à Caractère Industriel et Commercial, EPIC) responsible for the provision and management of urban and suburban transportation services in the Algiers province. It plays a crucial role in the mobility of the city's population and contributes to the economic and social development of the region.

1.2. Historical Background

ETUSA was established in 1959 under the name Régie Syndicale des Transports Algérois (RSTA). Initially, the company was created to manage public transportation in the capital, ensuring accessibility for residents. Over the decades, ETUSA has undergone significant restructuring to modernize its services and expand its operations. Today, it stands as a key player in Algeria's public transport sector.

1.3. Core Services

1.3.1.Public Transport Services

ETUSA operates an extensive bus network with 124 lines covering both urban and suburban areas of Algiers. These services are designed to facilitate mobility for commuters, reduce congestion, and offer an affordable alternative to private transportation.

1.3.2.Training and Capacity Building

The company also manages a driving school aimed at training and certifying professional drivers. This initiative supports the development of skilled labor within the transport sector and ensures high safety standards in urban mobility.

1.4. Recent Technological Developments

[1] ETUSA (2024), *Company History and Services*, [en ligne] Disponible sur : www.etusa.dz consulté le 24/05/2025 à 15:30.

In response to the growing demand for efficiency and digital transformation, ETUSA has introduced innovative technological solutions:

- **E-Khadamati:** In March 2024, ETUSA launched an electronic payment system (e-Khadamati), allowing passengers to recharge their transport subscriptions online. This system aims to improve convenience, reduce cash handling, and streamline the ticketing process.

- **Real-Time Tracking:** The company is progressively integrating digital tools to enable real-time tracking of buses, enhancing the reliability and predictability of public transport services.

1.5. Organizational and Operational Structure

ETUSA is structured to optimize service delivery through various operational divisions, including fleet management, passenger services, infrastructure maintenance, and technological innovation. It collaborates with local and national authorities to ensure regulatory compliance and continuous improvements in urban transport policies.

ETUSA remains a cornerstone of public transportation in Algiers, continuously adapting to new challenges such as increasing urbanization, environmental concerns, and the need for digital transformation. Through its extensive network and recent innovations, it seeks to enhance mobility, reduce traffic congestion, and contribute to the sustainable development of the city[1]

2.Presentation of Algiers Metro Operating Company SEMA [2]

Métro El Djazaïr is a 100% subsidiary of the Entreprise Métro d'Alger (EMA) and operates as a national company with a capital of 300,000,000 DZD. Established in 2020, the company is responsible for the operation and maintenance of the Algiers Metro network. It plays a vital role in the urban mobility of the capital, offering a safe, comfortable, and efficient transport solution across key municipalities.

[1] AOTU-Alger (2024), *Transport and Training Initiatives*, [en ligne] Disponible sur : www.aotu-alger.dz consulté le 25/05/2025 à 15:45.
[2] EMA (2024), *Métro El Djazaïr – Mission et Engagements*, [en ligne] Disponible sur : www.metroalger.dz consulté le 14/03/2025 à 10:30

2.1.Historical Background

Although the Algiers Metro was inaugurated in 2011, Métro El Djazaïr was specifically created in 2020 to take over and professionalize its operation and maintenance. The launch of this company marked a new phase in the modernization and sustainable development of urban transport in Algiers. Since its inception, Métro El Djazaïr has positioned itself as a symbol of reliability and excellence in the field of mass transit.

2.2.Core Services

2.2.1.Metro Operations

Métro El Djazaïr oversees a network stretching over 16.8 km, covering 19 stations across 10 municipalities in Algiers. The company ensures the safe and efficient transport of approximately 150,000 passengers daily. Key responsibilities include service activation, traffic regulation, equipment monitoring, passenger orientation, and staff training.

2.2.2.Maintenance

Maintenance operations are at the heart of service reliability. The company applies a proactive approach focused on anticipation and regular planning. Services include train servicing, infrastructure and systems maintenance, and technical training for maintenance teams to uphold the integrity of the rail system.

2.3.Corporate Values

Métro El Djazaïr is guided by a strong set of values that shape its internal culture and client relationships:

- **Professionalism:** Commitment to expertise and high-quality service
- **Responsibility:** Ensuring safe, consistent, and eco-friendly transport
- **Trust:** Building strong relationships with passengers and staff
- **Innovation:** Implementing creative solutions to improve performance
- **Performance:** Meeting daily challenges to satisfy user expectations

2.4.Strategic Missions

- Deliver a high-standard, secure, and comfortable metro service
- Adhere to international quality and performance benchmarks
- Integrate innovation and modern technologies to enhance operations
- Promote sustainable and civic-minded development policies
- Establish Métro El Djazaïr as a leader in urban transport in Algeria and beyond

Métro El Djazaïr is more than a transport operator; it is a key player in the evolution of urban mobility in Algiers. Through its commitment to safety, innovation, and environmental responsibility, the company aims to become a regional benchmark for sustainable metro services.[1]

3.Presentation of SETRAM: Company for the Operation of Tramways.[2]

SETRAM is a 100% Algerian company responsible for operating and maintaining tramway networks across Algeria. Established in 2012, SETRAM plays a pivotal role in enhancing urban mobility in several Algerian cities, including Algiers, Oran, Constantine, Sidi Bel Abbès, Ouargla, Sétif, and Mostaganem. With a commitment to safety, comfort, and efficiency, SETRAM serves as a cornerstone in the nation's public transportation infrastructure.

3.1. Historical Background

SETRAM was founded in September 2012 as a joint venture between the Entreprise du Métro d'Alger (EMA), the Etablissement Public de Transport Urbain et Suburbain d'Alger (ETUSA), and the French company RATP Dev. Initially, RATP Dev held a 49% stake, while EMA and ETUSA held 15% and 36%, respectively. In March 2023, SETRAM became entirely Algerian-owned after Transtev acquired the shares previously held by RATP Dev.

3.2. Core Services

[1] AOTU-Alger (2024), *Urban Mobility and Infrastructure*, [en ligne] www.aotu-alger.dz, consulté le 12/03/2025 à 23:20.
[2] SETRAM, *Site officiel*, [en ligne] www.setram.dz, consulté le 04/04/2025 à 20:45.

3.2.1.Tramway Operations

SETRAM operates tramway services in seven Algerian cities:

- **Algiers** (since May 2011)
- **Oran** (since May 2013)
- **Constantine** (since July 2013)
- **Sidi Bel Abbès** (since July 2017)
- **Ouargla** (since March 2018)
- **Sétif** (since May 2018)
- **Mostaganem** (since February 2023)

These networks collectively enhance urban connectivity, reduce traffic congestion, and provide reliable transportation options for residents.

3.2.2.Maintenance and Engineering

SETRAM is responsible for the maintenance and engineering of tramway infrastructure and rolling stock. The company ensures the safety and reliability of services through regular inspections, preventive maintenance, and the implementation of advanced engineering solutions.

3.2.3.Training and Capacity Building

To support its operations, SETRAM has established training centers in Algiers, Ouargla, Constantine, and Oran. These centers focus on developing the skills of tramway operators, maintenance personnel, and other staff, ensuring high standards of service delivery.

3.3. Recent Developments

- **Transition to Full Algerian Ownership**: In March 2023, SETRAM became entirely Algerian-owned, marking a significant milestone in the country's transportation sector.

- **Expansion of Services**: The inauguration of the Mostaganem tramway in February 2023 expanded SETRAM's operational footprint, further enhancing urban mobility in

Algeria.

- **Recognition**: SETRAM received the "Project of the Year over €50 million" award at the 2017 Light Rail Awards in London for its work on the Sidi Bel Abbès tramway.

3.4.Organizational Structure

SETRAM's organizational framework includes divisions dedicated to operations, maintenance, engineering, and training. The company's headquarters is located in Kouba, Algiers, and it employs a workforce committed to delivering high-quality tramway services across its operational areas.

SETRAM stands as a key player in Algeria's public transportation landscape, offering efficient and reliable tramway services across multiple cities. Through its commitment to excellence, innovation, and local capacity building, SETRAM contributes significantly to the sustainable development and modernization of urban mobility in Algeria.

Section 02 : Survey Methodology and Data Analysis

This section presents the practical part of our research. It outlines the methodology used, including the type of research, data collection process, and sampling method. It also provides an overview of the survey conducted in five Algerian cities and explains how the data was analyzed using statistical tools.

The aim is to understand users' experiences with public transport and evaluate how digitalization such as payment systems and real-time information can improve both satisfaction and operational performance. The results from the questionnaire and statistical analysis help validate the hypotheses discussed in the theoretical chapter.

1. Type of Research Chosen

The main objective of this research is to evaluate user satisfaction with public urban transportation services in Algeria. The study seeks to understand users' current experiences, identify recurring issues, and assess their openness to potential improvements, particularly in terms of digitalization such as diversified and modern payment methods, real-time information, and overall system modernization.

2. Presentation of the Survey and the Sample

2.1. Choice of the Research Area

This study was conducted across five major regions in Algeria: Algiers, Oran, Blida, Tipaza, and Bordj Bou Arreridj. These areas were selected due to their high population density and significant reliance on public urban transport, making them suitable for a representative and diverse sample.

2.2. Data Collection

Data was collected through a Google Forms online questionnaire, which allowed for wider and more efficient outreach across the selected regions.
The survey was available for a full month, giving participants sufficient time to respond. This method was chosen over in-person surveys due to practical constraints and the advantages of reaching a broader demographic through digital platforms.

2.3. The Questionnaire and its Objective

2.3.1.Purpose of the Questionnaire

The questionnaire was designed with two main objectives:

- First, to gather detailed insights into users' experiences with the current public urban transport system (bus, tramway, metro).

- Second, to measure their level of satisfaction and explore their willingness to accept and adopt new features, particularly in terms of digital transformation (e.g., diversified payment methods, safety of digital transactions, access to real-time information).

2.3.2.Sampling

A total of 256 valid responses were collected from individuals residing in the targeted regions. The sample included users from various age groups, income levels, and employment statuses to ensure diversity and representativeness.
Respondents were invited to participate online, which allowed those actively using public transport to reflect on their experiences in real-time and in their own environment.

2.3.3.Sampling Method

Due to the absence of an official list of public transport users and limited access to in-person contact points, the sampling method used was non-probability convenience sampling via online channels.
This method was practical for gathering responses quickly and efficiently, given time and resource constraints. The approach allowed the research team to distribute the questionnaire broadly across social media and messaging platforms, targeting public transport users in the five selected regions.

2.3.2.Number of Responses and Validity

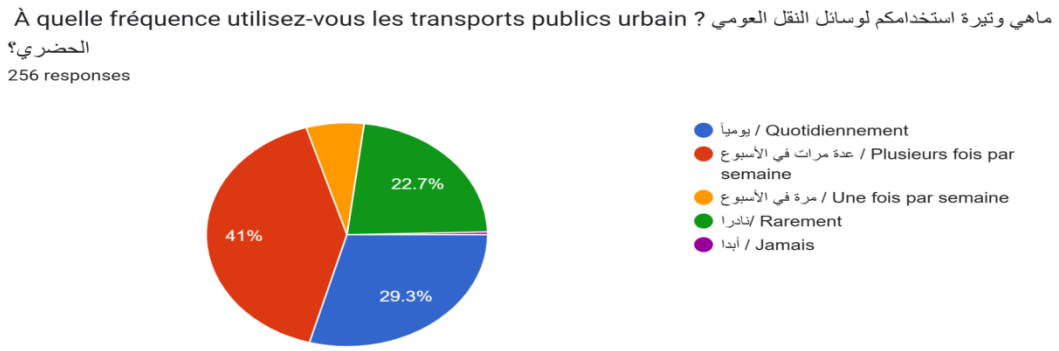
Out of the total responses received, 256 were considered valid and used for analysis. Some entries were excluded due to incomplete answers or inconsistent data.
The structure of the questionnaire based mostly on multiple-choice questions and scaled ratings helped ensure the clarity and reliability of the responses.

This study aims to identify the most important factors influencing user satisfaction, determine how well the current system meets public needs, and assess the public's readiness for innovations such as digital payments, real-time tracking, and overall smart transport features.
This structured methodology allowed for a clear, systematic interpretation of the data, facilitating insightful conclusions and practical recommendations for improving Algeria's public urban transport system.

2.3.3.Data processing and analysis :

A- Flat sorting :

Figure 01 : The frequency of urban mobility usage .



Resource : Our forum data, results collected from google sheets.

The chart above presents the responses of 256 users to the question “À quelle fréquence utilisez-vous les transports publics urbains ?” (How often do you use urban public transport?). The chart offers a clear overview of the distribution of usage frequency across five different categories, each represented by a distinct color and accompanied by Arabic translations to ensure bilingual accessibility.

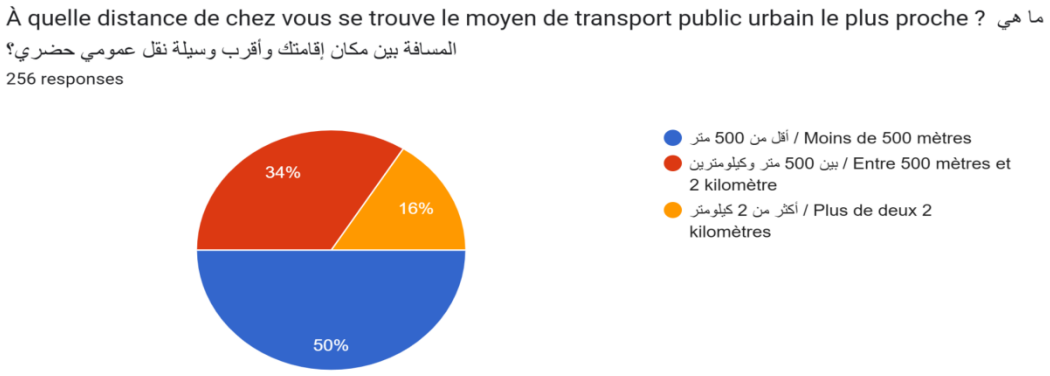
The largest portion of respondents, representing 41%, reported using public transportation “plusieurs fois par semaine” (several times a week), shown in red. This indicates that public transport is an integral part of the weekly routines for a significant portion of the population.

The second most common response, indicated in blue and comprising 29.3%, is “quotidiennement” (daily). This suggests that nearly one-third of users rely on public transport as their primary mode of commuting. When combined with the previous category, we see that a total of 70.3% of respondents use public transportation multiple times per week or more, highlighting a strong dependency on urban transit systems.

22.7% of users (green section) reported using transport “rarement”, which may reflect occasional or need-based usage, perhaps due to proximity to destinations or availability of alternative transport means. Meanwhile, 4.3% of respondents use public transportation only “une fois par semaine” (orange), and a very small segment, approximately 2.7%, indicated “jamais” (never), shown in purple.

The overall distribution indicates that urban public transport plays a critical role in the daily and weekly lives of the majority of users. With more than 70% of participants relying on it regularly, public transportation infrastructure appears to be a necessity rather than a convenience. However, the presence of 22.7% rare users and a small fraction of non-users suggests that certain barriers may exist—such as lack of coverage, comfort, timing, or personal preference—which could be worth investigating further.

Figure 02 : The main distance between passengers and transports stations



Resource : Our forum data, results collected from google sheets.

The chart above presents the responses of 256 users to the question: "À quelle distance de chez vous se trouve le moyen de transport public urbain le plus proche ?" (How far from your home is the nearest urban public transportation?). The bilingual format in French and Arabic ensures inclusivity and clarity across different language users in the target population.

The largest segment, representing exactly 50% of respondents (blue section), indicated that the nearest public transport is located less than 500 meters from their residence. This result reflects a relatively high level of accessibility to urban transport infrastructure for half of the surveyed population, likely encouraging regular usage due to convenience and proximity.

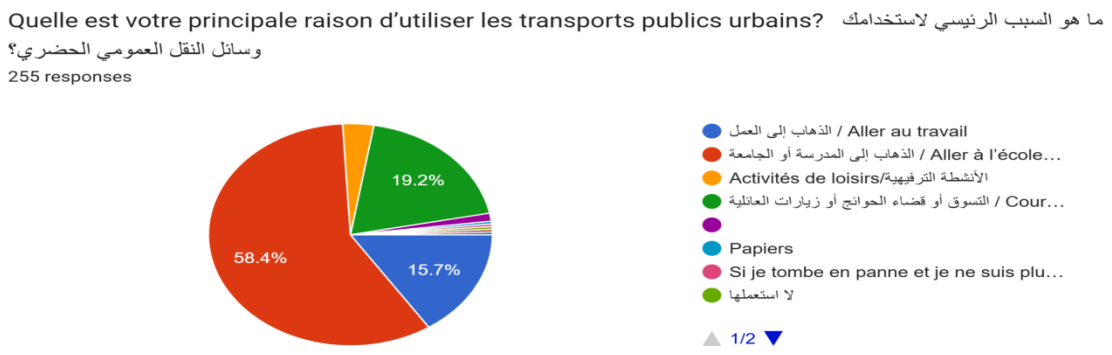
34% of users (red segment) reported that public transportation is located more than 2 kilometers away from their home. This significant portion may face challenges in accessing transport services, especially in the absence of connecting modes like bicycles, shuttles, or safe walking routes.

A smaller portion, 16% (orange section), stated that the nearest stop is located between 500 meters and 2 kilometers away. This middle range may represent users in semi-urban or suburban areas, or in zones with moderate coverage, who may need to walk or use secondary transportation to reach their nearest stop.

The use of color-coding and proportional representation allows for a quick visual grasp of the disparity in access distances.

The data reveals that while half of the users benefit from excellent proximity to public transport services (less than 500 meters), nearly one-third face significant access limitations (over 2 km away). This indicates a geographical gap in the distribution of transport infrastructure.

Figure 03 : The main reason of the use of transport



Resource : Our forum data, results collected from google sheets.

The chart above illustrates the responses of 255 individuals to the question: "Quelle est votre principale raison d'utiliser les transports publics urbains ?" (What is your main reason for using public transportation?), presented in both French and Arabic to ensure accessibility across a bilingual audience.

The largest portion of respondents, a striking 58.4% (represented in red), reported that their primary reason for using public transport is "Aller à l'école ou à l'université" (going to school or university). This dominant percentage suggests that students make up the majority of frequent users of urban transport, possibly due to the regularity of their commutes, limited access to private vehicles, or cost considerations.

The second most selected reason, accounting for 19.2% of responses (green), is "Courses et déplacements personnels" (personal errands and outings), indicating that nearly one-fifth of users rely on public transport for non-obligatory, everyday tasks such as shopping, visiting friends, or handling responsibilities.

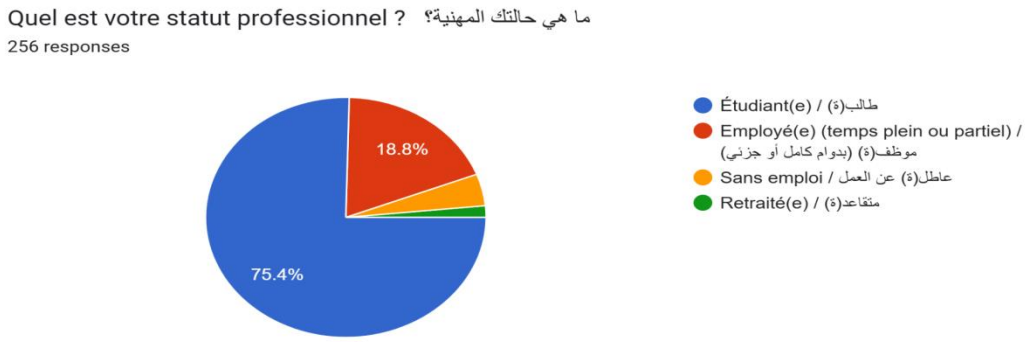
15.7% of users (blue) cited "Aller au travail" (commuting to work) as their main motivation, reflecting a significant though smaller segment of working individuals depending on public transit for professional purposes. This suggests that while working adults use public transport, they may be more likely to have alternative modes of transport compared to students.

Other reasons, including leisure activities, paperwork-related errands, occasional use during car breakdowns, and non-users, represent much smaller slices of the population, together making up less than 7% of the total responses.

The results clearly demonstrate that educational commuting is the leading driver of public transport usage among surveyed participants. This insight highlights the crucial role urban

transit systems play in supporting access to education. Meanwhile, the combined percentages for work and personal errands (over 34%) show that public transportation also fulfills a broad range of daily mobility needs beyond academic life.

Figure 04 : The professional status of the main audience



Resource : Our forum data, results collected from google sheets.

The chart above presents the responses of 256 participants to the question: "Quel est votre statut professionnel ?" (What is your professional status?), with multilingual labeling in French and Arabic to enhance comprehension and inclusivity across diverse respondents.

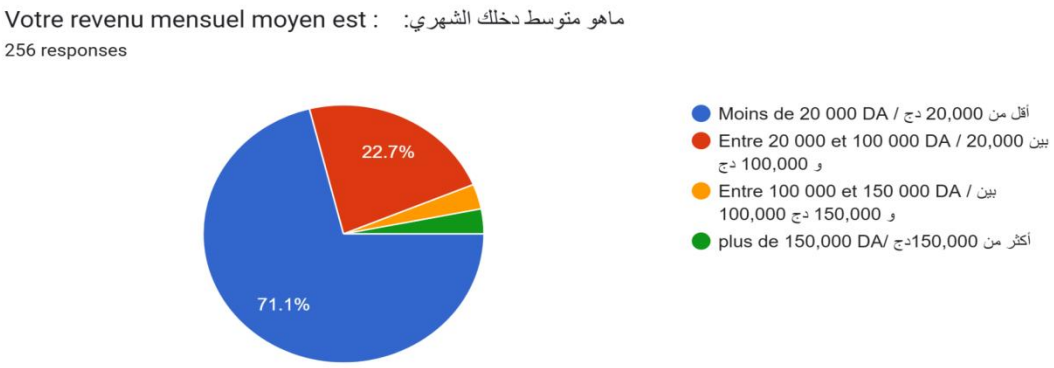
A significant 75.4% of the respondents (represented by the large blue segment) identified themselves as students (étudiant(e)s). This overwhelming majority confirms that the principal user base of the surveyed group consists of individuals pursuing education. This result aligns with earlier findings (Figure 03), where "aller à l'école ou à l'université" was the primary reason for using public transport. It also reinforces the idea that public transit plays a vital role in facilitating access to education.

The second-largest category, accounting for 18.8% (red section), comprises employees (temps plein ou partiel). While much smaller in comparison to the student group, this segment still represents nearly one-fifth of the respondents, indicating that public transport remains a meaningful commuting option for the working population.

Other categories include unemployed individuals (3.1%) and retired persons (2.7%), shown in orange and green respectively. These groups represent a small minority of the audience, likely due to either lower mobility needs or alternative transportation options.

The data clearly demonstrates that the student demographic dominates the surveyed population, making up three-quarters of total users. This finding is consistent with the earlier insight that education is the primary motivation for using public transportation

Figure 05 : The monthly revenue of the audience



Resource : Our forum data, results collected from google sheets.

The chart above illustrates the responses of 256 participants to the question: " Votre revenu mensuel moyen est :" (What is your average monthly income?), with bilingual labeling in French and Arabic to ensure clarity and accessibility for a linguistically diverse audience.

The largest segment of respondents 71.1% (in blue) reported earning less than 20,000 DA per month. This significant majority reflects the economic reality of the primary surveyed audience, who are predominantly students (as confirmed in Figure 04). Their limited or non-existent income aligns with their life stage and reliance on public services like transportation.

The second-largest group, comprising 22.7% of respondents (in red), indicated a monthly income between 20,000 DA and 100,000 DA. This group likely includes part-time workers, early-career professionals, or individuals receiving modest allowances or stipends.

A smaller portion 3.5% (orange segment) earns between 100,000 DA and 150,000 DA, possibly representing more established employees or individuals with stable professional income.

Finally, only 2.7% (green) reported earning more than 150,000 DA, suggesting that higher-income individuals are a minority within this sample and likely have different mobility or transport preferences.

The distribution of income levels reinforces prior findings: students, who often have limited income, form the core user base of the public transport system in this context. The dominance of the lowest income category (71.1%) directly supports earlier insights that education (Figure 03) and affordability (Figure 04) are key drivers for public transit use.

Synthesis :

The survey results offer a comprehensive view of public transport usage patterns and preferences among respondents. On a scale of 1 to 5, the average transport frequency is 3.04, indicating moderate usage, with 36.5% of participants selecting a frequency of 3 and 31.4% using transport very frequently (score of 5). Notably, 27.1% report rarely using transport (score of 1), reflecting a significant portion of infrequent users. In terms of distance traveled, the mean score is 1.78 on a 1–3 scale, suggesting that most respondents undertake short trips; 47.8% report traveling short distances, while only 26.3% make longer journeys.

As for the modes of transport, all respondents (100%) reported using the bus, likely due to the survey's design or the prevalence of buses in the transport system. However, usage of other modes is limited: only 10.6% use trams, and 21.6% use the metro. The primary purpose for travel is educational, with 52.2% using transport to attend school, followed by 21.2% for work-related travel. Leisure and shopping trips are less common, at 11% and 15.7%, respectively.

Transport-related issues are a major concern among users. A striking 83.9% report delays as a frequent problem, while 79.2% struggle with access to real-time travel information. Payment-related difficulties affect 63.5% of respondents, and 20.8% cite crowding as an issue. Regarding payment methods, the system is heavily reliant on cash, used by 89% of respondents. Only 16.1% use cards, and none reported using tickets, indicating limited adoption of modern or alternative payment methods. This aligns with the 62.7% of users who expressed a desire for more diverse payment options.

Security and satisfaction levels vary across payment types. Satisfaction with cash payment security is moderate (mean around 3), while digital payment security scores slightly higher (around 3.4). In terms of overall satisfaction, card payments yield greater satisfaction (mean ~3.8) compared to cash (mean ~3.2), suggesting a preference for digital methods among those who use them.

Demographically, the sample is dominated by young people, with 94.9% falling into the first age group, likely young adults or students. This is consistent with the employment data, where 78.8% identify as students, 16.1% are employed, and only 5.1% are retired. Income levels further reflect this demographic, with 73.7% earning less than 20,000 DZD monthly, and only 7.5% earning more than 150,000 DZD, indicating a low-income majority.

B.Cross-tabulation

We conducted a cross-tabulation analysis along with Chi-square and Pearson correlation tests using Jamovi software to explore relationships between user satisfaction and demographic variables such as age and gender. These statistical techniques allowed us to evaluate how

different user groups perceive the public transport services and digital features such as modern payment systems and real-time information.

-Study Variables & Hypotheses

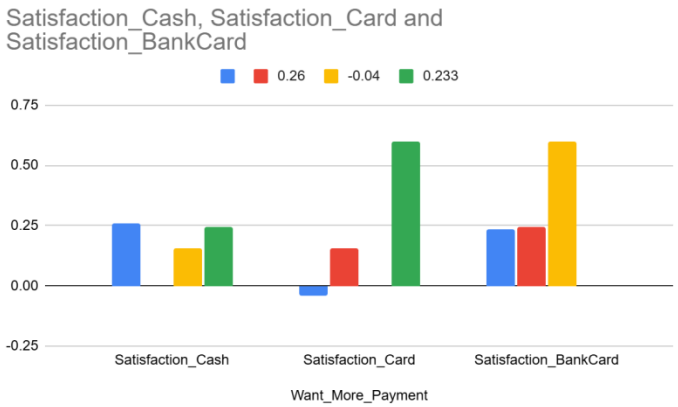
- **H1**: The diversity of modern payment methods has a positive effect on passenger satisfaction.

Table 03 : Correlation Matrix 01

Want_More_Payment	Satisfaction_Cash	Satisfaction_Card	Satisfaction_BankCard
—	0.260 (p = 0.051)	-0.040 (p = 0.777)	0.233 (p = 0.077)
0.260 (p = 0.051)	—	0.155 (p = 0.253)	0.246 (p = 0.051)
-0.040 (p = 0.777)	0.155 (p = 0.253)	—	0.601 (p < 0.001)
0.233 (p = 0.077)	0.246 (p = 0.051)	0.601 (p < 0.001)	—

Ressource : Our forum data, results collected from Jamovi.

Figure 06 : Correlation between satisfaction and diversity of payment method



Ressource : Elaborated by Jamovi.

There is a weak to moderate positive and statistically significant correlation. Individuals who are more satisfied with cash payments are more likely to want better pay. This may indicate that those who rely on cash may feel undercompensated or experience more financial stress.

There is a moderate, statistically significant positive correlation. This supports the idea that people who are satisfied with one form of card-based payment tend to be satisfied with others indicating a general favorability toward digital payments.

A weak but statistically significant positive correlation. Individuals who are satisfied with cash may also have a slightly positive attitude toward card payments, though the relationship is not strong.

Although this correlation appears moderately negative, the lack of statistical significance means that no reliable conclusion can be drawn. However, it could hint at a potential division between cash-preferring and digital-preferring users.

These correlations are very weak and not significant, indicating that digital payment satisfaction is not meaningfully related to the desire for increased payment.

This matrix reveals several key points:

a.There is a clear, positive relationship between satisfaction with cash and the desire for better pay, possibly suggesting that cash users feel more financial pressure.

b.Users satisfied with one type of digital card payment tend to be satisfied with others, showing consistency in digital payment experiences.

c.There appears to be no significant link between digital payment satisfaction and payment adequacy perception, possibly implying that digital payment methods are neutral tools, not influencing perceived fairness of compensation.

-Main recommendations :

- Cash-reliant workers might require greater financial support or targeted compensation strategies.

- Promoting card and bank card options may benefit from the positive correlation in user satisfaction, easing adoption.

- Future studies could explore whether payment method preference correlates with socioeconomic status, helping tailor platform features or government interventions.

H2: Simplifying payment processes improves both the operational efficiency of companies and passenger satisfaction.

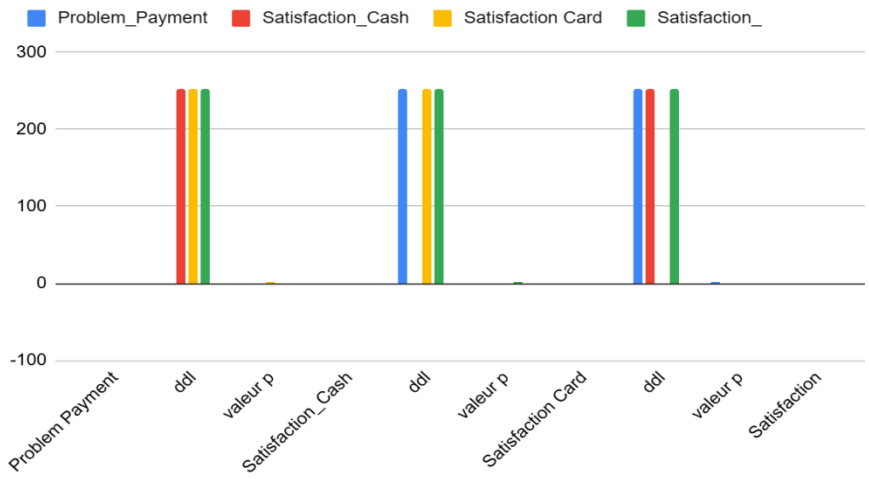
Table 04 : Correlation Matrix 02

	Problem_ Payment	**Satisfacti on_Cash**	**Satisfaction Card**	**Satisfaction_ BankCard**
Problem Payment	—	-0.098	-0.301	0.071
ddl	—	253	253	253
valeur p	—	0.940	1.000	0.128
Satisfaction_Cas h	-0.098	—	0.125	-0.313
ddl	253	—	253	253
valeur p	0.940	—	0.023	1.000
Satisfaction Card	-0.301	0.125	—	0.445
ddl	253	253	—	253
valeur p	1.000	0.023	—	<0.001
Satisfaction BankCard	0.071	-0.313	0.445	—
ddl	253	253	253	—

valeur p	0.128	1.000	<0.001	—

Ressource : Our forum data, results collected from Jamovi.

Figure 07 : Correlation Chart of Payment Problems and Customer Satisfaction with Different Payment Methods



Ressource : Our forum data, results collected from Jamovi.

This analysis yields two important findings:

- Users who are satisfied with card payments are also likely to be satisfied with bank card payments, suggesting that these digital methods may be perceived similarly and positively.
- Cash satisfaction does not strongly correlate (positively or negatively) with satisfaction in other payment types or payment problems, suggesting cash users form a distinct segment.

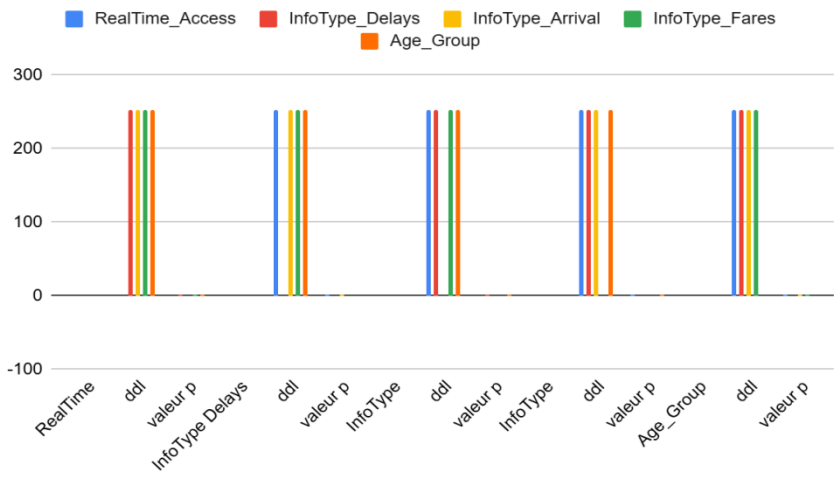
H3: The availability of real-time information on payments and services enhances passenger satisfaction.

Table 05 : Correlation Matrix 03

	RealTime_Access	InfoType_Delays	InfoType_Arrival	InfoType_Fares	Age_Group
RealTime Access	**—**	**-0.131**	**0.094**	**-0.255**	**-0.300**
ddl	**—**	**253**	**253**	**253**	**253**
valeur p	**—**	**0.982**	**0.066**	**1.000**	**1.000**
InfoType Delays	**-0.131**	**—**	**-0.265**	**-0.012**	**0.119**
ddl	**253**	**—**	**253**	**253**	**253**
valeur p	**0.982**	**—**	**1.000**	**0.578**	**0.029**
InfoType Arrival	**0.094**	**-0.265**	**—**	**0.496**	**-0.447**
ddl	**253**	**253**	**—**	**253**	**253**
valeur p	**0.066**	**1.000**	**—**	**<0.001**	**1.000**
InfoType Fares	**-0.255**	**-0.012**	**0.496**	**—**	**-0.222**
ddl	**253**	**253**	**253**	**—**	**253**
valeur p	**1.000**	**0.578**	**<0.001**	**—**	**1.000**
Age_Group	**-0.300**	**0.119***	**-0.447**	**-0.222**	**—**
ddl	**253**	**253**	**253**	**253**	**—**
valeur p	**1.000**	**0.029**	**1.000**	**1.000**	**—**

Ressource ; Our forum data, results collected from Jamovi.

Figure 08: Correlation Chart Between Real-Time Access, Information Types, and Age Group



Ressource : Our forum data, results collected from Jamovi.

A moderate and statistically significant positive correlation. People who are interested in fare information also tend to be interested in arrival time information. These two types of information likely reflect a general interest in trip planning and efficiency.

A weak but statistically significant positive correlation. As age increases, interest in delay information also slightly increases. This could suggest older users are more cautious or place higher value on reliability.

While the correlation is moderately negative, the p-value indicates it's not statistically significant. So, no meaningful conclusion can be drawn. However, descriptively, it hints that older users may be less likely to access real-time info.

This correlation matrix highlights a few key findings:

- Users interested in fare information are also likely to be interested in arrival times, showing a coherent preference for practical, planning-related transport information.
- Age has a weak influence on information preferences, particularly a greater interest in delays among older respondents.
- The absence of significant correlations with realtime access could suggest that access to real-time information is broadly distributed across user types, regardless of age or specific information preferences.

-Main recommendations :

- Younger users may prioritize sleek design and basic real-time access.

- Older users might appreciate highlighted delay notifications and simplified fare info access.

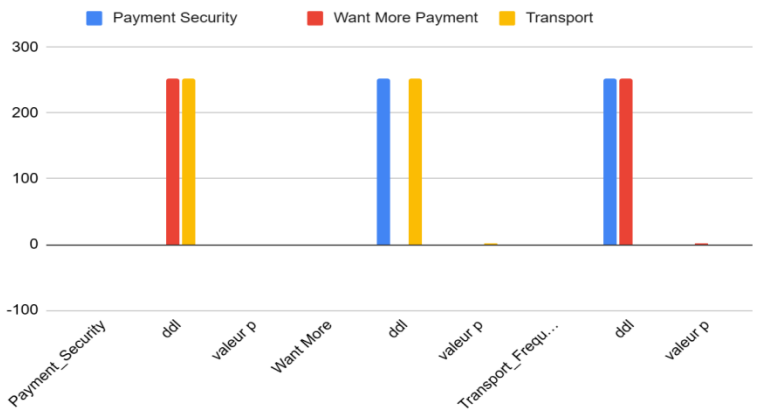
H4: The use of modern digital payment solutions reduces operational costs and increases company productivity.

Table 06 : correlation matrix 04

	Payment Security Digital	**Want More Payment**	**Transport Frequency**
Payment_Security Digital	**—**	**0.507**	**0.385**
ddl	**—**	**253**	**253**
valeur p	**—**	**<0.001**	**<0.001**
Want More Payment	**0.507**	**—**	**-0.154**
ddl	**253**	**—**	**253**
valeur p	**<0.001**	**—**	**0.993**
Transport_Frequency	**0.385**	**-0.154**	**—**
ddl	**253**	**253**	**—**
valeur p	**<0.001**	**0.993**	**—**

Ressource : Our forum data, results collected from Jamovi.

Figure 09 : Correlation Chart Between Payment Security, Digital Payment Demand, and Transport Frequency



Ressource : Our forum data, results collected from Jamovi.

There is a moderate, positive, and statistically significant correlation between perceived digital payment security and the desire for more payment. This suggests that individuals who feel more secure using digital payments are also more likely to express a desire for better compensation.

There is also a moderate and significant positive correlation between digital payment security and transport frequency. This implies that individuals who frequently use transport services tend to perceive digital payments as more secure.

- Correlation Analysis

A.Interpretation:

- Digital payments strongly improve satisfaction(Rho = 0.507).

- Real-time info reduces delays (negative correlation, Rho = -0.255).

- Payment security increases satisfaction with bank cards (Rho = 0.496).

B.Some Testing Results

-Payment_Cash vs.Problem_Payment < 0.001; Significant; Cash users report more issues

-Satisfaction_BankCard vs. Age_Group ; < 0.001 ; Significant; (Younger users prefer digital)

C.Group Differences;

- Satisfaction across payment methods: $F(3, 251) = 8.92$, $p < 0.001$; Digital payment users are more satisfied

Section 3 : Operator Interviews and Field Insights**.**

In our research, we relied on the survey method because we found it allows us to obtain relevant and precise data on the theme of digitizing payment systems in Algeria's urban public transport sector. Collecting structured and standardized data is essential for making informed decisions and facilitates the analysis of responses.

Moreover, surveys enable reaching a large number of participants efficiently and economically. They also often provide respondents with a degree of anonymity, which can encourage greater honesty in their answers.

To achieve our research objectives, we chose a qualitative approach rooted in an investigative framework. Thus, a survey was conducted targeting stakeholders involved in the urban public transport sector. We decided to carry out semi-structured individual interviews with key personnel to gather in-depth insights.

3.1. Choice of Field Application

As part of our graduation project, we selected the urban public transport sector in Algeria as our field of study. We focused on three national operators, each representing a mode of transport:

- ETUSA (urban buses)
- SEMA (Algiers metro)
- SETRAM (tramway system)

3.2.Research Methodology

As mentioned in the first chapter, interviews support a qualitative approach that encourages the expression of personal views and opinions rather than purely quantitative data collection. This method suits a comprehensive understanding of the subject.

Interviews are particularly useful when the researcher is unfamiliar with the interviewee’s reference world or when it is not appropriate to predefine the internal consistency of the sought information. The interview method is especially appropriate when the study focuses on individuals or a small, specific group.

To answer our research question and meet our objectives, we conducted qualitative research based on an investigative survey approach. This choice reflects our intention to deeply understand the perceptions and experiences of public transport operators regarding the digitalization of payment systems, and how these affect both operational efficiency and passenger satisfaction.

3.3.Study Context and Participants

Our interview took place online, lasting 30 minutes, with the communication manager responsible for Setram, covering Etusa and the Metro services. The participant requested to remain anonymous to protect confidentiality.

This allowed us to obtain valuable insights on the practical challenges and opportunities related to the integration of modern digital payment methods within Algerian public transportation companies.

3.4.Interview Guide

We developed an interview guide inspired by previous research. A semi-structured qualitative analysis typically includes four main areas of exploration.

In our case, the guide was adapted to fit the context of public transportation and the digitization of payment systems.

The main themes explored in the interview guide included:

- Cost optimization
- Revenue increase
- Digital tools and equipment
- Transaction security

The interviewees were invited to share their thoughts, experiences, and professional insights regarding the implementation and use of digital payment solutions in public transport companies.

Semi-structured interviews were first recorded and then transcribed verbatim. In the next phase, the transcriptions were coded, categorized, and analyzed to extract meaningful insights.

3.5.Data Transcription :

-Interviewer one : from SETRAM :

‘’Salaries and electricity costs could be reduced with digitalization ‘’(Q3)

‘’Current system includes computerized revenue tracking’’ (Q4)

‘’Devices break down often, causing maintenance issues ‘’(Q5)

‘’Reduction in salary and electricity costs via digitalization’’ (Q3)

‘’Internal automation tools are in use’’ (Q7)

‘’Obstacles include maintenance costs and connectivity issues ‘’ (Q6, Q9)

‘’Revenue tracking is already computerized’’ (Q4)

‘’Customers are perceived to trust digital payment’’ (Q12)

‘’A subscription system could help build long-term trust’’ (Q13)

‘’Computerized system in place for revenue tracking’’ (Q4)

‘’But also frequent breakdowns’’ (Q5)

-Interviewer Two: ETUSA

‘’Ticket printing and cash management are major cost factors’’ (Q1)
‘’Digitization could reduce manual labor and improve energy efficiency’’ (Q2)
‘’Revenue is tracked through internal accounting software’’ (Q3)

‘’Revenue tracking faces issues with data entry errors and lack of real-time monitoring’’ (Q4)
‘’Main obstacles to revenue growth: resistance to digital transition ’’(Q5)
‘’Plan to adopt QR code scanners and mobile ticketing ‘’(Q7)
‘’Challenges: …Maybe staff training gaps but we keep encouraging the learning and formations initiatives ….’’ (Q8)
‘’Security concerns include fraud and cash theft and sometimes even with the new technologies ‘’ (Q9)
‘’We believe that the solution is a centralize transactions and introduce encrypted systems’’ (Q10)
“Clients still prefer cash but trust is growing for digital payments’’ (Q11)
“Trust could be reinforced with education campaigns and customer service hotlines’’ (Q12)

-Interviewer Three: Metro d'Alger-SEMA

‘’High costs from paper ticketing and machine maintenance’’ (Q1)
‘’Digitization would cut paper costs and reduce queuing times’’ (Q2)
‘’Obstacle to digital revenue:sometimes is insufficient customer data and analytics’’ (Q5)

"Use of ticket kiosks and limited mobile interface" (Q6)
"From our past barriers was the limited funding and dependency on international suppliers…" (Q8)
"Fraud and data privacy are key security concerns" (Q9)

"Most users are open to digital payment, especially younger demographics "(Q11)
"Trust could grow through reward programs and consistent system performance" (Q12)

3.6.Analysis

Interviewer One: SETRAM Analysis:

A-Cost Optimization (Q3):
SETRAM identifies electricity as areas where digitalization can help reduce operational costs. This aligns with a broader trend of automation reducing expenses and increasing energy efficiency.

B-Revenue Management (Q4):
The company already has a computerized revenue tracking system, reflecting some maturity in digital integration. This is a strong starting point for further digital upgrades, such as real-time data analytics.

C-Maintenance Challenges (Q5):
A recurring issue is the frequent breakdown of devices, which increases maintenance needs and costs. This suggests that infrastructure robustness is a weak point, possibly due to outdated technology or poor-quality equipment.

D-Digital Tools in Use (Q7):
Internal automation tools are already in use, implying a foundation for further digital transformation. However, there is no mention of customer-facing tools like apps or contactless payments.

E-Obstacles (Q6, Q9):
Key obstacles include maintenance costs and poor connectivity, both critical for the reliability of digital payment systems.

F-Customer Trust & Adoption (Q12, Q13):
SETRAM perceives customers as trusting digital payment, and proposes subscription models to build long-term trust. This indicates readiness for a user-centric digital strategy.

Interviewer Two: ETUSA

Analysis:

A. **Cost Factors (Q1, Q2):**
Ticket printing and cash handling are highlighted as expensive. ETUSA sees

digitization as a means to enhance energy efficiency, pointing to a desire to modernize back-office operations.

B. **Revenue Tracking (Q3, Q4):**
They use accounting software, but struggle with data entry errors highlighting the need for integrated, automated solutions.

C. **Barriers to Growth (Q5):**
The main issue is resistance to digital transition, possibly from employees or users, which is a cultural and change management challenge.

D. **Tools and Future Plans (Q7, Q8):**
There is a plan to adopt QR code and mobile ticketing. However, staff training gaps persist, though efforts are made to encourage learning. This reflects proactive management but also a human capital gap.

E. **Security (Q9, Q10):**
ETUSA acknowledges fraud and theft, even with new tech, and recommends centralized, encrypted systems suggesting awareness of cybersecurity needs.

F. **Customer Behavior (Q11, Q12):**
Cash remains dominant, but digital trust is growing, especially with educational campaigns and support systems proposed to ease the transition.

Interviewer Three: Algiers Metro (SEMA)

Analysis:

A. **Cost and Efficiency (Q1, Q2):**
Paper ticketing and maintenance are expensive. Digitization is viewed as a solution to reduce paper use and decrease queuing, showing a focus on both cost and customer experience.

B. **Digital Infrastructure (Q6, Q8):**
Current tools are limited to ticket kiosks.

C. **Security (Q9):**
Strong concern about data privacy, indicating the need for trusted security protocols to be built into any system upgrades.

D. **User Readiness (Q11, Q12):**
Younger users are more open to digital payments. Proposals like rewards programs

and system reliability aim to enhance trust and improve adoption.

Key Takeaways :

- **Digital Readiness Varies:** All three companies are at different stages of digital maturity. ETUSA is slightly ahead with computerized systems already in place, while SETRAM and Metro d'Alger still face foundational issues like data entry errors.

- **Common Cost Pressures:** High operational costs, especially related to ticket printing, cash handling, and maintenance, are universal. All three recognize digital tools as potential cost savers.

- **Infrastructure and Training Gaps:** Maintenance, connectivity issues, and staff training gaps are persistent obstacles across the board. These reflect systemic challenges in Algeria's public transport sector.

- **Security is a Major Concern:** Fraud and data privacy issues were repeatedly mentioned, even when digital tools are already in place. Cybersecurity must be a core pillar of any future implementation.

- **Trust in Digital Payments is Growing:** While there's still a preference for cash, especially among older users, there's growing acceptance particularly among younger passengers. Proposals like subscriptions, rewards, and customer education could accelerate adoption.

- **Strategic Recommendations Needed:** Solutions must go beyond just deploying tech. Companies must invest in training, security, customer education, and infrastructure reliability. Public-private partnerships and pilot projects could support these transformations.

- Key Findings & Recommendations

A. Passenger Satisfaction (Y1)

-Digital payments and security drive satisfaction.

-Recommendation: Promote contactless payments and improve app reliability.

B. Operational Efficiency (Y2)

-Real-time info reduces delays and crowding.

-Recommendation:Invest in live tracking systems and digital signage.

C. Demographic Insights

- Younger users prefer digital payments.

- Low-income riders face more payment issues (cash dependency).

Key Results from the Hypotheses :

- H1: The diversity of modern payment methods has a positive effect on passenger satisfaction.

This hypothesis is validated and supported by our Quantitative study.

Quantitative evidence: Pearson correlation analysis shows a strong positive correlation between digital payment usage and satisfaction (Rho = 0.507).62.7% of users expressed a desire for more payment options, indicating unmet expectations with current systems.Mean satisfaction for card users was ~3.8, while for cash users it was ~3.2, confirming higher satisfaction through digital payment use (statistically significant at $p < 0.001$).

-H2: Simplifying payment processes improves both operational efficiency.

This hypothesis is validated and supported by our Qualitative study.

ETUSA and SETRAM both confirmed that digitization (e.g., e-ticketing) reduces costs (manual labor, ticket printing) and streamlines operations.

ETUSA's move toward centralized transaction systems highlights the perceived operational benefits of simplifying payment flows**.**

-H3: Access to real-time payment and service information enhances user satisfaction. This hypothesis is Partially Validated by our Quantitative and Qualitative study.

There is a moderate negative correlation between lack of real-time information and operational issues like delays (Rho = -0.255), suggesting that real-time systems reduce inefficiencies and boost satisfaction.However, adoption barriers exist. Real-time features are not yet fully operational or widespread. Operators acknowledge infrastructure challenges (e.g., frequent device failures, lack of connectivity). Also, there is a generational gap younger users demand app-based solutions, whereas older users prioritize reliability and prefer physical systems.This indicates that real-time systems improve satisfaction but aren't equally accessible or effective across all demographics.

-H4: The use of digital payment tools reduces operational costs and improves productivity.

This hypothesis is Rejected for now by primarily our qualitative study

Quantitative data shows low digital adoption: only 16.1% of users use cards, and no ticketing systems are widely adopted. There is no measurable increase in productivity or cost reduction at scale yet.Qualitative insights suggest strong potential, but practical limitations delay impact:SETRAM reports frequent breakdowns of digital systems and high maintenance costs. ETUSA highlights security concerns and resistance to change (staff and users). Operators note that trust-building is still in progress and that staff training and system reliability are prerequisites for actual productivity improvements**.**

As a strategic recommendation (Based on Both Studies) Scale up digital payment systems with inclusive design:Deploy QR codes, mobile apps, and e-wallets tailored to young users (94.9% of the sample).

Keep cash options to ensure accessibility for low-income and older users.

Invest in infrastructure stability:Address device maintenance, ensure network connectivity, and establish reliable real-time tracking systems.

Launch encrypted payment pilot projects:Use centralized systems with data encryption to build user and operator trust.

Support with awareness campaigns and customer service channels to ease the transition.

Synthesis of the Results

This second chapter provided a comprehensive exploration of both quantitative and qualitative findings related to the integration of digital payment systems in Algeria's public transport sector.

The survey results revealed a clear demand for modernization: the majority of users are young (94.9% students), use transport frequently, and expressed a strong preference for diversified and secure digital payment methods. Card users reported higher satisfaction than cash users, and 62.7% of respondents desired more payment options. Real-time information also emerged as a critical factor for improving the passenger experience.

On the operator side, interviews with ETUSA, SETRAM, and SEMA highlighted the operational and financial burdens of manual systems, including paper ticketing and cash handling. While most companies have adopted some internal digital tools, barriers such as device maintenance issues, connectivity problems, limited funding, and staff training gaps persist. Security concerns and user trust were also raised, although most operators believe that education and gradual transition can improve adoption.

The hypotheses were mostly validated, showing that digitalization can improve satisfaction and reduce costs though challenges remain in implementation and scaling.

Together, these findings emphasize the need for a balanced strategy: enhancing digital infrastructure, preserving inclusivity, and supporting operators through training and secure systems. This lays the groundwork for strategic recommendations that aim to modernize Algeria's public transport while addressing both user needs and company constraints.

Conclusion ;

This chapter presents an empirical investigation into the digitalization of public transport in Algeria, focusing on company practices, user experiences, and operational efficiency. Drawing from both qualitative interviews with transport operators (ETUSA and SETRAM) and a quantitative user survey, the chapter explores how the integration of digital payment systems and real-time service information is shaping passenger satisfaction and operational outcomes.

Findings reveal a growing interest in digital tools among younger users, while highlighting persistent barriers such as infrastructure instability, low digital adoption rates, and demographic divides in accessibility. Despite promising qualitative evidence of cost and workflow improvements through digitization, quantitative data show that operational gains remain limited due to maintenance issues, security concerns, and incomplete system implementation.

The chapter underscores the importance of inclusive payment design, targeted user education, and strategic investments in infrastructure to fully leverage the potential of digital transformation in Algeria’s public transport sector.

General Conclusion

The public transport sector plays a vital role in the economic and social development of nations. It provides essential mobility to citizens, connects people to jobs and services, and contributes to overall urban sustainability. However, in urban areas such as Algiers, the sector faces persistent challenges, including outdated infrastructure, inefficiencies, environmental concerns, and widespread passenger dissatisfaction.

In recent years, digital transformation has emerged as a powerful lever to address these issues. Technologies such as smart ticketing, real-time information systems, mobile applications, and contactless payments are reshaping how public transport services are delivered and experienced. By integrating these tools, transport systems can become more efficient, responsive, secure, and user-friendly.

This study based on insights gathered from passengers and professionals within ETUSA, SETRAM, and the Algiers Metro confirms that the lack of modern, digital payment methods is a significant pain point. Respondents highlighted frustrations linked to manual processes, cash dependency, and service delays, indicating a clear demand for smarter, more accessible transport solutions.

The analysis supports the hypothesis that the adoption of modern payment systems can:

- **Improve passenger satisfaction** by offering greater convenience, speed, and transactional security.
- **Enhance operational efficiency** by minimizing human error, reducing cash handling costs, and enabling more accurate revenue management.

And also promote environmental sustainability through the reduction of paper-based tickets and the encouragement of eco-conscious behaviors.

Operators expressed a generally positive outlook toward digitalization, acknowledging its benefits in terms of service quality, safety, and cost optimization. Nonetheless, obstacles such as limited infrastructure, financial constraints, and regulatory inertia continue to hinder large-scale digital adoption.

Key Findings

- Algerian public transport still relies on outdated, manual systems.
- There is strong passenger demand for digital services particularly mobile payments and real-time updates.
- Operators are open to digital innovation but lack adequate resources and infrastructure.
- A clear link exists between digital tools and improved user satisfaction.
- Mobile applications and e-payment platforms are perceived as key drivers of transformation.

Recommendations :

To bridge the current gaps and accelerate digital transformation in Algerian public transport, the following measures are recommended:

- **Implement modern payment systems** including QR code validation, e-wallets, and digital subscriptions.
- **Provide real-time travel information** to reduce uncertainty and help users plan their journeys more efficiently.
- **Invest in training programs** and digital literacy initiatives to support both staff and passengers during the transition.
- **Foster public-private partnerships** to fund infrastructure development, ensuring robust legal frameworks for risk-sharing and compliance, alongside technical standards for quality and sustainability, with full regulatory support.
- **Pilot digital solutions** in major cities before scaling them nationally, using measurable KPIs to evaluate impact.
- **Promote a digital culture** within institutions to nurture innovation and long-term sustainability.
- **exploit data for management :** to more effectively manage revenue and passenger flows.
-

One of the key actionable outcomes of this research is the development of YallaRide, a mobile application and digital payment platform conceptualized during this study. YallaRide enables users to purchase transport tickets for bus, underground, and tram services directly from their smartphones using QR codes and a secure e-wallet system. The app aims to eliminate the dependence on cash, simplify access to public transport, and offer a seamless digital experience aligned with modern mobility standards. We

recommend its integration as a pilot solution in partnership with local operators, paving the way for a broader digital shift within the Algerian transport ecosystem.

Research Outlook

Further research can build on this work by exploring:

- The financial impact of digital payment systems on transport operators.
- User acceptance and behavioral shifts across different regions, age groups, and income levels.
- Comparative studies between Algerian transport systems and similar networks in other emerging economies.
- The role of marketing and public trust in accelerating the adoption of digital mobility solutions.

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Appendix

- **Google Forms :**

Amélioration des Services de Transport Public Urbain تحسين خدمات النقل العمومي الحضري

Dans le cadre de la préparation de notre mémoire master 2 en e-business sous le thème **"L'impact de la digitalisation des moyens de paiement dans les transports publics urbains en algérie"**, nous lançons une étude sur l'impact de l'usage des paiements numériques dans les transports public urbain (Metro, tramway et bus/public) en Algérie. L'expérience des usagers est essentielle pour mieux comprendre et cerner les défis et proposer des solutions pour améliorer la situaion. **Vos réponses sont totalement anonymes et confidentielles.**
Merci pour votre précieuse contribution.

في إطار اعداد مذكرة الماستر 2، في مجال الاعمال الإلكترونية، تحت عنوان " **تأثير رقمنة وسائل الدفع في مجال النقل العمومي الحضري بالجزائر**"، نطلق دراسة حول تأثير إستخدام الدفع الرقمي في وسائل النقل في المناطق الحضرية (مترو، الترامواي و الحافلات العمومية) في الجزائر.

تجربة المستخدم ضرورية لفهم و تحديد التحديات و اقتراح الحلول لتحسين الوضع. **ستكون إجاباتكم مجهولة الهوية و سرية تماما.**

إشكرا لمساهمتكم القيمة

* Indicates required question

1. **À quelle fréquence utilisez-vous les transports publics urbain ?** * **ماهي وتيرة استخدامكم لوسائل النقل العمومي الحضري؟**

Mark only one oval.

- يوميا / Quotidiennement
- عدة مرات في الأسبوع / Plusieurs fois par semaine
- مرة في الأسبوع / Une fois par semaine
- نادرا/ Rarement
- ابدا / Jamais

2. **Quels types de transports publics urbain utilisez-vous le plus souvent ? (Cochez toutes les réponses qui s'appliquent)**

ما هي أنواع وسائل النقل العمومي الحضري التي تستخدمها بشكل متكرر؟ (اختر الإجابات التي تنطبق)

Check all that apply.

- [ ] Bus / حافلة
- [ ] Tram / ترامواي
- [ ] Metro / مترو

3. **À quelle distance de chez vous se trouve le moyen de transport public urbain le plus proche ?** *

ما هي المسافة بين مكان إقامتك وأقرب وسيلة نقل عمومي حضري؟

Mark only one oval.

- ( ) أقل من 500 متر / Moins de 500 mètres
- ( ) بين 500 متر وكيلومترين / Entre 500 mètres et 2 kilomètre
- ( ) أكثر من 2 كيلومتر / Plus de deux 2 kilomètres

4. **Quelle est votre principale raison d'utiliser les transports publics urbains?**
ما هو السبب الرئيسي لاستخدامك وسائل النقل العمومي الحضري؟

Mark only one oval.

- ( ) الذهاب إلى العمل / Aller au travail
- ( ) الذهاب إلى المدرسة أو الجامعة / Aller à l'école ou à l'université.
- ( ) Activités de loisirs/الأنشطة الترفيهية
- ( ) التسوق أو قضاء الحوائج أو زيارات العائلية / Courses ou shopping ou visite familiale
- ( ) Other: _____

5. **Quels sont les problèmes que vous rencontrez habituellement dans l'utilisation des transports publiques ? (cochez toutes les réponses qui s'appliquent)** *

ما هي المشاكل التي تواجهها عادةً عند استخدام وسائل النقل العمومي؟ (اختر كل ما ينطبق)

Check all that apply.

- [ ] Retards et non respect des horaires /التأخير وعدم الالتزام بالمواعيد
- [ ] Difficulté de paiement à cause d'indisponibilité de monnaies /صعوبة الدفع بسبب عدم توفير النقد
- [ ] Absence d'informations en temps réel sur les horaires / غياب معلومات فورية حول مواعيد الحافلات
- [ ] Absence de moyens de paiement électroniques / عدم توفر وسائل دفع إلكترونية
- [ ] Other: _____

Sur une échelle de 1 à 5, comment évaluez-vous la simplicité du processus de paiement pour les transports publiques ? (1 = Très difficile, 5 = Très simple)

على مقياس من 1 إلى 5، كيف تُقيّم سهولة عملية الدفع في وسائل النقل العمومي؟ (1 = صعبة جدًا، 5 = بسيطة جدًا)

Mark only one oval per row.

	Très difficile / صعب جدا	Difficile / صعب	Moyen / متوسط	Simple/ بسيط	Très simple / بسيط جدا
Espèces (paiement direct en liquide) / نقدا (الدفع النقدي المباشر)	◯	◯	◯	◯	◯
Tickets / التذاكر	◯	◯	◯	◯	◯
Cartes de transport (abonnement) / بطاقات النقل (الاشتراكات)	◯	◯	◯	◯	◯

7. **Quels moyens de paiement avez-vous utilisé pour les transports publiques ? (Cochez toutes les réponses qui s'appliquent)** *
ما هي طرق الدفع التي استخدمتها في وسائل النقل العمومي؟ (اختر كل ما ينطبق)

Check all that apply.

- ☐ نقدا / Espèces
- ☐ ببطاقة الشراك قابلة للشحن / Carte d'abonnement rechargeable
- ☐ Other: _____

8. **Souhaitez-vous avoir plus de modes de paiement diversifiés pour les transports publiques ?** *
هل ترغب في وجود خيارات دفع أكثر تنوعاً ؟

Mark only one oval.

- ◯ نعم / Oui
- ◯ لا / Non
- ◯ je ne sais pas / لا ادري

9. Si oui , lesquels?
اذا نعم ، ماهي؟

_____
_____
_____
_____
_____

16. **Quel est votre statut professionnel ?** *
ما هي حالتك المهنية؟

Mark only one oval.

- ◯ Étudiant(e) / طالب(ة)
- ◯ Employé(e) (temps plein ou partiel) / موظف(ة) (بدوام كامل أو جزئي)
- ◯ Sans emploi / عاطل(ة) عن العمل
- ◯ Retraité(e) / متقاعد(ة)

17. **Votre revenu mensuel moyen est :** *
ماهو متوسط دخلك الشهري:

Mark only one oval.

- ◯ Moins de 20 000 DA / أقل من 20,000 دج
- ◯ Entre 20 000 et 100 000 DA / بين 20,000 و 100,000 دج
- ◯ Entre 100 000 et 150 000 DA / بين 100,000 و 150,000 دج
- ◯ plus de 150,000 DA/ أكثر من 150,000دج

11. **Globalement, sur une échelle de 1 à 5, comment évaluez-vous votre satisfaction vis-à-vis des modes de paiement actuels dans les transports publics ?** *
بشكل عام، على مقياس من 1 إلى 5، كيف تقيم مدى رضاك عن طرق الدفع الحالية في وسائل النقل العام؟

Mark only one oval per row.

	Très insatisfait/ غير راضٍ تماما	Insatisfait غير راضٍ/	Neutre محايد /	Satisfait راضٍ /	Très satisfait/ راضٍ جدا
Paiement en espèces/ الدفع نقدا	◯	◯	◯	◯	◯
Cartes de transport rechargeables / بطاقات النقل القابلة لإعادة الشحن	◯	◯	◯	◯	◯
Paiement par carte bancaire ou Edahabia/ دفع عبر بطاقة بنك أوبطاقة ذهبية	◯	◯	◯	◯	◯

Untitled Section

12. **Avez-vous actuellement accès à des informations en temps réel sur les horaires et les services des transports publiques ?** *
هل لديكم حالياً إمكانية الوصول إلى معلومات في الوقت الراهن حول أوقات وخدمات النقل العمومي؟

Mark only one oval.

- ◯ نعم دائماً / Oui, toujours
- ◯ أحياناً / Parfois
- ◯ نادراً / Rarement
- ◯ أبدا / Jamais

13. **Si vous avez obtenu des informations, où les avez-vous trouvées ?** *
إذا حصلت على معلومات، أين وجدتها؟

Check all that apply.

- ☐ Sources officielles(Sites web officiels des entreprises de transport ....) / المصادر الرسمية: (المواقع الرسمية لشركات النقل، التطبيقات...)
- ☐ Sources communautaires et médias(Réseaux sociaux ,Forums et blogs spécialisés, Médias...) / المصادر المجتمعية والإعلامية: (وسائل التواصل الاجتماعي، المنتديات والمدونات المتخصصة، وسائل الإعلام...)
- ☐ Expérience personnelle et l'entourage / التجربة الشخصية والمحيط

14. **Quel type d'information en temps réel améliora le plus votre expérience ? (Cochez toutes les réponses qui s'appliquent)** *
ما هي نوعية المعلومات في الوقت الراهن التي ستُحسن تجربتك؟ (اختر كل ما ينطبق)

Check all that apply.

- ☐ أوقات الوصول في الوقت الراهن / Heures d'arrivée en temps réel
- ☐ تأخيرات أو انقطاعات في الخدمة / Retards ou perturbations de service
- ☐ تفاصيل الأجرة وحالة الدفع / Détails des tarifs et statut des paiements
- ☐ Other: _____

15. **Quel est votre âge ?** *
ما هو عمرك؟

Mark only one oval.

- ◯ أقل من 18 سنة / Moins de 18 ans
- ◯ من 18 إلى 34 سنة / 18–34 ans
- ◯ من 35 إلى 50 سنة / 35–50 ans
- ◯ أكثر من 50 سنة / Plus de 50 ans

-Interview guide;

H.S.M.D.E

Guide d'entretien

LA DIGITALISATION DES SYSTÉMES DE PAIEMENTS DES TRANSPORRTS PUBLIQUES EN ALGERIE

2024-2025
E-Business
5eme année Master

A PROPOS NOUS

Tidafi Nour EL-Houda Djamila
et
Bechane Asma

- Nous sommes 2 étudiantes en Master 2 en E-Business à l'école supérieure de gestion et d'économie numérique a kolea . Dans le cadre de notre projet de fin de cycle , nous réalisons une série d'entretiens pour mieux comprendre la digitalisation dans le secteur de transport.
- Notre objectif est d'approfondir nos connaissances sur les alternatifs et les défis à l'égard de la digitalisation du secteuret d'identifier des solutions ou des tendances qui pourraient être bénéfiques.
- Nous sommes motivées, curieuses et passionnées par ce domaine, et nous remercions chaleureusement Les entreprises : ETUSA, METRO D'ALGER et SETRAM pour leur précieux temps et leur collaboration.

OBJECTIFS POUR CET ENTRETIEN

- Mieux comprendre le process de digitalisation , les défis et les challenges dans le secteur de transport publiques algérien .
- Échanger sur L'intégration de modes de paiement modernes dans les systèmes de transport public en Algérie et son impact sur l'efficacité opérationnelle des entreprises et la satisfaction des passagers.
- Établir des recommandations concrètes et enrichir notre projet académique grâce à vos retours d'expérience.

QUESTIONS DU GUIDE

Outils et équipements numériques

- Quels outils numériques utilisez-vous actuellemen ?

□ Logiciel de traitement des paiements
□ Machines de billetterie
□ Applications mobiles
□ Autres (veuillez préciser) : _____

- Quels nouveaux outils ou fonctionnalités numériques souhaitez-vous adopter à l'avenir ?

.....

- Quels défis anticipez-vous pour l'acquisition des outils numériques nécessaires ?

Évaluez chaque point sur une échelle de 1 à 5, où 1 = Pas un défi et 5 = Défi majeur.
Contraintes financières : □1 □2 □3 □4 □5
Manque d'expertise : □1 □2 □3 □4 □5
Résistance au changement : □1 □2 □3 □4 □5
Autres (veuillez préciser) : _____

QUESTIONS DU GUIDE

Optimisation des coûts

- Quels sont les principaux coûts opérationnels liés à la gestion des paiements ?

□ Impression des tickets
□ Gestion des espèces
□ Maintenance des systèmes actuels
□ Autres (veuillez préciser) : _____

- Selon vous, quels coûts (directs ou indirects)pourraient être les plus faciles à réduire grâce à la numérisation, et pourquoi ?

.....

QUESTION DU GUIDE

Augmentation des recettes

- Comment suivez-vous les revenus ?

□ Comptabilité manuelle
□ Système informatique
□ Service tiers
□ Non suivi

- Quels défis rencontrez-vous dans le suivi de vos revenus ?

.....

- Quels sont, selon vous, les principaux obstacles à la création de nouvelles sources de revenus grâce à un système numérique ?

.....

QUESTIONS DU GUIDE

Sécurité des transactions

- Quelles sont les principales préoccupations en matière de sécurité liées aux systèmes de paiement actuels ?

□ Fraude
□ Vol
□ Violation des données
□ Autres (veuillez préciser) : _____

- Quelles solutions ou améliorations pourriez-vous envisager pour répondre à ces préoccupations ?

.....

- Pensez-vous que les clients feront confiance à un système de paiement entièrement numérique pour le transports publics ?

□ Oui
□ Non

QUESTIONS DU GUIDE

Questions de clôture

- AVEZ-VOUS D'AUTRES SUGGESTIONS OU REMARQUES CONCERNANT LA MISE EN PLACE D'UN SYSTÈME DE PAIEMEN NUMÉRIQUE DANS VOTRE ENTREPRISE ?

.....

- Y A-T-IL UNE QUESTION QUE VOUS AURIEZ AIMÉ QU'ON VOU POSE ET QUI N'A PAS ÉTÉ ABORDÉE DANS CET ENTRETIEN ? OUI, QUELLE EST CETTE QUESTION ET QUELLE SERAIT VOTRE ÉPONSE ?

.....

QUESTION DU GUIDE

Augmentation des recettes

- Comment suivez-vous les revenus ?

□ Comptabilité manuelle
□ Système informatique
□ Service tiers
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- Quels défis rencontrez-vous dans le suivi de vos revenus ?

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.....