Fare and Ticketing System

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Executive Summary

This paper evaluates fare and ticketing system models to determine suitability for a regional rail network. The design of an effective fare system presents several challenges. As a result, a benchmarking analysis was conducted across four transit systems: Calgary, New York City, London, and Mexico City. These cities were selected due to their diverse fare structures, validation models, and operational environments.

The analysis indicates that no individual system meets all the requirements of a regional rail network. Although elements and characteristics from London and New York are the most relevant benchmarks, Calgary and Mexico City provide insights into cost-efficient fare models.

The recommended approach is a hybrid model that integrates distance-based pricing, multimodal fare integration, and multiple payment options, including both open-loop and closed-loop systems. From an infrastructure standpoint, the system should balance strong fare control with cost efficiency by implementing controlled-access systems in high-volume stations and a proof-of-payment model in lower-volume stations (City of Calgary, n.d.).

Finally, an effective regional rail fare system must align technological capabilities with operational realities. The proposed hybrid model provides a flexible and strategic foundation for implementing a fare system to support long-term expansion.

Project Background and Context

Regional Rail Ticketing Challenges

A regional rail system connects suburbs and metropolitan areas, integrating the region. It is focused on longer distances rather than an urban network. The design of a fare and ticketing system presents multiple operational and technological challenges.

The main challenge might be the fare structure that reflects the travel distance while remaining simple and accessible for passengers. Another challenge is the integration with existing urban transit systems; without an integrated media payment system, the transfers between systems would be complex.

Additionally, the architecture must consider infrastructure costs, operational efficiency, and scalability, and make a critical decision on the appropriate ticketing system.

Importance of Fare System Design in Regional Rail

Fare systems play a critical role in the effectiveness and accessibility to public transit; a well-designed ticketing system simplifies operations, the travel experience and supports a high volume of passengers.

In the Regional Rail case, the system must balance travel distance and price and support integration across multiple transit modes. (TfL, n.d.-a; MTA, n.d.-a)

Modern transit systems depend on digital payment technologies to improve transaction speeds and convenience; the payments and transactions are processed through backend systems, rather than physical fare media (OMNY, n.d.-a). These technologies improve flexibility and enable agencies to modify fare policies without requiring equipment modifications.

Benchmarking Approach

The objective of this report is to evaluate fare and ticketing systems across four cities using a defined criterion to identify the most suitable model for a regional rail network. To develop an effective ticketing strategy, a benchmark was established based on analysis of four metropolitan transit systems: Calgary, New York City, London, and Mexico City.

These cities represent different fare architectures, systems and environments. Comparing these systems, the benchmark analysis identifies key characteristics related to validation models, fare structure, requirements, and scalability. The objective is not to replicate a system, but to identify appropriate practices to replicate in a regional rail network.

Methodology and Evaluation Framework

Benchmark Selection

Looking for the best reference for a Regional Rail network, A benchmark was developed with four cities as reference cases: Calgary, Canada; New York City, United States; London, United Kingdom; and Mexico City, Mexico. Each one has a different architecture, model, operational context, and governance.

Calgary is an example of a low-infrastructure system within a Canadian urban transit setting, and New York City gives signs of a large-scale multimodal system under an account-based payment architecture. London exemplifies a highly integrated fare ecosystem that operates on a Pay-as-you-go model. And finally, Mexico City demonstrates a simple stored-value card system that supports extremely high passenger volumes within a dense urban environment.

The next sections present the benchmark analysis of these four systems, highlighting their strengths and limitations.

Benchmark System Analysis

The benchmark shows that no single system addresses all operational requirements for a regional context. Still, London's zone-based PAYG architecture and New York's account-based payment offers high scalability and pricing flexibility among the benchmarked cities. (TfL, n.d.-a; OMNY, n.d.-a). The following section analyzes each system:

Calgary, Canada

As the largest city in Alberta, Canada, Calgary host 1.3 million residents (Statistics Canada, 2023). Calgary is a major economic hub in Western Canada. Calgary's urban development features low-density suburban areas, which force the use of private vehicles.

Public transportation is operated by Calgary Transit, which includes the CTrain, a Light Rail Transit (LRT) system, and a bus network. The CTrain operates on almost 60 km of track and more than 40 stations, over residential corridors to downtown. (Calgary Transit, n.d.-a). This system was designed for intra-city mobility rather than intermunicipal regional connections.

System type

Calgary operates a public transit system composed of Light Rail Transit or LRT (CTrain) and an extensive bus network, optimized for high-frequency urban trips rather than corridor travel. (Calgary Transit, n.d.-a).

The CTrain functions as the structural backbone of the network, and the buses operate as feeder routes between neighbourhoods and LRT stations.

Calgary's structure represents a single-agency, urban-focused transit model optimized for short-distance intra-city trips.

As a Canadian reference case, Calgary is useful for understanding a low-to-moderate infrastructure fare-collection model and how it can be deployed without the need for access gates.

Ticketing Type

Calgary Transit offers multiple fare payment options:

- mobile ticketing through the My Fare App
- Paper tickets purchased at ticket vending machines

Calgary Transit offers fare products, including single-ride and period passes (weekly or monthly), that can be purchased through the My Fare App or vending machines. (Calgary Transit, n.d.-b).

Validation Model

Calgary's CTrain uses a proof-of-payment (POP) model. Proof-of-payment (POP) means riders do not pass through turnstiles or physical gates; instead, they must have a valid proof of fare (City of Calgary, n.d.). The POP model reduces the number of physical gates and their infrastructure requirements, relying on inspection-based enforcement.

Fare Structure

Calgary Transit uses a flat fare with time-based validity (typically 90 minutes), allowing riders to transfer within that window without paying an additional fare. Additionally, a designated free-fare zone operates in the downtown area. (Calgary Transit, n.d.-a). Time-based fare is well-suited to urban transfer trips, but it will require enhancement (zones/distance bands) for intercity services.

Booking Model

Calgary operates under a non-reservation model, so there are no bookings or seat reservations; it has a turn-up-and-go service. It has a higher-frequency service during peak hours. (Calgary Transit, n.d.-b).

Integration with Other Transit Modes

Calgary's main system is the LRT, under a unified fare structure. The buses work as a feeder service to the CTrain stations, and park-and-ride facilities and a partial cycling infrastructure support the commuter access. Calgary's fare integration is limited to intra-agency coordination between LRT and bus services under Calgary Transit. It does not operate under a multi-agency or regional fare integration framework (Calgary Transit, n.d.-a).

Infrastructure requirement

The infrastructure requirements for Calgary are relatively low and include:

- Ticket vending machines
- Visual validation protocols
- Mobile ticketing backend.
- Fare inspection personnel

(Calgary Transit, n.d.-a; Calgary Transit, n.d.-b).

Calgary's proof-of-payment systems do not use physical turnstiles or gates, which reduces the upfront investment; however, it will require validators and an inspection team.

Connectivity Dependence

Calgary has a moderate connectivity dependence. The MyFare mobile app allows riders to purchase and activate tickets. Ticket purchase requires internet connectivity; once activated, tickets can be displayed without data access. (Calgary Transit, n.d.-b).

Paper tickets do not require real-time banking authorization or validation, reducing dependence on financial networks. Connectivity dependence is therefore during the purchase stage rather than the validation.

Security / Fare Control

Calgary's proof-of-payment model relies on random inspections by transit officers, who issue fines for non-compliance. Unlike other models, proof-of-payment models reduce infrastructure costs but are more exposed to fare evasion. (City of Calgary, n.d.). As ridership scales, a POP model typically requires proportional increases in inspection coverage to maintain compliance and protect revenue.

Scalability

Calgary has a scalable system, but its time-based structure limits growth and underscores the need for backend modernization.

- Volume: The POP model doesn't have physical gates, which avoids bottlenecks, has faster passenger boarding speeds, enabling scalability for large volumes. However, it may increase the risk of fare evasion.
- Geography: Even though there is integration between the LRT and buses, a geographic expansion would require zone restructuring and backend coordination.
- Pricing: Under a POP model, implementing scalable distance-based pricing would require a structural redesign

Strengths

- Reliable LRT Network
- Free fare Zone in Downtown
- Low infrastructure cost
- Strong urban LRT backbone

Limitations

- Weak suburb-to-suburb connectivity
- Dependence on inspection staff for compliance
- The flat fare structure limits pricing differentiation and fairness in distance travelled.
- High dependency on the private vehicle, mainly outside downtown.

Relevance to a Regional Rail Context

Calgary provides a useful Canadian baseline to evaluate ticketing and fare models. From a regional rail perspective, Calgary is a consolidated urban system that is not regionally scaled yet presents an opportunity for intermunicipal expansion. Also, the fare system should evolve to distance-based pricing, and the reliable, robust LRT network provides a suitable backbone for intermodal connectivity.

New York City, USA

New York City has a population of 20 million in its metropolitan area (U.S. Census Bureau, 2023), many of whom depend on public transit to reach Downtown (U.S. Census Bureau, 2022).

Public transport services are operated by the Metropolitan Transportation Authority (MTA), which supervises the subways, buses and commuter rail services (Long Island Rail Road and Metro-North Railroad). The New York subway operates 24 hours a day at 472 stations, making it one of the largest rapid transit systems in the world. (MTA, n.d.-a).

System Type

New York has one of the world's largest and most complex urban transportation ecosystems, including a high-capacity subway network, a bus system and commuter rail service (Long Island Rail Road and Metro-North railroad) providing structured regional connectivity across New York State and parts of Connecticut under the same institutional governance framework (MTA, n.d.-a; MTA, n.d.-b).

New York’s structure represents a hybrid urban-regional model:

- Urban rapid transit (Subway and buses)
- Distance-based commuter rail for suburban and regional connections

Ticketing Type

New York uses an open-loop model, account-based payment architecture through OMNY (One Metro New York). An open-loop model means that users can use a bank-issued contactless card or even a mobile wallet directly on the fare validator (OMNY, n.d.-a). The payment is processed through the bank network rather than a transit card.

The system is account-based, meaning fare calculation and rule application occur on the backend rather than on the card itself. Although OMNY is the primary fare system, the legacy closed-loop MetroCard system is still in a phased transition.

Commuter rail services (LIRR and Metro-North) operate under a separate ticketing structure, where fares are purchased via a mobile app or station vending machines and validated on board (MTA, n.d.-b).

Validation Model

Validation for the urban service, subway, and buses occurs at access points, where users tap their contactless card or device at turnstiles before entry (MTA, n.d.-a). At the commuter rail station, passengers activate their tickets in the mobile app before boarding, and conductors validate them during the onboard inspection. (MTA, n.d.-b).

Fare Structure

The fare structure is mixed:

- Subway and buses have a flat base fare with a 2-hour transfer window and a 7-day fare cap (OMNY, n.d.-b).
- For commuter rail service, fares depend on the origin-destination and are differentiated between peak and off-peak. (MTA, n.d.-b)

Booking Model

The Subway and buses operate under a walk-up model with no seat reservations. Commuter rail service could allow passengers to purchase tickets in advance through the mobile app, although seat reservations are not really required. (MTA, n.d.-b).

Integration with Other Transit Modes

The OMNY systems support integrated payments over buses and subways with a single contactless payment. (OMNY, n.d.-a). Although commuter rail uses a different fare logic, all operate under the same institutional framework, allowing for coordinated management.

Infrastructure requirement

The infrastructure requirements for New York’s transport system are high and include:

- Turnstiles or electronic gates
- Contactless readers
- Vending machines
- Backend account-based processing system.

This infrastructure provides strong revenue control and pricing flexibility but requires a high investment.

Connectivity Dependence

The OMNY system operates under an open-loop architecture that depends on financial network connectivity and backend transaction settlement (OMNY, n.d.-a).

Although validators may temporarily operate offline, the system depends on the backend financial settlement.

Security / Fare Control

To establish security compliance, New York uses a combination of controlled access gates at the subway, fare inspection at the commuter rail and backend transaction auditing.

The subway has physical barriers to entry, requiring payment to use the turnstiles to prevent fare evasion. (MTA, n.d.-b). However, the system also requires enforcement and technical monitoring.

Scalability

The New York system has high scalability over volume, geography, and pricing complexity.

- Volume: The subway supports extremely high passenger volume every day, and the system processes millions of daily transactions at scale through its account-based backend architecture. (MTA, n.d.-b).
- Geography: The OMNY system includes multiple services from commuter rails, subway and buses, which demonstrate that an account-based system can scale across several types and geographic areas. (OMNY, n.d.-a).
- Pricing: The backend system allows the pricing logic to be modified without requiring hardware replacement, showing a mature and scalable fare architecture for multi-city operations.

Strengths

- Open-loop, account-based architecture
- Proven scalability with high user volume
- Integration across urban-regional services
- Hybrid validation models, with different service types.

Limitations

- High investment in infrastructure.
- High backend technological and financial system complexity.
- Dependence on financial institutions (cybersecurity exposure)
- Complex fare structure for users

Relevance to a Regional Rail Context

The enormous New York transport system provides a strong reference model of an integrated urban-regional corridor. It combines a hybrid architecture of flat urban fares and distance-based commuter rail pricing. However, the level of infrastructure and backend sophistication required may exceed the needs of an early-stage regional rail deployment.

London, UK

London has a population of 14 million people in the metropolitan area (Office for National Statistics [ONS], 2023).

London is characterized by high density in the central areas and a structured expansion linked by rail corridors. According to the Office for National Statistics (2022), a large proportion of commuters rely on public transport, especially rail and underground services, rather than private vehicles.

Public transportation services in London are operated by Transport for London (TfL), which oversees the Underground, Overground, Docklands Light Railway (DLR), Elizabeth Line, trams, buses, and National Rail services. (TfL, n.d.-a).

System Type

London operates a highly integrated, multimodal transportation system which combines urban rapid transit, suburban rail and bus services under a unified governance and fare framework. Structurally, London represents a multimodal, zone-based metropolitan transit model.

Ticketing Type

London uses a hybrid fare media architecture.

- Open-loop contactless: In the open-loop, payments can be made with a credit/debit card or a mobile wallet; the user taps their device at the reader (TfL, n.d.-a).

- Closed-loop: The system uses the Oyster Card, an RFID-based card issued by Transport for London (TfL). This smart card stores value and only works within the TfL system. (TfL, n.d.-a).

Both fare media operate within a Pay-as-you-go (PAYG) ecosystem, meaning open and closed loops share the same backend fare logic, improving accessibility and reducing adoption barriers. (TfL, n.d.-a).

Validation Model

The system operates on a tap-in/tap-out model, where passengers must tap their card at the start and end of their trip. The backend calculates the appropriate fare according to the points of entry and exit (TfL, n.d.-b). Bus and tram services require only tap-in validation due to flat fare application.

If the tap sequence is not completed, the system may apply a maximum fare. This validation structure provides a distance-zone-based pricing without pre-selecting the destination. (TfL, n.d.-a).

Fare Structure

London uses a Pay-as-you-go (PAYG) model; this model is not necessary because purchasing predefined tickets in advance. Instead, they tap in at the beginning of their journey and tap out at the end. It also employs a zone-based fare system, meaning fares are calculated based on the geographic zones travelled. (TfL, n.d.-a).

In addition to the zone fare, it has daily and weekly fare caps that eliminate the need for riders to purchase daily or weekly passes. (TfL, n.d.-c). This combination of zone-based pricing and capping provides fair, structured, and balanced pricing precision while maintaining customer convenience. This structure enables precise pricing while maintaining user simplicity, shifting complexity from the passenger to the fare backend.

Booking Model

In the pay-as-you-go system, most travel is walk-up, without the need to purchase a ticket in advance or reserve a seat (TfL, n.d.-a). Some rail services outside the PAYG structure may be available for booking.

Integration with Other Transit Modes

A strong feature of London's transport network is the integration of multimodal fares, with the Oyster card and contactless payments accepted across multiple services and a unified fare calculation logic (TfL, n.d.-a). The same fare media can be used across the underground, overground, DLR, Elizabeth Line, Buses, Trams, and National Rail services.

Infrastructure requirement

London's model requires a significant infrastructure investment, which includes:

- Contactless readers at bus and station entrances.
- Fare gates in rail stations
- Backend account-based fare system

While the infrastructure provides strong fare control and sophisticated pricing, the infrastructure's needs and costs increase with system complexity.

Connectivity Dependence

London exhibits a moderate dependence on connectivity. Oyster cards support offline validation, while contactless payments may temporarily validate offline with backend reconciliation occurring later.

Security / Fare Control

London’s fare control model is based on controlled access, meaning that entries have gates or station validators that require a tap to begin the journey and another to finish and open the gates. (TfL, n.d.-b). This approach reduces fare evasion.

Scalability

London’s fare and ticket system shows high scalability across multiple dimensions. The PAYG with the Oyster card is deployed across a wide range of stations, validating the system scalability (TfL, n.d.-a).

- Volume: London supports high daily passenger volume processes by its tap-in/tap-out model and backend fare calculations, enabling passenger volume scalability.
- Geographic: The zone-based fare structure demonstrates multi-operator integration and scaling across multiple geographic zones.
- Pricing: London has a strong pricing scalability, supporting zone-based differentiation, fare capping, and multi-operator integration without hardware replacement.

Strengths

- Mature hybrid architecture, combining open/closed loop.
- Automated zone-based fares.
- Multimodal Integration.
- Proven scalability in a metropolitan environment.

Limitations

- High investment requirements
- Dependence on a robust backend ecosystem
- Long-term implementation
- Workload due to incomplete tap events

Relevance to a Regional Rail Context

London's ecosystem provides one of the most structurally relevant benchmarks for regional rail on how a unified payment architecture can operate across urban and suburban services with a single fare logic framework. (TfL, n.d.-a).

The tap-in/tap-out validation model provides an easy, accurate zone-fare calculation without the need for advanced ticket selection. This structure aligns well with a corridor-based travel where users move between multiple cities and intermediate stations.

London demonstrates strong multimodal integration with rail and bus services, which is relevant to a regional rail system; however, the high cost of infrastructure investment is a disadvantage. Although London provides a structural model aligned for corridor-based rail integration, its infrastructure and system maturity are the results of years of investment that may not be immediately replicable in an early-stage regional rail deployment.

Mexico City, Mexico

With 21 million residents, Mexico City is one of the largest metropolitan areas in America. (INEGI, 2023)

Public transportation is highly used for urban mobility, and millions of daily trips are made on Metro, Bus Rapid Transit, Trolleybus, and other systems.

The primary rapid transit network is the Metro, operated by Sistema de Transporte Colectivo Metro (STC Metro), with 12 lines and more than 190 stations, creating the backbone of high-capacity urban mobility (STC Metro, n.d.-a). Fare media across these systems is coordinated through the Tarjeta de Movilidad Integrada (TMI).

System Type

Mexico City operates an urban transit network with metro services and other integrated multimodal transportation. Structurally, Mexico City is a dense, metropolitan transit model optimized for high-volume, short-distance travel within a single metropolitan area. Unlike London or New York, Mexico City does not operate an integrated regional commuter rail system under the same fare governance framework.

Ticketing Type

Mexico City operates a closed-loop stored-value smart card system known as Tarjeta de Movilidad Integrada (TMI), in which fare value is stored directly on the card and deducted per ride at the point of entry (STC Metro, n.d.-b). Direct open-loop bank card payments are not supported.

The TMI card can be used across multiple transit systems, including Metro, Metrobus, Trolleybus and Cablebus. (Gobierno de la Ciudad de México, n.d.)

Validation Model

Mexico City transit operates a tap-in-only validation model with turnstile control; there is no tap-out requirement because fares are flat. (STC Metro, n.d.-b)

Fare Structure

Mexico City operates a flat fare structure across most transit modes. While the TMI card enables fare media integration across systems, the fare is calculated for each ride without distance-based calculation, fare capping, or peak/off-peak differentiation (STC Metro, n.d.-c).

Booking Model

Mexico City Metro operated under a walk-up, no-reservation model.

Integration with Other Transit Modes

Mexico City payment method smart card (TMI) has expanded its use across multiple systems, including Metro, Light rail, Metrobus, Trolleybus and Cablebus. (Gobierno de la Ciudad de México, n.d.). Having fair media integration across modes.

The card TMI integration is limited to the metropolitan area, excluding regional and intercity rail services.

Infrastructure requirement

The system needs a medium-cost infrastructure, including turnstiles, card readers at the entry point, and infrastructure to recharge the card’s stored value. The system does not require banking network integration; however, it relies on centralized backend systems for card management, balance reconciliation, and system monitoring.

Connectivity Dependence

The closed-loop stored-value architecture reduces dependence on external digital and banking connectivity. The TMI cards operate as stored-value smart cards that deduct fare directly from the card's preloaded balance at the entry point, without the need for real-time banking authorization (STC Metro, n.d.-b). However, low connectivity dependence reduces system flexibility for real-time fare innovation. While low connectivity dependence enhances operational resilience, it limits pricing flexibility and real-time policy adjustments.

Security / Fare Control

Mexico City relies on physical access control for fare enforcement, using turnstile-based entry controls that prevent users from entering the paid area without a valid payment. (STC Metro, n.d.-b). The turnstiles create a strong entry control and reduce fare evasion.

Scalability

Mexico City’s fare ticketing system demonstrates strong scalability in capacity, although there is no algorithmic ability to evolve its pricing logic to support distance sensitivity, capping or peak pricing.

- Volume: Though the turnstile-controlled access and stored-value card access payments are made at the gate, discarding a backend fare calculation, and allowing volume scalability.
- Geography: Mexico City's system has coverage in the urban area rather than the intercity.
- Pricing: Mexico City operates under a flat fare model; this simple fare logic cannot scale without a huge modification. Implementing distance-based or zone-based pricing would require a structural redesign of the fare calculation logic.

Strengths

- Simple and reliable fare system
- Low reliance on external financial infrastructure
- High passenger throughput capacity
- Multimodal fare expansion across the metropolitan area

Limitations

- No distance differentiation
- No open-loop integration
- Poor adaptability to corridor-based regional networks
- No pricing flexibility

Relevance to a Regional Rail Context

The ticketing system used by Mexico City is a useful reference model for simplicity, cost control, and fare enforcement; however, its applicability to regional rail is limited.

The flat fare structure and tap-in-only prioritize speed and simplicity for high-frequency city travel; however, this system does not require the distance-based logic needed on regional corridors. (STC Metro, n.d.-c).

Mexico City provides valuable insights through turnstile-based access and backend simplicity. Even though Mexico City is a strong reference for cost-controlled urban context, its flat pricing model and closed-loop structure would require an upgrade to support a distance-sensitive regional rail corridor.

The benchmark provides a detailed overview of different metropolitan transit systems that operate their fare collection systems, although each system reflects the operational needs and governance structure of its city. An evaluation is necessary to determine which features are most applicable to a regional rail context.

Evaluation Framework

After analyzing each city, the next step is to compare the ticketing systems. The objective is to determine which system characteristics are best suited to a corridor-based rail system. To support this, an evaluation framework was developed using the following criteria, which focus on usability, infrastructure requirements, scalability, security and integration capability.

Usability

Usability assesses how easily a passenger can engage with the ticketing system, including simplicity of payment methods, transaction speed, and overall user experience. (OMNY, n.d.-a; Transport for London [TfL], n.d.-a).

Infrastructure requirements

This refers to the physical and technological components required to operate the fare system, including gates, validators, ticket vending machines, a backend processing system, and network connectivity. Usually, a high infrastructure requirement provides stronger control. (Metropolitan Transportation Authority [MTA], n.d.-a; TfL, n.d.-a).

Scalability

Scalability refers to the ability to support large passenger volumes, expand geographically, and accommodate an increasingly complex pricing structure. Regional rail must be able to scale up and down with ridership and geographic coverage. (MTA, n.d.-b; TfL, n.d.-a).

Security and Fare Control

Security evaluates how effectively the system prevents fare evasion, and fare control mechanisms may include controlled stations with gates, onboard ticket inspections, or proof-of-payment enforcement. (City of Calgary, n.d.; MTA, n.d.-b).

Integration Capability

Integration assesses how easily the system can operate across multiple transportation modes. In a regional rail context, integration with other systems and local transit is critical to ensure seamless passenger travel. (TfL, n.d.-a; Gobierno de la Ciudad de México, n.d.).

Pricing flexibility

Refers to the ability of a fare system to support multiple pricing structures, such as distance-based, zone-based or fare capping. (TfL, n.d.-c).

With the established criteria, an evaluation matrix was developed. A detailed version of the evaluation matrix is presented in Appendix B.

Comparative analysis of systems

London

In this benchmark, London demonstrates the most advanced fare collection ecosystem. Transport for London (TfL) integrates multiple transit modes, and Oyster card and contactless bank card payments allow using different transit systems without needing a separate ticket. (TfL, n.d.-a).

One of London's strengths is its Pay-as-you-go (PAYG) ecosystem, which calculates fares based on travel zones. The system demonstrates strong scalability. (TfL, n.d.-c).

New York City

The New York OMNY system supports multiple payment methods, including contactless bank cards, mobile wallets, and transit cards. (OMNY, n.d.-a).

Its strong fare control, though gated stations, reduces fare evasion over a proof-of-payment system, and its high passenger volumes demonstrate high scalability. However, the use of legacy infrastructure introduces operational complexity. (MTA, n.d.-a; MTA, n.d.-b).

Calgary

Calgary uses a low-infrastructure ticketing system based on a proof-of-payment model, though it relies on transit officers to enforce compliance. (City of Calgary, n.d.). A strong feature of Calgary's system is its MyFare application, which allows digital payments for passengers. (Calgary Transit, n.d.-b).

Its time-based rather than distance-based structure may not be adequate for a regional rail context, considering the travel distances. (Calgary Transit, n.d.-a).

Mexico City

Mexico City uses a stored-value card that can be used across multiple transit modes throughout the metropolitan area. (Gobierno de la Ciudad de México, n.d.).The key strength of Mexico City's system is its ability to support extremely high passenger volumes with a simple fare structure; however, the simplicity and the lack of a zone-based fare structure limit flexibility for longer regional trips. (Sistema de Transporte Colectivo Metro, n.d.-c).

This analysis reveals differences in fare architectures across multiple operational conditions. However, each system demonstrates strengths in its own context; still, not all of its features can be transferred to a regional rail environment. It is important to consider the potential risks and constraints associated with implementing these models in a regional rail corridor. (TfL, n.d.-a; MTA, n.d.-b; City of Calgary, n.d.).

A structured comparison of system characteristics is summarized in Appendix A.

Risks and Constraints

During the implementation of the fare collection system, several operational, technological, and financial risks will be involved. Although benchmarks provide best practices from other cities, transferring these models into a new regional environment may present some constraints.

Infrastructure Investment and Implementation Costs

The most significant constraint in a ticketing system implementation is the level of infrastructure required. Systems with controlled-access gates, like those in London and New York City, require a substantial upfront investment. (MTA, n.d.-a; TfL, n.d.-a). Although these systems provide strong fare control, they entail high capital costs, even when expanded to multiple stations across a regional rail corridor. Meanwhile, in proof-of-payment models, such as Calgary, the required infrastructure is less, but it depends on the inspection staff. (City of Calgary, n.d.).

Institutional Coordination and Governance Complexity

The multiple transit agencies involved in a regional rail system can pose governance risks, particularly when they operate different fare structures and technologies. (TfL, n.d.-a). Without a clear governance structure, issues such as fare revenue allocation, fare policy decisions, and operational standards arise. These challenges can slow or limit the level of fare integration achieved.

Technological integration

Digital payments technologies improve the user experience, but they also introduce technical dependencies (OMNY, n.d.-a). Integrating technologies could bring challenges to regions with limited technological infrastructure. Additionally, new systems often require upgrades to legacy infrastructure, increasing costs and complexity. (MTA, n.d.-b).

Fare Evasion and Enforcement Challenges

Fare evasion strategies are different in each ticketing system. Controlled-access provides control but requires a higher infrastructure investment, while other systems, such as proof-of-payment, minimize infrastructure costs but rely on inspections to prevent fare evasion. (City of Calgary, n.d.). Effective enforcement requires trained inspectors, as well as standardized enforcement protocols and fine management infrastructure. In the regional rail network case with widely distributed stations, maintaining consistency is a challenge.

Understanding the risk is critical to evaluating when the elements can be realistically implemented within a regional rail context; meanwhile, some systems have strong technological capabilities, but their infrastructure requirements can limit their implementation. However, the most effective solution is to combine features from multiple systems rather than replicating a single model.

Implications for Regional Rail Development

The comparative evaluation shows the differences in fare architecture and the challenges they face in their respective environments. Still, each system addresses a specific mobility need in its city; this analysis provides key insights for designing a regional rail fare system. (TfL, n.d.-a; MTA, n.d.-b)

- Multiple payment options: The system should support multiple payment methods. (OMNY, n.d.-a; TfL, n.d.-a).
- Flexible pricing structure: A zone or distance-based system works better for a Regional rail system. (TfL, n.d.-c).
- Multimodal Integration: The system should allow easy transfers between regional rail and local transit networks. (TfL, n.d.-a).
- Scalable fare technology: Ticketing technology must be ready for a high passenger volume and future network expansions. (MTA, n.d.-b).
- Balanced infrastructure investment: The system should balance the benefits of strong fare control with the infrastructure cost.

The findings provide a strategic foundation for determining which architecture best fits a regional rail system; however, rather than relying on a single system, the analysis suggests combining elements from multiple fare architectures. These insights are derived from the comparative system analysis (Appendix A) and the evaluation matrix (Appendix B).

Recommended Ticketing Model for Regional Rail

The analysis indicates that no individual fare system addressed all the requirements of a regional rail network; the proper solution would include a hybrid ticketing architecture, combining New York and London systems, which serve as strong references for scalability, pricing flexibility, and integration with other networks. The recommendation is informed by the evaluation results summarized in Appendix B.

One key characteristic of a regional rail system is the use of a zone- or distance-based fare structure. For a regional rail corridor with a longer travel distance, a pricing structure based on the travelled distance will maintain fairness for passengers on shorter trips. London's pay-as-you-go ecosystem demonstrates how zone-based pricing can integrate multimodal systems while maintaining a simple user experience. (Transport for London [TfL], n.d.-a).

Another essential feature to adopt is multiple payment options, such as contactless payment, mobile wallets, and transit smart cards. Open-loop architectures, such as the OMNY system in New York, allow passengers to use their bank-issued cards to pay directly without a dedicated transit card (OMNY, n.d.-a). Although the closed-loop transit card option is important too, such as London architecture, which allows both payments, the Oyster card and bank cards, showing accessibility, maintaining flexibility (TfL, n.d.-a).

Another recommended feature in the architecture is multimodal integration. Regional rail serves as a backbone for an ecosystem of transit systems, integrating fare media across multiple modes, enabling seamless transfers between systems, and improving usability.

From an infrastructure approach, the system should seek a balance between strong fare control and cost efficiency. Turnstiles or controlled-access gates provide strong protection against fare evasion. However, in situations with budget constraints, a proof-of-payment model similar to that used in Calgary is a viable alternative (City of Calgary, n.d.).

In such cases, the system could adopt a proof-of-payment approach supported by digital validation technologies and targeted inspection programs. This approach would maintain operational efficiency while reducing initial infrastructure costs, and controlled-access gates could be progressively introduced at major stations as ridership grows.

Finally, for fare technology to be scalable, it must be able to adapt to increased passenger volume and evolve its fare policies, and support backend-based fare processing structures with pricing logic that can be modified without hardware replacement, thereby improving long-term system flexibility. (MTA, n.d.-b).

To summarize, the recommended model should integrate:

- Distance-based fare structure (London's PAYG zone model)
- Open-loop contactless payment (OMNY System in NYC)
- Closed-loop smart card. (London's Oyster Card)
- Multimodal fare integration (London's)
- Balanced infrastructure requirements. (New York gated stations, Calgary Proof-of-payment)
- Scalable backend technology (New York account-based architecture)

Conclusion

This document analyzes the fare systems among four big metropolitan transit networks, Calgary, New York City, London, and Mexico City, to identify key features relevant to regional rail development.

The benchmark highlights the differences in fare systems in diverse operational contexts. From the benchmarked city systems, London has the most relevant reference model for regional rail. Its Pay-as-you-go (PAYG) ecosystem has zone-based pricing, a hybrid payment media, scalability, and multimodal fare integration. However, the system requires significant infrastructure investment that has been implemented over the years and may not be immediately replicable in an emerging regional rail network.

The results indicate that a single system does not satisfy all requirements for a regional rail; instead, the best solution would be to incorporate select characteristics from each city's system to create a hybrid architecture that addresses regional rail needs.

A successful regional rail fare system must balance multiple features and characteristics; the most important in this context would be infrastructure costs, fare enforcement, passenger convenience, and scalability. If a system has a distance-based model, multiple payment options, and multimodal fare integration, it can achieve operational efficiency and a positive passenger experience.

The results of this study give a strategic framework to design a fare system that can be integrated into the regional rail context. The principles identified through this benchmarking analysis can be used as guidance for future ticketing system design to support the expansion of regional mobility.

References

Statistics Canada. (2023). *Census profile, Calgary*. https://www.statcan.gc.ca

Calgary Transit. (n.d.-a). *Fares and passes*. https://www.calgarytransit.com/fares-passes.html

Calgary Transit. (n.d.-b). *My Fare mobile ticketing*. https://www.calgarytransit.com/fares—passes/my-fare.html

City of Calgary. (n.d.). *Transit fare evasion*. https://www.calgary.ca/transportation/transit-fare-evasion.html

U.S. Census Bureau. (2022). *Commuting characteristics by sex*. https://www.census.gov

U.S. Census Bureau. (2023). *QuickFacts: New York City, New York*. https://www.census.gov

Metropolitan Transportation Authority. (n.d.-a). *Subway and bus fares*. https://www.mta.info/fares-tolls/subway-bus

Metropolitan Transportation Authority. (n.d.-b). *LIRR and Metro-North fares*. https://www.mta.info/fares-tolls/lirr-metro-north

OMNY. (n.d.-a). *How OMNY works*. https://omny.info/how-omny-works

OMNY. (n.d.-b). *Fare capping*. https://omny.info/fares

Office for National Statistics. (2023). *Population estimates for the UK, England and Wales, Scotland and Northern Ireland*. https://www.ons.gov.uk

Transport for London. (n.d.-a). *Pay as you go with an Oyster card*. https://tfl.gov.uk/fares/ways-to-pay/pay-as-you-go

Transport for London. (n.d.-b). *Touching in and out*. https://tfl.gov.uk/fares/touching-in-and-out

Transport for London. (n.d.-c). *Fare capping*. https://tfl.gov.uk/fares/find-fares/capping

Transport for London. (n.d.-d). *Didn't touch in or out*. https://tfl.gov.uk/fares/refunds-and-replacements/didnt-touch-in-or-out

Gobierno de la Ciudad de México. (n.d.). *Tarjeta de Movilidad Integrada*. https://www.cdmx.gob.mx

Sistema de Transporte Colectivo Metro. (n.d.-a). *Información general del Metro*. https://www.metro.cdmx.gob.mx

Sistema de Transporte Colectivo Metro. (n.d.-b). *Tarifa y tarjeta de movilidad integrada*. https://www.metro.cdmx.gob.mx

Sistema de Transporte Colectivo Metro. (n.d.-c). *Tarifas vigentes*. https://www.metro.cdmx.gob.mx

Appendix

Appendix A

Detailed Comparative Analysis of Benchmark Systems

The following table summarizes the key characteristics of each system.

Element	Calgary	New York City	London	Mexico City
System Type	Urban LRT (CTrain) + Bus	Subway + Bus + Commuter Rail	Underground + Bus + Rail Integration	Metro + Bus + BRT
Ticketing Type	Mobile app + Paper tickets + Monthly pass	Open-loop contactless + Mobile + Legacy options	Open-loop contactless + Mobile + Legacy options	Closed-loop RFID, stored value
Validation Model	Proof-of-Payment (no gates)	Tap-in gates (controlled access)	Tap-in / Tap-out gates	Turnstile gate entry
Fare Structure	Time-based (90 min) + Day + Monthly	Flat subway + Distance-based commuter rail +	Zone-based + + Fare capping	Flat fare
Booking Model	Walk-up (no reservation)	Walk-up metro + Mobile purchase commuter rail	High (gates + Rail booking external	Flat fare
Infrastructure Requirement	Unified fare bus + LRT (intra-city)	Integrated across subway, bus, commuter rail	Fully integrated across multiple operators	Partial integration within metro/BRT
Infrastructure Requirement	Low (No gates)	High (gates + backend)	High (gates + account-based backend)	Moderate (turnstiles + card network)
Connectivity Dependence	Mobile purchase requires internet	Reduced via contactless tap	Card works conttactless trader	Low (offline stored-value card)
Security / Fare Control	Inspection-based enforcement	Physical gate control	Physical gate control + backend recondilation	Physical gate control
Scalability	Urban scale	Extremely high volurne, multi-mode	Mature large-scale systern	High-density metropolitan scale
Relevance to Regional Rail	Low-cost baseline Canadian model	Strong multimodal integration model	Strong distance-based and capped pricing model	Limitid Tare soplitcstaoffline capable

Appendix B

Evaluation Framework Matrix

The following matrix presents a comparative evaluation of the systems based on the selected criterion. Each system is assessed on a scale from 1 (low performance) to 5 (High performance) based on its operational capabilities, infrastructure requirements, and adaptability to a regional context.

Criteria	Weight	Calgary	New York City	London	Mexico City
Usability (Passenger Experience)	20%	4	4	5	3
Infrastructure Requirement	20%	5	3	4	4
Security / Fare Control	20%	3	5	5	3
Scalability	20%	3	5	5	4
Integration with Other Modes	10%	3	5	5	4
Pricing Flexibility	10%	3	4	5	3
Weighted Score	**100%**	**3.6**	**4.4**	**4.8**	**3.6**

Scoring scale: 1 = low suitability | 5 = high suitability