

GUIDELINES FOR IMPLEMENTERS OF **Personal Rapid Transit (PRT)**



What is it about?

Characteristics

Personal Rapid Transit (PRT) is a state-of-the-art form of public transport (PT) that uses small automated electric 'podcars' to:

- provide a taxi-like service for individuals or small groups of travellers;
- provide demand responsive feeder and shuttle services connecting facilities such as parking lots with major transport terminals and other facilities such as shopping or exhibition centres.

The podcars run on a segregated guideway in order to ensure unhindered direct trips between origin and destination. They provide clean, green, efficient and sustainable transportation. With high vehicle speeds and very small headways, PRT provides fast, individual, on-demand and point-to-point PT with very short waiting times.



Photos: courtesy of BAA

Key Benefits

PRT provides:

- highly efficient "on-demand" operation;
- low operating costs as drivers are not required;
- personal public transport;
- pollution reduction as vehicles are automated, electric and quiet;
- direct origin to destination stop services, i.e. no intermediate stops;
- simple, accessible services similar to a lift;
- very short waiting time;
- congestion-free transport due to operating on a segregated guideway.

Good Practice: PRT at London's Heathrow Airport, UK

The pilot PRT scheme at Heathrow Airport (UK) which is scheduled to open late Spring 2010, is the first implementation of PRT in the world. It provides transport for travellers between the business car park and the new Terminal 5, about 2 km away.

21 automatic electric podcars, each with room for 4 persons and their luggage, transport users along a segregated guideway at up to 40kph. The trip takes about 5 minutes, the podcars operate on-demand, but are usually waiting so that waiting times are zero for 70% of users and very low for the others.

The capital cost is reckoned to be about half that of an equivalent tram scheme and with the potential to provide a similar passenger carrying capacity.

If the pilot is successful, it is planned to extend it eventually, to interconnect all the car parks and terminals with the bus, rail and metro stations, car rentals and hotels on the airport site.

Is this something for us?

PRT provides personal transport, like a taxi, and so can expect to be highly attractive to users. The concept supports transport, environmental, economic, and social inclusion policy objectives, and can complement existing public transport services by providing the link between them within cities.

Economic benefits include:

- efficient use of land;
- high level of on-demand service;
- substantial modal shift;
- flexibility: unlike conventional PT, PRT can operate over a network and not just along a line or route.

Check list

City size	Initially for widening catchment areas e.g. for stations etc. and serving dispersed sites, but city sized networks are possible.
Costs	Less than for an equivalent bus scheme using drivers, and less than for a tram. Capital costs are needed to procure the podcars; provide the control system/centre and a depot for vehicle maintenance/charging; and also to provide and equip the guideway, stations and security measures.
Implementation time	Medium term, 5 years or more may be needed to plan and implement a scheme in a city environment.
Stakeholders involved	Operating company, local authority as the infrastructure owner, national government for safety certification. Local community and users.
Undesirable secondary effects	Possible visual intrusion caused by elevated sections of guideway, and of severance caused by sections at-grade, although these can be mitigated by using 'cut and cover' or tunnels.

"We have seen the potential of PRT in Sweden. Our KOMPASS network represents 13 interested cities. Four of them have been shortlisted by the government and invited to bid for a pilot scheme. We expect to learn the results in early 2010 and to have a 5 km pilot scheme running in 2014.

Carl-Johan Engström, Director of Strategic Planning, City of Uppsala, Sweden

"PRT is a potential form of public transport that could offer a travel experience sufficiently close to using a private car (e.g. personal space, on-demand) that it should be able to compete directly in a wide range of implementations."

Richard Caple, PRT Project Manager, Daventry District Council, UK
(NICHES+ Champion City)

The main application areas of PRT:

- airports;
- tourist attractions;
- shopping parks and malls;
- university and hospital campuses;
- industrial business parks;
- eco towns;
- new urban city developments;
- park & Ride;
- extension of existing modes.

The Frost and Sullivan report on 'the global emergence of PRT system markets' (2009)

Benefits & Costs

Benefits

PRT provides a new system of public transport offering personal, on-demand and direct origin to destination services similar to a taxi. These advantages offer great potential for achieving modal shift, and combine with the safety and cost savings arising from automated i.e. driverless operation.

Significant benefits are therefore:

- potential for high public acceptance and modal shift;
- reduced operating costs from driverless operation and the more efficient use of vehicles which are only used when there is a demand;
- low waiting times and hence time savings for passengers;
- reduced noise and environmental pollution locally from using electric vehicles.

PRT therefore provides a potentially sustainable and convenient solution for urban mobility.

Costs

PRT schemes require a dedicated guideway and small 4 to 6 seater (i.e. car sized) driverless vehicles. The guideway will very probably be elevated for all or part of its length, though the structure can be relatively light. Representative costs for a variety of systems and 24/7 operations have been estimated in the CityMobil project and are reckoned to be:

Capital costs:

- cars cost 75 K€ each
- infrastructure costs 3.8 M€/km

Operating costs:

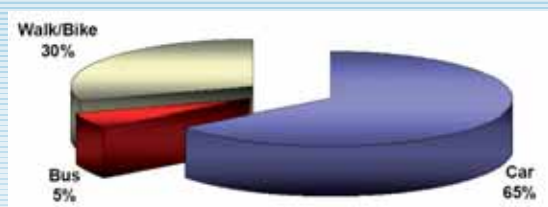
are made up from a base cost for 5 km of track and 25 vehicles (including staff) plus additions for infrastructure per km and per vehicle, and for staff per km and per vehicle, which total to:

$$1,600 + 67.0(L-5) + 11.0(N-25) \text{ K€ per year}$$

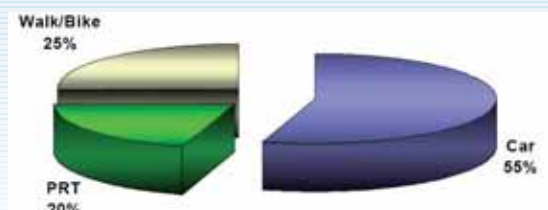
Where L is the length of single track guideway (in km) and N is the number of vehicles.

Mode split in Bolanderna, Uppsala

today



forecast in 2020 using PRT



Figures: courtesy WSP Sweden

Daventry PRT Scoping Study

Feasibility studies suggest that PRT should recover its costs.

Detailed costings for a 5 km pilot PRT scheme with 5 stations and 25 'podcars' have been produced by SKM (Consulting Engineers) for Daventry District Council in the UK.

Capital costs were estimated in 2006 to be £14M with operations and maintenance costs of £1.7M pa.

PRT was compared with a High Quality Bus scheme in a discounted cash flow analysis over a scheme lifetime. The results showed similar total costs, but the benefit to cost ratio for the PRT scheme was substantially higher at 2.4 compared with 1.7 for the bus.

Users & Stakeholders

Users and target groups

There are essentially two classes of users for PRT systems: the end users i.e. **passengers**, and the **buyers** of the systems. Clearly, the buyers must recognise the needs of the end users, but have additional needs of their own.

Passengers include all classes of travellers on trips for all purposes e.g.:

- leisure;
- commuting;
- business;
- people with individual requirements, such as:
 - mothers with pushchairs;
 - travellers with heavy luggage;
 - wheelchair users and other physically disabled travellers;
 - visually impaired travellers.

Their main expectations and needs include accessibility, information, ease of use, comfort, cost, reliability, safety and security.

Buyers may be PT operating companies or local authorities. Their additional concerns relate to factors regarding operations, maintenance, costs and financial viability.

A **Public Advisory Panel (PAP)** has been established in Daventry. This is chaired by a senior officer from the District Council and includes 29 members of the public who responded to a public invitation for members.

The purpose of the PAP is to provide early public consultation through a forum for project updates/status from Daventry District Council, and to receive comments/opinions from members designed to shape the project direction.

Key stakeholders for implementation

Like buses and trams, PRT schemes are typically procured by a local authority or a public transport operator, and may be financed through a Private Finance Initiative (PFI). The main actors will be:

- **local authority**, as the planning authority and owner of the infrastructure on which the scheme will run;
- **PT operating company**, as the operator of the PRT system;
- **technology supplier** and system integrator who will provide the podcars, the control centre and communications systems;
- **infrastructure supplier** a contractor to implement the necessary civil engineering facilities, including the guideway and stops, and buildings for the control centre and depot;
- **managing consultant** to act as project manager to oversee the overall implementation and ensure co-ordination between the technology and infrastructure suppliers;
- **national government** for certification and perhaps funding;
- other **funding partners** e.g. banks, and the developers of the sites served by the PRT scheme.

Other groups that should be consulted will include:

- neighbouring local and regional authorities;
- emergency services;
- local community;
- passenger interest groups;
- special needs groups;
- media.

From concept to reality

Preparation



A proposal for a PRT scheme will generally arise as a consequence of an identified need for a new public transport scheme, such as to provide a new park and ride scheme or to serve a new development or regeneration area. Planning will then proceed along the usual lines, starting with a feasibility study to confirm the likely level of demand and that PRT is the preferred solution.

Key aspects at this stage

- PRT proposed in response to an identified need;
- Feasibility study to confirm demand and show PRT is the preferred solution;
- Work to win necessary media and stakeholder support;
- Produce scheme/system specification;
- Develop a business case and funding mechanism;
- Prepare EU-PIN (Pre-Information Notice);
- Prepare/publish Invitation to Tender (ITT);
- Receive/evaluate tenders;
- Select contractor/consortium.

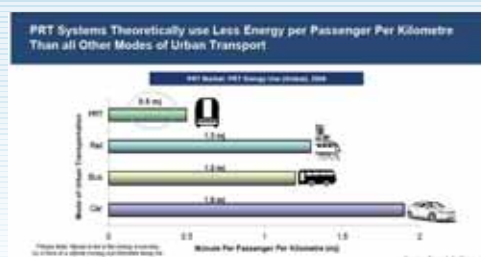


Figure: courtesy Frost and Sullivan

Creating political support

PRT is not yet on the agenda of most planners. They will probably consider a bus or tram scheme first. However PRT has much to offer, and is highly competitive in many situations. **A champion** will be needed who can take plans forward and win the support of local politicians.

Feasibility Study

It is usual to employ consultants to estimate demand, investigate alternative schemes and systems, identify barriers and how to overcome them, show expected costs/benefits, and generally confirm PRT is the preferred solution. The study should identify if a public enquiry will be needed, and what approvals must be obtained to cover the operations, safety and certification of the scheme.

Stakeholder network

It will be essential to win the support of the local community, residents and businesses. It is therefore suggested to involve the media and to establish user groups as a means to inform users of the benefits and progress, and to learn their views and opinions. These will need to be taken into account.

Scheme/system specification

Again it is usual to employ (the same or different) consultants to develop the results of the feasibility study into a scheme/system specification.

Business case

A separate business case may be required, especially if it is proposed to involve private funding, to help identify the preferred funding mechanism.

Prepare/publish ITT

Standard procedures should be used to prepare and invite tenders, to evaluate them and select the successful consortium. The steps are:

1. **Prepare** a Pre-Information Notice (**PIN**), for publication in the Official Journal of the European Community. This notifies suppliers of an impending Invitation to Tender (ITT) and invites those interested to complete a PQQ (Pre-Qualification Questionnaire).
2. **Prepare** and publish an **Invitation To Tender** if it is intended to procure the system directly, or an **Invitation to Participate** if a Private Finance Initiative (PFI) is proposed.
3. **Receive/evaluate the responses** and enter into competitive dialogue if required.
4. **Select contractor/consortium** and prepare to award contract or, in the case of a PFI, a consortium partner position, but subject to satisfying certain conditions described in the next steps.

Tip

Mock-ups of stations and vehicles together with visualisations of how the scheme will impact on the local setting will be useful tools for helping to explain the system and win public acceptance.

Procurement and funding

Several studies have shown that PRT schemes should be able to recover their full capital and operating costs through the fare box. However, the initial capital outlay required is expected to be more expensive than for an equivalent bus scheme. Many local authorities with limited budgets will therefore be tempted to go for the apparently cheaper and better understood bus alternative rather than the riskier and unproven solution of PRT.

For these reasons, most proponents of PRT believe that procurement through a Private Finance Initiative (PFI) is to be preferred. This will enable involvement by the private sector who can be expected to accept some of the risk (both technical and financial) in return for a share of the profits.

Several models for PFIs are possible, known as DBFOs (Design, Build, Finance, and Operate) in some countries, and BOTs (Build Transfer Operate) in others. In all cases they involve establishing a formal legal 'consortium' agreement between the public and private sector partners involved to clarify their respective roles, responsibilities and liabilities.

The funding might come from industry and banks, and also from the developers of new residential and retail parks, and out of town superstores and other e.g. leisure facilities, who should be keen to facilitate, if not actually provide, public transport links that will connect existing population centres to their new sites.

Visualisation of PRT in Södertälje, Sweden



Photo montage: WSP Sweden

Ready for implementation? ✓

Political support and champion in place?	
Feasibility proven?	
Approvals required?	
Public enquiry needed?	
Stakeholder support obtained?	
Path to certification established?	
Funding available?	

From concept to reality

Implementation



Following selection of the contractor/consortium we can proceed to implementation.

Key aspects at this stage

- Put consortium and funding in place;
- Prepare and apply for necessary approvals;
- Prepare for public enquiry if needed;
- Notify certification body and set up independent Quality Assurance (QA) team;
- Let contract;
- Build scheme i.e. civils infrastructure, control and communications system, vehicles;
- Train staff;
- Continue working with media and stakeholder groups;
- Trials/tests;
- Certification.

Reliability

The application of modern technologies using sensors and on-board diagnostics to provide early warnings of possible problems will ensure that PRT vehicles are robust and operate with very high reliability.

Freight

PRT systems also have potential for collecting and distributing goods.

* The relevant standard is CENELEC EN50126 Railway applications - The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS). IEC 61508 «Functional safety of electrical/electronic/programmable electronic safety-related systems» was also used for the certification of the Vectus test track in Sweden.

Consortium

Decide the funding mechanism and the partners who will be involved in the consortium to build and operate the scheme. If a PFI is to be used then a special company, and the funding sources, may need to be established for the purpose.

Approvals

In the UK for example, a Transport Works Act (TWA) order is needed to provide planning permissions and powers to become a transport operator.

Public Enquiry

A public enquiry may be required to ensure public and political support. Involve the consortium, contractors, and politicians as necessary to prepare for and present at the PE to show the justification and success factors, and also how any barriers and risks will be overcome or mitigated.

Stakeholder network

Undertake additional briefings to prepare the stakeholders and media, and try to enlist their support at the Public enquiry.

Requirements for certification

If this is the first PRT (driverless) scheme to be implemented in your country, you must speak to the Ministry of Transport to learn what is required. In most countries PRT falls under railway regulations*. These require that systems such as PRT with automated vehicles running at less than 40kph are self-certifying. An independent QA team with the necessary expertise will need to be established to secure this self-certification.

Following successful outcomes from the public enquiry, and the requirements for certification:

Let the contract with the successful contractor/consortium.

Build the scheme: there are three main components:

- the civil engineering infrastructure which includes the guideway, the depot and control centre;
- the vehicles;
- the control and communication system.

The construction of all three must be co-ordinated so the component parts can be tested individually before being brought together and tested as a complete system.

Train the operators and staff to ensure good customer relations and the safe and reliable operation of the scheme.

Continue working with **media** and **stakeholder groups** as necessary to learn their opinions and overcome problems.

Conduct **trials and tests** as needed to satisfy requirements and obtain the **certification** needed to carry passengers.



The PRT test track in Uppsala

Photo: Vectus Ltd

Certification

PRT (and GRT i.e. Group Rapid Transit) systems using automated vehicles have so far been certified for operation in the UK (e.g. ULTra at Heathrow), the Netherlands (e.g. Parkshuttle at Rivium), Sweden (Vectus at Uppsala) and France (various systems at theme parks implemented by Robosoft).

Italy is presently going through the process for a system being installed at the new Rome Exhibition Centre, and Abu Dhabi for the system in Masdar city.

The process is well defined for railways, and has arisen largely from the need to certify automated people movers i.e. transits, at airports, and the new generation of automated metro systems.

However, there is so far only very limited experience of trying to apply the regulations to schemes in cities. It is expected that the necessary process and procedures will be clarified and documented within the EC supported CityMobil project for the future.

Certification for PRT in Daventry

SKM undertook a HAZOP (Hazard Operations) identification exercise of a scheme operating in a city, and spoke with the UK Railway Inspectorate who confirmed that PRT had already been considered in the UK and no fundamental difficulties were identified.

An independent QA team would be required to work with the directorate and to assess the risks and produce a full safety case relating mainly to:

- safety of passengers;
- system failure and recovery;
- separation of PRT from other traffic and pedestrians;
- integrity of vehicle routing and control systems.

From concept to reality

Operation



Following successful implementation and certification it will be possible to proceed to full operation.

Key aspects at this stage

- Operate and maintain;
- Monitor operations and customer relations;
- Continue working with media and stakeholder groups;
- Evaluate.

Operate and maintain the system as necessary to provide the required level of service and performance. Extra staff may be needed in the early days to help users familiarise themselves with the new automated system, and so help to ensure customer satisfaction.

Continuous **monitoring** of operations is needed to ensure the system performs as required in terms of factors such as reliability, safety, usability, user satisfaction, etc.



The PRT vehicle developed for the Masdar eco-city project in Abu Dhabi

Photo: courtesy of '2getthere'

Continue working with **media** and **stakeholder groups** as necessary to learn their opinions and overcome any problems.

Evaluation will be needed in the early days to ensure user needs and the performance specification are fulfilled, and at a later phase to confirm usability and public acceptance as well as the costs and benefits.

Masdar City in Abu Dhabi

Aims to be the world's first carbon neutral, zero-waste to landfill, car-free city powered entirely by alternative energy sources. Masdar City will be built on six and a half square kilometres and will grow eventually to house 1,500 businesses, 40,000 residents and 50,000 commuters.

There will be no fossil fuel cars within Masdar City. The city will be a pedestrian-friendly environment, with a Personal Rapid Transit system (PRT) available for longer journeys. The PRT vehicles will travel at speeds up to 40km/h, with the longest routes in the city taking around 10 minutes. Ultimately there will be 3,000 PRT vehicles serving 130,000 trips/day over the 85 stations.

The dedicated guideway in the undercroft, an artificial basement created by raising the pedestrian level, will also accommodate the Freight Rapid Transit system (FRT). The FRT system is capable of making 5,000 trips per day carrying the loads and deliveries for residents, stores and hotels. The flatbed vehicles can carry two pallets, with a maximum total payload of 1,600kg.

The PRT & FRT will be entirely powered by renewable energy.

Courtesy of '2getthere'

Further information & contacts

Further information

The global emergence of PRT system markets, report by Frost and Sullivan, 2009

BAA (ULtra):

<http://www.heathrowairport.com/portal> (and search for PRT)

ATS:

<http://www.atsltd.co.uk/>

2getthere:

http://www.2getthere.eu/Personal_Transit/Projects/Masdar_City_PRT/

Masdar City:

<http://www.masdaruae.com/en/home/index.aspxCityMobil>

Vectus Ltd:

<http://www.vectusprrt.com/prt/overview.php>

Robosoft :

http://www.robosoft.fr/eng/sous_categorie.php?id=1023

CityMobil project:

<http://www.citymobil-project.eu/>

University of Washington:

<http://faculty.washington.edu/jbs/itrans/>

Advanced Transit Association:

<http://www.advancedtransit.net/>

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Acknowledgments

The NICHES+ Consortium would especially like to thank Richard Caple for reviewing a final draft version of this document, as well as all experts that commented or participated in NICHES+ working group meetings and interviews (see www.osmose-os.org for expert database).

The mission of NICHES+ is

to build on the success of the first NICHES project by stimulating a wide debate on innovative urban transport and mobility between relevant stakeholders from different sectors and disciplines across the EU and accession countries, in order to promote the most promising new urban transport concepts, initiatives and projects and promote them from their current "niche" position to a mainstream urban transport application.

This publication is part of a series of 13 publications presenting the NICHES+ outcomes.

NICHES+ Champion City, Daventry, UK:

The City of Daventry is developing an implementation scenario for Personal Rapid transit in the framework of NICHES+. Daventry is a market town situated in a rural green environment in the midlands area of the UK where car manufacturing in nearby towns and cities has traditionally been a major industry. Daventry is designated as an area for future development and a vision was set out in a Master Plan in 2006 to provide for the development required to accommodate a proposed growth from a town with a population of 23,000 currently to 40,000 with associated business, retail and leisure activities by 2021. The vision requires a new sustainable transportation system to facilitate the planned expansion. Significant new roads building will not be possible, so the new system will need to provide flexible transport between residential, business, retail and leisure areas; help reduce the need to travel, especially by car; support the development of sustainable communities; reduce social exclusion and improve intermodality. Daventry has investigated the potential of PRT to serve these mobility requirements in a sustainable way, and as a Champion City in the NICHES+ project is developing an implementation scenario that will serve as a case study for other cities.

Photo on title page:

BAA

Prepared for the European Commission by:



David Jeffery, TRG

June 2010

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Further information on NICHES+

www.niches-transport.org
www.osmose-os.org