

Provided for non-commercial research and education use.
Not for reproduction, distribution or commercial use.



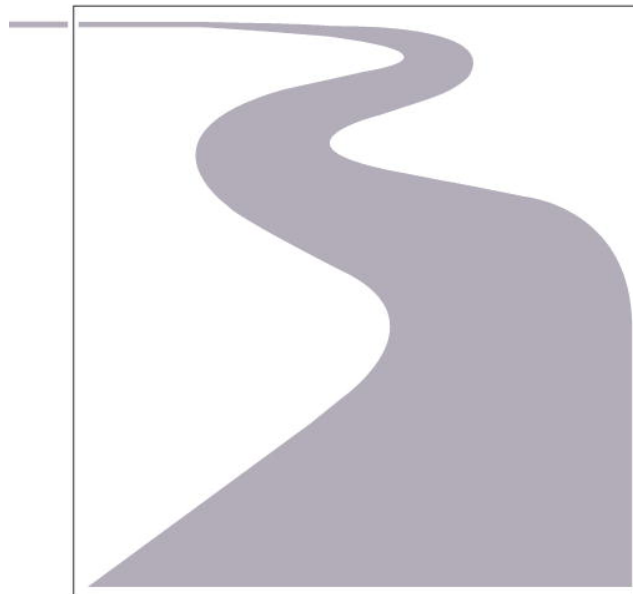
Volume 41A, issue 10, December 2007

ISSN 0965-8564

TRANSPORTATION RESEARCH

AN INTERNATIONAL JOURNAL

Part A: Policy and Practice



Editor: Phil Goodwin
Co-Editor: Debbie A. Niemeier

This article was published in an Elsevier journal. The attached copy is furnished to the author for non-commercial research and education use, including for instruction at the author's institution, sharing with colleagues and providing to institution administration.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier's archiving and manuscript policies are encouraged to visit:

<http://www.elsevier.com/copyright>



ELSEVIER

Available online at www.sciencedirect.com

Transportation Research Part A 41 (2007) 891–898

**TRANSPORTATION
RESEARCH
PART A**

www.elsevier.com/locate/tra

Some lessons from the LRT in Tunis and the transferability of experience

Xavier Godard *

Inrets, 1555 Chemin des Sts Peres, 13090 Aix en Provence, France

Abstract

Considering the debate about the technological options to get a modern mass transport supply in developing cities the experience of Tunis is very interesting to analyse and to appraise as this city is operating a LRT network since 1985. This paper presents the elements of success of this experience (satisfying level of ridership, moderate cost of investment, coverage of operating cost by receipts, accessibility of the central area, etc.) but also its limits coming from the limited capacity at the city scale and the inability to stop the extension of the car use in the city. That means this project has to be completed by another one, more complex and costly which would consist of a railway regional network, which is now studied in detail.

A short comparison is made with other cities in Maghreb (Algiers, Casablanca) experimenting also the design of metro projects which were more ambitious but with less success as they could not yet be implemented. Among the lessons thrown from this experience one insists on the importance of studies which have accompanied the design and the implementation of the project.

© 2007 Elsevier Ltd. All rights reserved.

Keywords: Mass transport; LRT; Developing countries; Tunis

1. Introduction

The debate about the justification of investment in metros in developing cities is a classical one and many papers have been produced (see for instance a synthesis offered by [Halcrow Fox, 2002](#)). In the case of more developed countries the question deals with the attractiveness of the system in car dominated societies (see [Kuby et al., 2004](#) for the US experience). This question is also very considered in countries in transition like Poland ([Brezinski and Suchorzewski, 2004](#)) There are many technological mass transport options influenced by many factors such as the context of the city size or the financial context. Considering the developing countries experience one interesting and unique experience is the LRT (Light Rail Transit) in Tunis which was built mainly in the period 1983–1995. What can be the appraisal of this experience and what can we learn about it to

* Tel.: +33 4 42 59 09 17.

E-mail address: godard@inrets.fr

give some advice to other cities which do want to develop a metro or LRT project to improve their public transport system?

This paper presents some elements thrown from an ex post appraisal made in 2000 (Godard and Belaid, 2000) through a study conducted by Inrets with Smlt, the LRT operator in Tunis.¹ These elements are completed by the most recent data from the Tunis LRT operation and from the project of regional railway network (RFR) under study (Baltagi, 2004). This analysis is used also to wonder about the transferability of the lessons offered by this experience to other cities in Maghreb.

2. A brief history of the LRT project in Tunis

At the origin of the LRT project (called *Metro léger* in French, but it looks like a *tramway*) there was the need to fight the congestion and to improve the decreasing accessibility of the city centre. The project was decided in 1980 and its implementation has been delayed by many uncertainties coming from the policy-makers who disagreed with some options. An important debate was particularly held about the option of crossing the main Avenue (Bourguiba Av): an underground crossing was too expansive and it was decided to cross at ground level which involved an interference with traffic. The potential conflicts with cars traffic were managed by the traffic scheme which was designed in the same period.

The first step was the opening to operation of the south line in 1985 followed again by an uncertainty on the layout of lines in the northern part of the centre. Arbitration was made in 1987 by the new president Ben Ali so that the remaining part of the basic network could be implemented correctly during the period 1988–1995:

- 1989: north line;
- 1990: north west line;
- 1990: west line (first trunk);
- 1992: short extension of north west line to Intilaka;
- 1994: ending of north west line to Ibn Khaldoun;
- 1995: ending of west line to Den Den.

After the implementation of the basic network, many extensions of lines have been considered by the Authorities and discussed according to the results of feasibility studies. Actually there has been a period of slowing down and postponement in the rhythm of investment. But finally two main lines extensions have been confirmed or decided by the Authorities in 2002–2003 and are now in the process of implementation:

- Line 1 extension to El Mourouj in south to deserve a large area of population: it has been planned for many years, but the funding was postponed.
- Line 4 extension to Manouba in north-west to deserve the new University: it is a new project based on political considerations to satisfy the numerous students of this university campus, but it does not seem very satisfactory from the point of view of transport engineering and economics.

The LRT network can be summarized by what follows: the length of it is 32 km in double track. There are five lines. Two main transfer stations are located in the centre: Barcelone in south, République in the north. There are also some stations with an organised transfer to the bus but they are not well developed.

3. Investment and operating cost and revenues

As usual there has been many over-costing in LRT implementation compared to the forecasted costs formalised when the project commitment was engaged with the first contract with Siemens. The usual problems of renewing the various networks concerned by works on streets (electricity, gas, sewage, etc.) have been experimented with an underestimation of their cost (over-cost 292%). Besides this an important over-cost was due

¹ Smlt and the bus operator Snt have been merged in 2002 in only one company, Stt.

Table 1
Evolution in rate of cost coverage (unit: 1000 current DT)

	1987	1993	1995	1996	1998
Operating cost (1)	2875	10561	13757	15280	15254
Amortization (2)	486	6139	6386	6263	7108
Total (3) = (1) + (2)	3361	16700	20143	21543	22362
Financial cost (4)	1104	3501	5209	4909	9318
Operating receipts (5)	2489	12566	16385	17269	17496
Compensation for scholars (6)	56	550	661	885	2944
Total (7) = (5) + (6)	2545	13116	17046	18154	20440
Rate of coverage (5)/(1)	86.6%	119.0%	119.1%	113.0%	114.7%
Rate of coverage (7)/(1)	88.5%	124.2%	123.9%	118.8%	134.0%
Rate of coverage (7)/(3)	75.7%	78.5%	84.6%	84.3%	91.4%
Rate of coverage (7)/(3) + (4)	57.0%	64.9%	67.2%	68.6%	64.5%

Source: (Godard and Belaid, 2000).

to the delayed works due to the changes in layout decisions by the Tunisian Authorities. It involved an increase in every cost item due to change and inflation reasons.

The overall cost is difficult to state as it depends on the elements one integrates in and the way one counts in a unique monetary unit. On the classical basis one has considered the track, the equipments, the installations and the cars, so that the estimated cost was 470 M DT (millions Tunisian Dinars) in value 1998. The cost by kilometre was 14.5 M DT or 13.3 M USD (value 1998).

Despite of these over-costs the final investment cost seems to be very reasonable at the international standard (Henry and Kuhn, 1996). That is true the main comparisons are made with LRT in Europe where the manpower cost are higher than in Tunisia: the LRT investment cost is around 20% more costly in European cities than in Tunis. The reality is also that Tunisia could get good loan conditions from Germany and Austria (supporting the supplier Siemens) to finance this project. But these conditions were probably less good for the most recent purchase of new metro cars.

The moderation of the investment cost was due to the option of a ground level network, at the exception of a tunnel in Bardo area. This option was cheap but the limits of capacity are one of its consequences.

The operating cost is covered by receipts from users (including compensation by the State for reduced fares to scholars) at a rate more than 100%. But if one integrates the amortization (mainly the cars which are under the responsibility of the operator Smlt, not the track which is under the State responsibility) the cost coverage by receipts is under 100% what expresses a deficit. According to a little old data the coverage was good and improving for operating cost, it was improving but negative when including amortization, and it was not really improving when adding the financial costs (see Table 1).

This figure of Tunis metro gives an image of a globally correct situation but the financial situation is still remaining difficult. The financial deterioration has probably increased in the 2000s as there was a trend to stagnation of receipts due to the evolution in the patronage.

4. Users and ridership

The level of metro ridership was around 350 000–370 000 daily passengers in 2004. The share of metro in the total trips by public transport in Tunis was estimated at 23.6% in 1998. This share is probably stable but it is decreasing if one considers this share in all the trips including the individual modes.

One observes a stagnation of passengers during the period 1996–1999, then a trend to increase in 2000–2002 and again a probable stagnation in 2003–2004. One has to observe the large increase of the share of scholars using passes (25% in 1995, 43% in 2002). It corresponds to the social function of this LRT but that involves financial difficulties resulting from the very low fare paid for this pass. That reinforces the pressure to get financing by the State through the compensation mechanism. Simultaneously the number of passengers paying detailed tickets has declined from 1996 to 2002 (see Tables 2 and 3).

Table 2

Evolution of yearly Metro passengers according to the type of fare (unit: millions passengers)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Tickets	51.6	53.9	61.4	62	61.6	60	59.2	56.9	56.1	55.8
Scholar Pass	15.7	17.5	22	26.4	28.4	30.5	33.5	39.6	42.7	47.3
Other pass	3.5	4	4.7	4.9	5	4.6	4.6	4.7	4.1	4.1
Total	71	75.5	88.2	93.5	95	95.3	97.4	101.3	102.9	107.3

Source: Smlt.

Table 3

Evolution of yearly Metro receipts according to the type of fare (unit: million of Tunisian Dinars)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Tickets	11.6	12.8	15.1	15.8	15.8	15.9	16	15.4	15.5	15.9
Scholar pass	0.3	0.4	0.5	0.6	0.6	0.8	0.9	1	1.1	1.2
Other pass	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total	12.5	13.8	16.3	17.2	17.2	17.4	17.6	17.1	17.4	17.8

Source: Smlt.

One has to say also a rigorous data production is difficult as there can be some differences between the official data and the reality registered in direct surveys implemented on samples of users. This difference comes from the balance between two inverse factors:

- overestimation by official data of trips made by pass users (scholars seem have around 2,7 daily trips by pass and not 4 trips as usually considered);
- underestimation of the real number of passengers due to the fraud which would be in extension and can be estimated at minimum in the range 10–20%² (by definition this aspect is not well known and very debated).

5. Elements of success of Tunis LRT

The LRT network in Tunis has appeared as a success considering many criteria, particularly:

- The accessibility offered by public transport to the centre;
- The patronage which was registered at a good level. It has permitted to get a good ratio of cost coverage by users receipts;
- The satisfaction of users is globally good as revealed by the surveys on quality of service, despite of increasing criticisms about overloading or insufficient regularity;
- The accessibility of the centre has permitted to stop the decline of its attractiveness and the commercial function has entered in a process of modernization: the metro is of course not the unique cause but it has permitted this process to develop.

Among the success factors at the origin there was the combined traffic plan in the central area which was designed to limit the access by car in the centre: it was implemented in 1985–1987 at the same time that the south line was opened to operation.

This success has pushed the Authorities to try to extend the network to deserve many peripheral areas by extensions of lines. It was a political approach which could be justified by equity and social reasons but which did not integrate well the technical performances and constraints of such a system which could not meet all the travel needs of people in the city.

² The problem of fraud has obliged the operator to modify his policy in 2005–2006, closing the access of stations and reinforcing the control of users.

So the conclusion stated in 1994 and confirmed in 2000 in the Inrets reports is still verified: this network can be victim of its success as the quality of service is deteriorating if the demand is too high compared to the offered capacity. The financial constraint has also obliged the operator Smlt to limit the supply: the number of seat-kilometres offered was approximately stable around 1.6 Md in the period 1996–2001 as there was a maximum in 1995 (1.7 Md) and again in 2002 (1.74 Md) The consequence of all these elements is the limit of capacity has become a structural problem.

6. Limits of Tunis LRT in terms of capacity

The question of a limited capacity of LRT was stated for many years. It had been analysed in 1994 when the critical segment was the central trunk of the network linking the southern line to the northern and western lines. It has been partially solved at the end of 1990s by new operational schemes avoiding some transversal lines but the obstacle of capacity was displaced to the Barcelone station and mainly to the République station and its access by the west. Alternatives of a second line crossing and deserving the central area have been considered but their feasibility was not confirmed.

The loading rate of metro cars is near 100% at the peak period, and even more than 100% for some lines. The data in 1999 were meaningful about the saturation of the main lines, and the trend to a ridership increase has accentuated this overloading at the peak (see Table 4).

7. Limits in terms of modal transfer: private car use is increasing

LRT was considered as a way to make public transport more attractive and efficient to meet the travel needs in the urban area of Tunis and to limit the private car use in this area. The goal during the 80's was to keep the modal share of public transport at 60% against 40% insured by private car. Until recently the official objective announced by the Authorities was to get a balance of 50–50% as it was stated in the Master Plan (1998).

The metro has contributed to some modal transfer as it appeared in the household survey in 1994 (Godard and Belaid, 2000): one estimated around 5% the share of metro users which used the car before (but mainly as car passengers). A more recent estimation made by a survey on the metro users profile in 1999 gives the following: 9% of users declared to have an alternative of using car for their trip, among them 5.5% as a driver and 3.5% as a passenger. That means the metro plays a role to limit the car use but this role is limited and cannot easily be increased for capacity reasons. This result is confirmed by global data on the evolution of modal share in Tunis.

The estimation of the real modal share is difficult without a up-to-date household survey, but the estimations made at the occasion of the RFR feasibility study (Baltagi, 2004) give a majority of trips by private car (60%) and not by public transport (40%). One has nevertheless to say metered taxis are counted with private car in individual modes. The new goal proposed would be to keep the public transport share at 40% and it is estimated that a strong policy of transport supply improvement is necessary to meet this goal; without the RFR project it is probable this share will decrease to 35% in 2015.

These elements mean that the LRT project could not involve a meaningful modal report from the car to public transport and even not stop the trend in the increase of car use in such a city. It is easy to understand

Table 4
The loading rate of metro according to the lines, peak period, 1999

	Morning peak		Evening peak	
	Centre-periphery	Periphery-centre	Centre-periphery	Periphery-centre
South line	15.7%	80.2%	41.5%	103.4%
North line	85.9%	65.8%	96.6%	61.8%
North-west line	19.9%	103.9%	48.2%	93.3%
West line	27.2%	103.3%	46.2	107.7%

Source: Inrets–Smlt, 2000.

if one considers the reality of the supply by LRT: the success of ridership in the different lines is expressed by a near 100% rate of utilisation of the metro cars in peak period, so that car drivers are reluctant to leave their car to use the metro. From the surveys made on the metro users, one can state there has been some modal report at the beginning of operation (period 1985–1990) but it concerned more the car passengers than car drivers. In the most recent period car users are less and less attracted by the metro for the above reasons (quality of service in peak period) and also because the parking facilities are not sufficient in the suburban stations to organize a multimodal trip (car plus metro).

Actually there has been a global trend of high increase of car ownership due to the increasing level of income in 1990s in Tunisia and due to the State policy to facilitate purchasing of cars in Tunisia by the middle class (programme said “the popular car”, which consisted of reduced taxes on imported cars). So the rate of car ownership is estimated to have increased from 60 cars for 1000 inhabitants in 1994 to 80 cars in 1999 and 90 cars in 2001 (Baltagi, 2004).

The improvement of public transport brought by LRT network was not sufficient to eliminate or to limit this pressure in favour of an increase in car equipment and in car use in Tunis. But it is possible and probable the announced increase of gasoline price in the future linked to the oil crisis will push a part of car users to go to public transport use for their daily travel.

8. Need of regional railway lines: a new project

After the conclusions stated by the first Inrets–Smlt study (1994) of ex post LRT appraisal, it appeared necessary to launch a Public Transport Master Plan, implemented in 1997–1998. This plan stated the need of a railway regional network (called RFR) in Tunis the principle of which was approved by the Authorities. A feasibility study was then launched in 2001–2002 with funding from the World Bank. This study is under implementation; its first phase has defined a detailed proposal of network with a renewed scheme of network different from the 1998 scheme. There is a proposal of a combined set of RFR lines and of LRT new lines or extensions aiming to get a consistent mass transport network (Miladi, 2002).

The new options were in discussion by Authorities in 2004–2006 as they interfere with many other urban projects and involve huge investments which the Ministry of Plan has not yet confirmed in totality but is probably reluctant on according to the debt constraint: there are no official estimates but a first hypothesis would be an investment cost of around 3 Md Euros, i.e. six times the investment cost of LRT network.

The main option which is structuring the proposed network is to implement a north south junction line with a large transfer station at the extremity of Bourguiba Avenue in the eastern boundary of the centre which is expanding through new urban project in this area. That would suppose an underground option for this segment of line and for the station in this area, which will be of course very costly in investment (Baltagi, 2004).

This scheme is designed to solve the recurrent problem of the capacity of mass transport in the centre of Tunis as LRT lines have their capacity limited in this area, both in the central trunk and in the two central stations (*République* and *Barcelone* stations) as mentioned above.

9. Comparison with metro projects in Algiers and Casablanca

A comparison was made (Godard, 2000) with metro projects in Algiers and Casablanca. Of course the city size and context are different for these three cities as Casablanca has a population around 4 millions, Algiers around 2.5 millions, and Tunis approximately 2.1 millions inhabitants. From the point of view of resources Algeria benefits from oil resources permitting to fund large investment projects.

The stories of metro projects in these three cities in Maghreb are very different. The idea of metro was present for many decades in each city but things have been different in the 1980s, when Tunis launched the LRT project in 1980 (first line operated in 1985).

In the same time Algiers launched in 1983–1984 the project of underground metro by a first step of building a 1500 m tunnel. The project was then influenced by multiple hazardous events coming from the political uncertainty and also from the financial difficulties in 1985 after the drop in the oil receipts by Algeria. The works for tunnelling have continued during the whole period of uncertainty with the view to get irreversibility but in 2004 the project was far from being finished. The Authorities have decided to accelerate the implemen-

tation of this project but the institutional status for its operation is not yet totally decided as contradictory discussions were made in 2005 with the World Bank which pushed unsuccessfully in favour of a PPP (Public Private Partnership) scheme.

Meanwhile the situation of public transport was deteriorating. A liberalization was introduced progressively in 1987 then in 1992 producing a large increase in the supply but also many difficulties in the management of the system; the Authorities were trying from 2003–2004 to reorganize the urban transport in Algiers through a renewal strategy of the bus operator Etusa and also the implementation of a LRT line deserving the eastern part of the city.

Casablanca has registered many metro studies, the main proposals were:

- Sofretu study in 1983;
- Jica study in 1990;
- Systra study in 1999.

The last study in 1999 seemed close of a decision to implement the metro but the financial obstacle of its investment cost was not solved at all. Even the justification of the metro in the global transport system was not really developed. Actually there was no real planning approach to design this metro project as decision-makers said they did not need more studies but they needed only to implement it. The reality of constraints offered a different answer: the project has been postponed as the urgent decision was to reorganize the bus supply. Following a call for tenders a new private bus operator (called M'dina bus) has been chosen to replace the activity of the collapsing public operator Ratc. The reality was also that from years to years the main component of public transport in Casablanca has become the shared taxis following the crisis of the bus sector, both public and private operators. The idea of LRT as an alternative to the metro option seems again considered, these options are analysed in the urban travel plan the study of which has been launched at the end of 2003.

As a conclusion of this comparison it appears that Tunis option for a LRT has permitted an effective implementation when the more ambitious and costly metro projects in Algiers and Casablanca could not be achieved as they were too difficult to manage and to fund.

10. Conclusion: lessons from Tunis LRT

An important lesson deals with the success factors of Tunis LRT. We identified many combined factors:

- A strong political willingness and arbitration;
- An insertion of the project in a scheme of planning and studies accompanying it;
- A joined project of traffic plan based on car restriction in the centre;
- Implementation of a real network and not only one or two lines;
- A relatively moderate and affordable investment cost.

Among them it is important to insist on the weight of the planning process which make the decision process more consistent in Tunis than in other cities, despite of political difficulties in the decision process. The decision-makers who want to implement such projects without supporting a constant endeavour of studies and planning are going probably to failure, as the examples of Algiers and Casablanca have shown. Even if the international expertise is involved profitably it is also important to mobilize a local expertise on these questions of urban transport planning and management.

But the main lessons deal with the ambiguity of conclusions thrown from the Tunis LRT success. Even if the LRT success is debated in Tunis, the conclusions of Inrets/Smlt were clear about it. Nevertheless there could be misunderstanding about the meaning and the consequences of this conclusion. Some ones have been tempted to conclude:

- A good effort was made for a good project, now we can operate it without any new effort;
- As this LRT option is good, we will extend the LRT network to the areas not yet deserved.

These two types of statements reveal to be wrong as the evolution of urbanisation and of travel demand obliges to continue to design new responses to meet the travel needs: it calls for new technological options which are covered by the RFR project at a regional scale. There was a sort of pitfall in this LRT success because the Authorities have waited too long before launching the process of RFR study as one knows that the negotiations of such a project then its implementation are very time consuming.

References

- Baltagi, A., 2004. Projet d'un réseau intégré de transport collectif dans la ville de Tunis. In: Proceedings Codatu XI, Bucarest.
- Brezinski, A., Suchorzewski, W., 2004. Tram systems in Poland. From neglect to a recognition of great potentials. In: Proceedings Codatu XI, Bucarest.
- Godard, X., 2000. Enseignements de l'expérience du métro léger de Tunis, confrontation avec les expériences de Alger et Casablanca. Compte-rendu de séminaire, Aix en Provence, Inrets.
- Godard, X., Belaid, S., 2000. *Evaluation a posteriori du métro léger de Tunis*, rapport final d'actualisation 2000, Inrets-Smlt.
- Halcrow Fox, 2002. Mass Rapid Transit in Developing Countries, report for the World Bank, Cities on the move, Urban Transport Strategy.
- Henry, E., Kuhn, F., 1996. Du métro à ses variantes, leçons mexicaines et autres. In: Proceedings Codatu VII, New Delhi.
- Kuby, M., Barranda, A., Upehurch, C., 2004. Factors influencing light rail station boardings in the United States. *Transportation Research Part A* 38.
- Miladi, S., 2002. Plan directeur régional de transport du Grand Tunis. In: Godard, X., Fatonzoum, I., Urban Mobility for all, Codatu X, Balkema ed.