Light Rail Transit System: Its Forms and Roles in Urban Areas

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1. LESSONS FROM HISTORY

What happened with tramways, the dominant transit mode in the first half of the 20th century?

1.1 Impact of the Automobile

Wide use of cars creates:
- Congestion - slows down tramways; and
- Competition - takes passengers away from transit, reduces revenues.

1.2 Eliminating the Tramways

- In many cities and countries tramways were practically eliminated:
  - Great Britain, France, Spain, most Italian cities, USA.

The reasons:
- Buses became more efficient - valid reason for lightly traveled lines;
- Lack of investment funds - lower investment buses are a forced short-term solution;
- Poor understanding of the long-range role of transit;
- "Buses are flexible, better mix with traffic" - naive thinking;
- Strong influences of the highway/auto lobbies to eliminate rail systems and weaken transit (GM
  - Firestone - Esso companies organized a conspiracy in the 1940's-1950's which destroyed streetcars (tramways) in many U.S. cities; the most famous case being Los Angeles).

1.3 Upgrading the Tramways

- In some countries, tramways were gradually, but consistently improved:
  - Countries: Germany, Switzerland, Austria, Belgium, The Netherlands, Finland.
    - Individual cities: Milano, Melbourne, Goteborg.

The reasons:
- Policy to keep transit competitive with car was adopted;
- The goal was to separate transit from street congestion, give it strong image;
- The intention was to utilize the advantages of electric rail vehicles: high capacity, high comfort, quiet, strong image, popular.

2. CREATION OF THE LIGHT RAIL TRANSIT SYSTEM - LRT

Major upgrading of tramways has created Light Rail Transit - Stadtbahn - a system more similar to
metros than to tramways running on streets in mixed traffic. Elements of upgrading are listed here by categories.

2.1 Right-of-Way Types:
- Running in streets - Category C - was replaced in most cases by:
- Partially separated right-of-way - Category B - mostly in raised street medians;
- Fully separated tracks - Category A - are in tunnels, on aerial structures, on separated tracks. This is by far the highest quality right-of-way category, but also by far the most expensive one to build.
- LRT often combines two or all three of these categories on one line: diversity of rights-of-way and types of operation is its characteristic and asset.
- Types of rights-of-way range from running through pedestrian zones (slow, but accessible and attractive) and streets, to tunnels and viaducts (fast, but high investment and limited access). Initially, during the 1950’s, tunnels were designed as “underground trams”; tracks from the streets with sharp turns and crossings were placed in tunnels under the same streets. That was later upgraded to LRT standards, which are similar to metro alignments, except that the stations are shorter because LRT trains are shorter than metro trains. The most common are, however, LRT rights-of-way category B, as curbed street medians with preferential signals at intersections.

2.2 Rolling Stock Development
- Articulated cars were developed in the 1950’s with high-capacity, comfort, and quietness, followed by introduction of one-person crews. This resulted in highly efficient vehicles with ultimate performance in acceleration, quietness, environmental friendliness and strong image.
- Invention of low-floor cars in the 1980’s increased diversity of LRT and made high-speed trains more “street-friendly.”
- Traction, performance, reliability and economy drastically improve.

2.3 Operational Innovations
- Self-service fare collection speeded up boarding/alighting;
- LRT priorities at intersections became widely used in some cities;
- Construction of intermodal terminals and introduction of joint fares improved integration of LRT with buses, metros, as well as private cars via park-and-ride.

2.4 Efficient System with Strong Passenger Attraction
- LRT is now an extremely environmentally friendly system: quiet, clean, attractive design, strong image, fits well in pedestrian areas;
- With strong image, popular appeal and permanence of its lines, LRT has considerable potential for impacts on urban form and character.

3. THE INCREASING IMPORTANCE OF INTERMEDIATE SYSTEMS

3.1 The Large Gap between Buses on Streets and Metros
- The failure of “flexible systems;” they cannot compete effectively with automobiles;
- Large difference between the upper limit of buses and lower limit of metros;
- Need for independent transit systems - rights-of-way B and A - is recognized.

3.2 Initial Attempts to Eliminate Tramways Reversed to Introduce LRT:
- Amsterdam, Toronto, Oslo, San Francisco, Munchen, Berlin;
- Bus Transit System development - buses on busways - have been built in: Ottawa, Sao Paulo, Curitiba,
Pittsburgh, several French cities.

3.3 Rapidly Increasing Number of Cities Introducing New LRT Systems
- North America: over 20 cities in the United States, Canada and Mexico have built new LRT systems since 1978.
- In Western Europe: France, Great Britain, Spain new LRT systems are being built in a number of cities.
- Developing countries: Tunis, Egypt, The Philippines.
- Lagging behind: Far East and South America.

4. JAPAN: LRT GREATLY UNDERUTILIZED

Present conditions: technical perfection of rail systems, but integration of modes is weak; rail systems are usually separated from buses and from AGT systems.
- Obstacles to LRT development: physical (narrow streets), conceptual (lack of information) and institutional (transit systems are under jurisdictions of two different Ministries: Transportation and Construction);
- The need and potential for LRT: there is a major gap in Japanese cities between buses and subways. Many medium and large cities could use LRT effectively to have services much better than buses can offer, at a cost far lower than rapid transit and regional railways require.

5. TYPES OF LRT/TRAMWAY SYSTEMS, THEIR PRESENT AND FUTURE ROLES

A systematic review of LRT / Tramway systems around the world leads to their classification in nine
categories. These nine categories are defined here. This is followed by a review of the roles and types of networks LRT’s have in different cities.

5.1 Major Categories of LRT/Tramway Systems

1. Conventional Tramways

These systems operate largely on rights-of-way C, on urban streets, with some lines on separated street medians; their networks are extensive, service in city center and along radial avenues very good.
- Examples: St. Petersburg, Prag, many other Russian and East European cities; Milano, Melbourne, Toronto.

2. Upgraded Conventional Tramways

These are old systems, very extensive, reliable and efficient, because they have priorities in traffic regulation, modern vehicles and operating control centers.
- Examples: Amsterdam, Zürich, Vienna.

3. New Tramway Systems

Following a strong trend of reducing or eliminating tramways, in during the last 15 years an increasing number of cities has been building new tramway systems which serve major arterials and newly designed pedestrian-oriented areas, utilizing not only right-of-way category B, but also rights-of-way C. Their networks are initially more limited than those of conventional, older systems.
- Examples: Grenoble, Nantes, Strasbourg, Valencia/Spain, Croydon.

4. LRT Networks Developed from Conventional Tramways

By consistent upgrading over several decades, these systems have retained excellent coverage by extensive networks of old tramways over the entire city and suburbs, but they are now mostly separated from other traffic, sometimes including short tunnels in city centers.
- Examples most medium-sized cities in Germany, such as Stuttgart, Dusseldorf, Frankfurt and Köln, Rotterdam, Göteborg. These systems represent the basic and dominant mode of transit in their cities. Figure 1 shows the Köln Stadtbahn (LRT) network.

Fig.2 Light Rail Transit Network in San Diego, Built Since 1981
5. New LRT Systems

Typically, new LRT systems serve center city and a couple of radial corridors. However, the most successful systems, started only 10-20 years ago, have already grown into networks of several lines.
- Examples: San Diego (Figure 2), Calgary, Sacramento (Figure 3), Portland and Nantes - all started by single lines, then continued to grow.

6. LRT Systems in the Suburbs of Megacities

Half a century ago tramways were triumphantly eliminated from London, Paris and New York. Now, its upgraded successor - LRT - is being introduced in one megacity after another: London - Docklands and Croydon, Hong Kong - Tuen Mun, Paris has several circumferential LRT lines, New York - Bergen-Hudson line in New Jersey are probably only the beginnings of this trend.

7. LRT-Regional Rail Integrated Systems

Diversity of LRT has gotten another dimension by its combination with Regional Rail and long-distance railway systems. These systems, exemplified by Karlsruhe, Manchester and Saarbrücken, have introduced new operating concepts and new service opportunities for entire regions. A major intermodal integration is achieved when the same vehicles operate in pedestrian zones, on urban streets, and on regional rail lines (Manchester) or on long-distance high-speed railway (Karlsruhe and Saarbrücken) lines.

8. Light Rail Rapid Transit - LRRT

An increasing number of rail systems have LRT-type cars and operations, but fully separated right-of-way. Although often referred to as LRT, these systems are actually small scale metros, and they should be better designated as Light Rail Rapid Transit - LRRT.

9. Automated Light Rail Transit - ALRT

The automated version of LRRT, this mode represents a medium-size metro, with 2-4 car trains. It can also be classified as an Automated Guided Transit - AGT mode with rail technology. It has capacity greater than that of rubber-tired AGT systems, but lower than that of standard metros.
- Examples Vancouver Skytrain, London - Docklands, Detroit, Kuala Lumpur.

5.2 Functions and Roles of LRT

- Radial lines (most systems have these lines)
- Central city networks (Vienna, Zürich, Göteborg, Oslo)
- Suburban feeders to metro (Philadelphia, Boston, Berlin, Rotterdam, Munchen)
- Connecting regional centers (Los Angeles Blue Line, Koln-Bonn, Lille)
- Circumferential lines in megacities (Paris, New York)
- LRT in car-based cities - an increasing role: Los Angeles, Dallas, Seattle, Houston.

5.3 The Roles of LRT in Cities of Different Size Categories
- Small cities: mostly modernized old systems: Freiburg, Bern, Augsburg, Russian and East European cities
- Medium-sized cities: the basic transit mode: Köln, The Hague, Melbourne
- Large cities: complementary with metros: Boston, Philadelphia, San Francisco, Milano, Toronto, Brussels, München, Vienna, Toronto

6. LIKELY FUTURE DEVELOPMENTS OF LRT

Factors influencing increasing use of LRT:
- Need for larger networks of high-quality transit than metros can provide
- Growth of suburbs in which LRT is usually more successful than buses in attracting persons from private cars (Park-and-Ride is much more successful on LRT than on bus lines)
- Increasing use of intermodal systems which include LRT
- There is a growing trend of coordinating transit with land use development, for which metros and LRT systems are well suited.
- Increasing popularity and attraction of LRT as pedestrian-friendly, environmentally attractive, distinct part of a livable city - both historic and modern - particularly in central areas, as exemplified by Zürich, Karlsruhe, Portland, Sacramento, Strasbourg and many other cities.

Naturally, there are also factors which limit applications and work against LRT development, such as high investment cost or narrow streets in city centers. Relative merits of LRT as compared to buses on one side, metro and AGT on the other, must be analyzed in each specific situation. Above all, the needs and characteristics of the city/region and its physical, historic, social and environmental conditions are the dominant factors. The trend toward emphasizing the livability of cities is, however, a very favorable element for further progress in developing Light Rail Transit in many countries and cities around the world.
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