# Detailed Project Report: Public Bicycle Share (PBS) System - Panaji

CORPORATION OF THE CITY OF PANAJI

EMBARQ India

## Support from

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# Section 1- Introduction to Public Bicycle Share (PBS) Systems

## Background- Public Bicycle Share (PBS) Systems

Public Bicycle Sharing (PBS) systems are a flexible public transport service that involves the creation of a dense network of cycle stations. Users can check out a cycle from any station and return it to any other station in the system. The station where the cycle is returned need not be the original station from where the cycle was borrowed.

This flexibility is one of the key features which differentiates PBS systems from traditional bicycle rental stores. PBS systems also encourage the use of cycles for short distances by making the use of cycles free for a short period of time (usually 30 mins), after which the cost of borrowing increases exponentially. This progressive fare structure ensures that the cycles are returned to the stations quickly, and are mostly used for last mile connectivity. This is another features which differentiates it from traditional rental systems where cycles are usually borrowed for a day or more.

PBS systems have evolved a lot since the first system, "White Bicycles" was launched in Amsterdam in 1965. "White Bicycles", where 50 white cycles were parked unlocked across the inner city regions of Amsterdam for anyone to use, was innovative but ultimately unsustainable because of theft and vandalism. The PBS concept has since evolved over the last four decades to become an IT based system. Today's PBS systems, often referred to as the "3rd Generation" of PBS, use automated systems. The features of PBS as it works today includes:

a. A dense network of cycle stations
b. Custom designed cycles which are designed for heavy use, mechanical reliability, sturdiness and stability
c. Unique design for the cycle which will discourage theft and help in brand building
d. Smart Card Access to the system for the user
e. Fully automated self-service terminals at stations.
f. A fully automated locking system at stations that allows users to check cycles in or out using smart cards, without the need for staffing at the station

g. Radio frequency identification devices (RFIDs) to track where a cycle is picked up, where it is returned, and the identity of the user

h. Real time monitoring of station occupancy rates to help with redistribution of cycles
i. Real-time user information provided through various platforms, including the web, mobile phones, and/or on-site terminals.
j. Advertising space on cycles and at stations (provides revenue generation options for system operator or city)
k. Pricing structures that incentivise short trips, helping to maximize the number of trips per cycle per day.

Although PBS systems have now been around for more than 3 decades, the concept gained worldwide popularity only after the launch of the first third generation systems, such as Velo'v in Lyon, France in 2005, and Velib in Paris, France in 2007 . These systems generated a large interest in PBS across the world and led to an exponential increase in the number of systems launched worldwide.

By 2013, PBS systems were operational in 52 countries and 635 cities. Europe has the largest number of systems currently operating, 469, followed by Asia (which started on PBS systems only in the last few years) with 108. These have been illustrated in the two diagrams below.


**Figure 1: Number of PBS in the world- 2007, 2010 & 2013 (Source: UNDECA, 2011)**


**Figure 2: Countries with PBS systems- 2013 (Source: UNDECA, 2011)**

Wuhan with 90,000 bicycles and Hangzhou with about 60,000 bicycles, both in China, are the largest PBS systems in the world. Velib, the PBS system in Paris, is the biggest system in the world outside of China with 17,000 cycles.

## *Benefits of PBS*

**a.** Increase the catchment area of Public Transport systems- PBS systems provide complimentary services to existing Public Transport systems like Buses and Metro by providing last mile connectivity. This in turn helps in increasing the reach of these Public Transport systems in an inexpensive manner to regions where it is not feasible to extend these services. People further away from the stations will gain access to the Public Transport services.

**b.** Reduce Congestion- By providing an alternative mode of transport in the city, especially for short- and medium-distance local trips, PBS systems help in reducing congestion on roads by reducing the number of private motor vehicle trips.

**c.** Increase modal share of cycling in the city- PBS systems have been shown to increase cycling modal shares in the cities in which they have been introduced. PBS systems offers the convenience of cycling without the burden of ownership and the flexibility to accommodate one-way trips. Increase in cycle modal shares are also because PBS leads to more people using their own personal bicycles. For example, Lyon, France saw a 44% increase in bicycle riding within the first year of their Velo'v program's introduction. Similarly, bicycle riding in Paris has increased 70% since Velib' was introduced in July 2007 (NYCDCP, 200).

**d.** Improve the city's image and branding: Since cycling is a sustainable mode of transport, cities which have launched city wide PBS systems have been recognised as green and sustainable. This in turn has had a positive impact on its tourism value and media coverage. Velib, Paris was awarded the "British Guild of Travel Writers' Best Worldwide Tourism Project" in 2007. Bixi, in Montreal, Canada, was recognised as one of the 50 best inventions of 2008 in Time Magazine.

Cycle sharing can also help to transform the image of cycling, making it a popular means of travel for all income groups.

**e.** Improve local economy: PBS systems have the potential to generate numerous jobs in the local economy, through the manpower required in the operation of the system itself and by spurring demand for new products and services related to cycling. PBS systems also provide connectivity to newer areas of the city which may not be served by public transport, thus improving the local economy.

Being a city of small size, the average trip lengths in Panjim are short enough to be comfortably covered using a cycle. However the current modal share of cycling in the city is very low. This can be attributed to the lack of cycling infrastructure and projects which encourage cycling in the city. The low numbers are also attributed to the perception of cycles as a poor man's mode of transport.

Launching a bicycle share in the city will help in addressing these issues. PBS systems with its automated infrastructure will have a large impact on improving the image of cycling in the city. This will help in not only getting people interested in using the system but also encourage a certain section of the population to own their own cycles and use it. Bike shares will also by way of its coverage be able to provide both end to end coverage and help in improving the coverage of exiting Public transport system in Panjim.

Launching a bike share will also help the city in its effort of cutting off the core and heritage areas of the city to motorised traffic. Locating PBS stations at convenient locations around the pedestrianized area, will help make available an alternate mode of transport which is non- motorised, flexible and cheap to use and also able to provide connectivity.

## *Successful Examples*

A few noteworthy PBS systems, from the over the 600 systems currently operating across the world, are listed below.

| Velib | |
|---|---|
| City | Paris |
| Country | France |
| Launched | 2007 |
| Links | www.velib.paris.fr |
| Entities | JCDecaux<br>Paris City Council |
| Number of Stations | 1230 |
| Number of Bicycles | 17,000 |


| Bixi Montreal | |
|---|---|
| City | Montreal |
| Country | Canada |
| Launched | 2009 |
| Links | https://bixi.com/ |
| Entities | PBSC<br>Stationement de Montreal |
| Number of Stations | 411 |
| Number of Bicycles | 5120 |


| Citibike | |
|---|---|
| Name | Citibike |
| City | New York |
| Country | USA |
| Launched | 2013 |
| Links | http://citibikenyc.com/ |
| Entities | PBSC<br>NYC Bike Share LLC (subsidiary of Alta) |

| | |
|---|---|
| Number of Stations | 330 |
| Number of Bicycles | 6000 |

## Barclays Cycle Hire

| | |
|---|---|
| City | London |
| Country | UK |
| Launched | 2010 |
| Links | http://www.tfl.gov.uk/roadusers/cycling/14808.aspx |

| | |
|---|---|
| Entities | PBSC<br>Serco |
| Number of Stations | 720 |
| Number of Bicycles | 8000 |


## Hangzhou Public Bicycle

| | |
|---|---|
| City | Hangzhou |
| Country | China |
| Launched | 2008 |

| | |
|---|---|
| Links | http://www.hzzxc.com.cn/ |
| Entities | Hangzhou Public Bicycle Company<br>Hangzhou Public Transport Group (Bicycle company) |
| Number of Stations | 2416 |
| Number of Bicycles | 65000 |
| <br> | |

## Wuhan Public Bicycle

| | |
|---|---|
| Name | Wuhan Public Bicycle |
| City | Wuhan |

| | |
|---|---|
| Country | China |
| Launched | 2009 |
| Links | http://www.hzzxc.com.cn/ |
| Entities | |
| Number of Stations | 1218 |
| Number of Bicycles | 90,000 |

# Section 2: Panaji

## Background- Panaji

**Panaji** is the capital of Goa and is the third largest city in the state after Madgaon and Vasco. The city, which has an average elevation of 7 m above sea level, lies on the banks of the Mandovi River and is also bounded by two creeks - Ourém and Santa Inêz. Located in the Tiswadi Taluka in the northern part of the state, the city also serves as the administrative headquarters for the North Goa district. The city comprises of 30 wards in total which includes Mala and Fontainhas in the east, Boca de Voca and St.Inez to the South, the Central Business District in the North and Campal to the West. Campal houses some of the most important institutions like Kala Academy & Indian Film Institute. The eastern part of the city like Fountainhas still maintains a lot of heritage character.

According to the Census 2011, Panaji, has a population of 114,405 in its metropolitan region. As a popular tourist destination, the city also has a large floating population. Females constitute 48% of the total population and the literacy rate, at 90.2%, is one of the highest in the country.

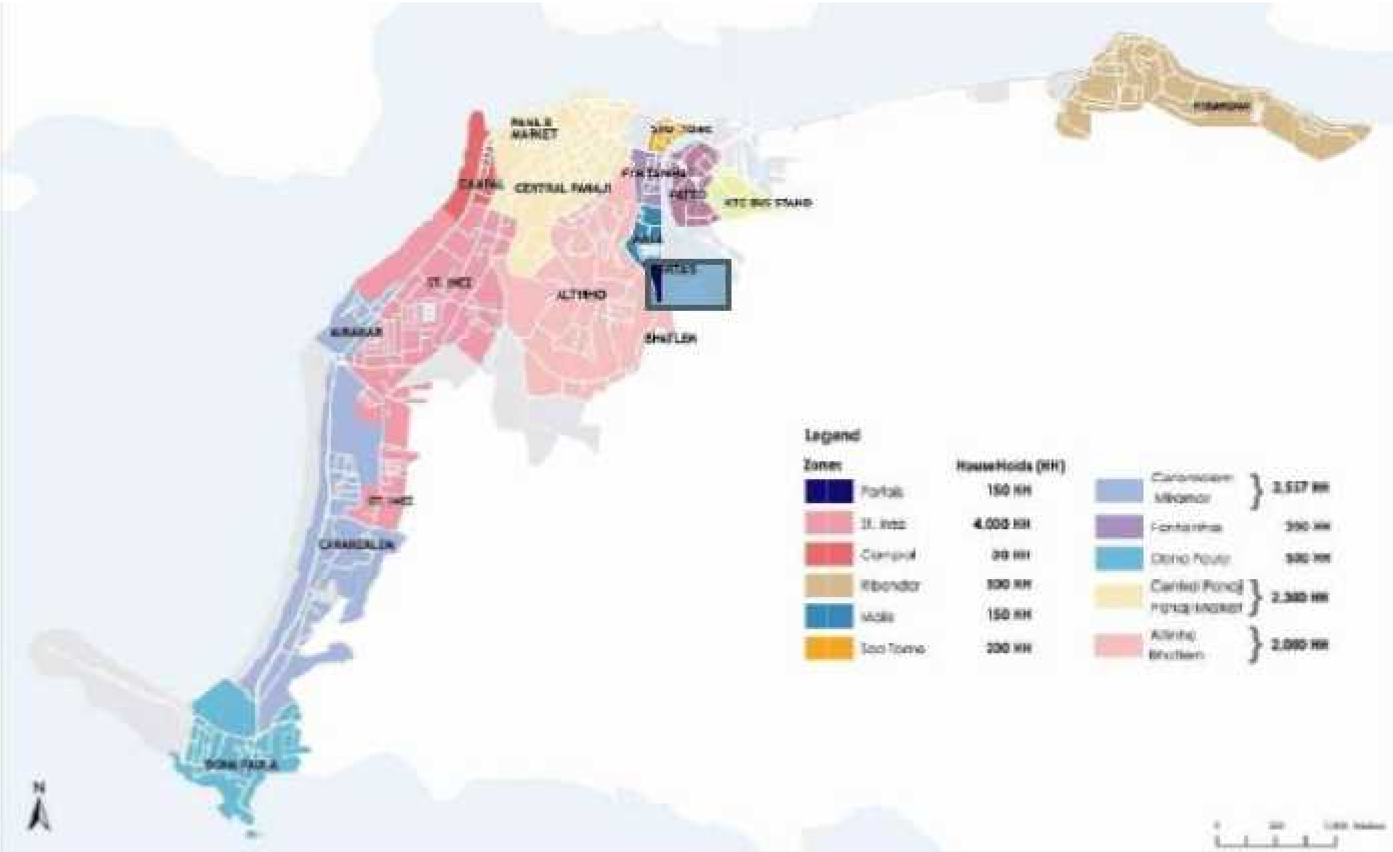


Figure 3: Panaji Map (Source: Proposed Decongestion Model for Panaji City Centre)

## Evolution of the City

The city has a long history which dates back to 11th century when the city was under the rule of the Kadambas. Goa was captured by the Portugese in 16th century, who changed the name of the city from Panaji to Panjim which means "the land which never gets flooded". The palace of Adil Shahis was turned into the residence of the Portuguese Viceroy. In the year 1843 after an epidemic destroyed the old capital of Goa, Panaji was by royal decree elevated to a city. It was called "Nova Goa" and made the capital of the region.

In December 1961, Goa was incorporated into the Union of India. From this time to 1987, the city of Panaji was the capital to the union territory of Goa, Daman and Diu. When Goa was elevated to become a state in 1987, Panaji became the state capital.

## Economy of the city- Trade, Commerce and Tourism

The city of Panaji has a mixed economy with Trade, Commerce, Tourism and Hospitality as the most significant sectors. Panaji markets and industrial units caters not only to the city population but also to smaller towns nearby, especially for consumer electronics and building materials.

As the capital of Goa, and famous for its beaches, distinctive architecture and churches, Panaji is a major tourist destination. Two famous beaches in Goa - Miramar and Dona Paula - are located in the city. The city also has a number of churches from the 16th century which serve as good examples of Gothic architecture. The most famous church is the Church of Our Lady of Immaculate Conception. Some of the other points of tourist interest in Panaji are Aguada Fort, Mala Lake, Ancestral Goa and Dr. Salim Ali Bird Sanctuary. There are also certain parts of the city which have been designated heritage areas because of their distinctive character. These include Campal and Fountainhas, which is famous for its traditional narrow winding roads and buildings with Portugese architecture.

The city acts as the transit hub for tourists to Goa. In the year 2001, about 4 lakhs tourists (both domestic and foreign) landed in the city. This number went up to 6 lakhs tourists in the year 2004.

**Table 1: Panaji District Tourists Volume, 2004 (Source: CDP)**

| Period | Tourist Arrivals in Tiswadi Taluka | | | Total Tourists in Goa State | Percentage Share of Goa |
|---|---|---|---|---|---|
| | Total Tourists | Foreign Tourists | Domestic Tourists | | |
| January | 48231 | 7321 | 40910 | 174690 | 27.6 |
| February | 35738 | 6774 | 28964 | 121987 | 29.3 |
| March | 47203 | 6261 | 40942 | 164693 | 28.T |
| April | 46124 | 3159 | 43065 | 166831 | _ |
| May | 44723 | 2653 | 42070 | 164863 | 27.1 |
| June | 30174 | 1236 | 28938 | 83714 | 36.0 |
| July | 21923 | 976 | 20947 | 71643 | 30.1 |
| August | 32839 | 1916 | 30923 | 108518 | 30.3 |
| September | 48495 | 1793 | 45702 | 152361 | 31.8 |
| October | 45637 | 4821 | 40816 | 156923 | 29.1 |
| November | 63244 | 12119 | 51125 | 143674 | 26.0 |
| December | 174746 | 15417 | 149319 | 474832 | 36.8 |
| Total | 639177 | 75456 | 563721 | 2085729 | 30.61 |

The location of the city by the Mandovi River and the Arabian Sea makes it possible to have inland water services. The city also hosts a state port.

## Urban Transport Scenario in Goa

### Road Network

2 National highways pass through Goa. Goa is linked to Bombay in the north and Mysore in the south through NH-17 which runs along the western coast of India. NH-4A which runs through Goa connects Panaji to Belgaum in east, which is further connected to Pune, Mumbai, Bangalore and Chennai.

The city has a total of 77.18 kms of road within its corporation limits (CCP,). The road pattern in Panaji is a mix of radial, organic and grid networks. While organic road networks are prevalent in the heritage areas like

Fountainhas, Portais and Boca Da Vaca, radial roads are prevalent in hilly regions like Alatinhos and grid networks are prevalent in planned parts of the city like central Panaji region and Patto complex area. The width of


roads ranges between 4 to 14 meters in the city. DB road which runs along the Mandovi river act as the main arterial road of the city. This road runs from Kadamba bus stand to NIO junction.

**Figure 4: Road network in Panaji (Source: Need Approval)**

Also adding to the road network of the city are 7 road bridges and 1 foot bridge. Of this the new Patto and the old Patto bridges act as major entry and exit points to the city. The road network in Panaji is also characterised by a large proportion of one ways. This is shown in the picture below.


Green Lines – Two Ways Blue Lines – One Ways

**Figure 5: One ways & Two ways in Panaji (Source: Proposed Decongestion Model for Panaji City Centre)**

## *Modal shares*

Private motor vehicles currently account for the majority share of motorised trips with the share for two wheelers being the highest at 34% and cars at 27%. The modal shares of buses in Goa is as low as 14% of all trips in Panaji. Of this private buses only account for 2% of total trips. The share of cycling is dismally low at 1%. Auto rickshaws and Taxis together account for 5% and ferries 1%. The modal shares are summarised in the figure below.

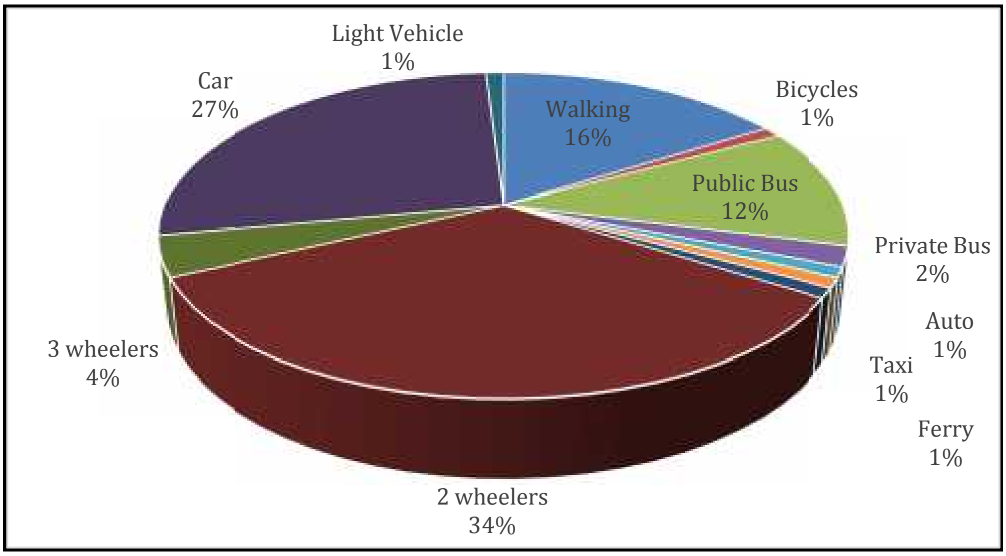


**Figure 6: Modal Shares for Panaji (Source: Comprehensive Mobility Plan under the JNNURM, 2008)**

## *Public Transport*

Public transport in the city comprises of public and private buses and ferries. The public buses are run by Kadamba Transport Corporation (KTC) which is a Goa state government undertaking and runs services across the state. Private buses account for more than two thirds of the total buses plying in the city. The general system is of a private bus operating on a route that was fixed by KTC. The KTC buses and private buses together run on 54 routes within the city and make 2619 trips connecting Goa to neighbouring towns.

The main bus terminal of the city is the Kadamba bus terminal which serves as a major hub for intercity and intra city buses. It also acts as the hub for other modes like taxis and rickshaws.

The unique placement of the city near both the Mandovi Rriver and Arabian Sea makes inland waterways possible. Three jetties operate in the city making ferry transport a significant mode of transport in the city.

## *Private Motor vehicles*

The total vehicular population in Goa in 2012 was 8.65 lakhs. Goa has one of the largest per capita vehicle ownership rates in the country, at 1 vehicle/ 2 people.

## Cycling

Cycling accounts for only 1% of the total number of trips in Panaji. Currently, there is no dedicated cycling infrastructure available in the city.

## Traffic Problems

One of the biggest issues in Panaji is the inadequacy of the public transport system. Public transport only accounts for 15% of the total trips in the city. Public transport routes are not comprehensive and do not cover all areas of the city. The existing bus services in the city are insufficient and inadequate. While a few regions are well served, like Kadamba Transport Corporation to Miramar beach, other areas have little to no bus services. This is especially true of private buses which only ply on certain major routes in the city.

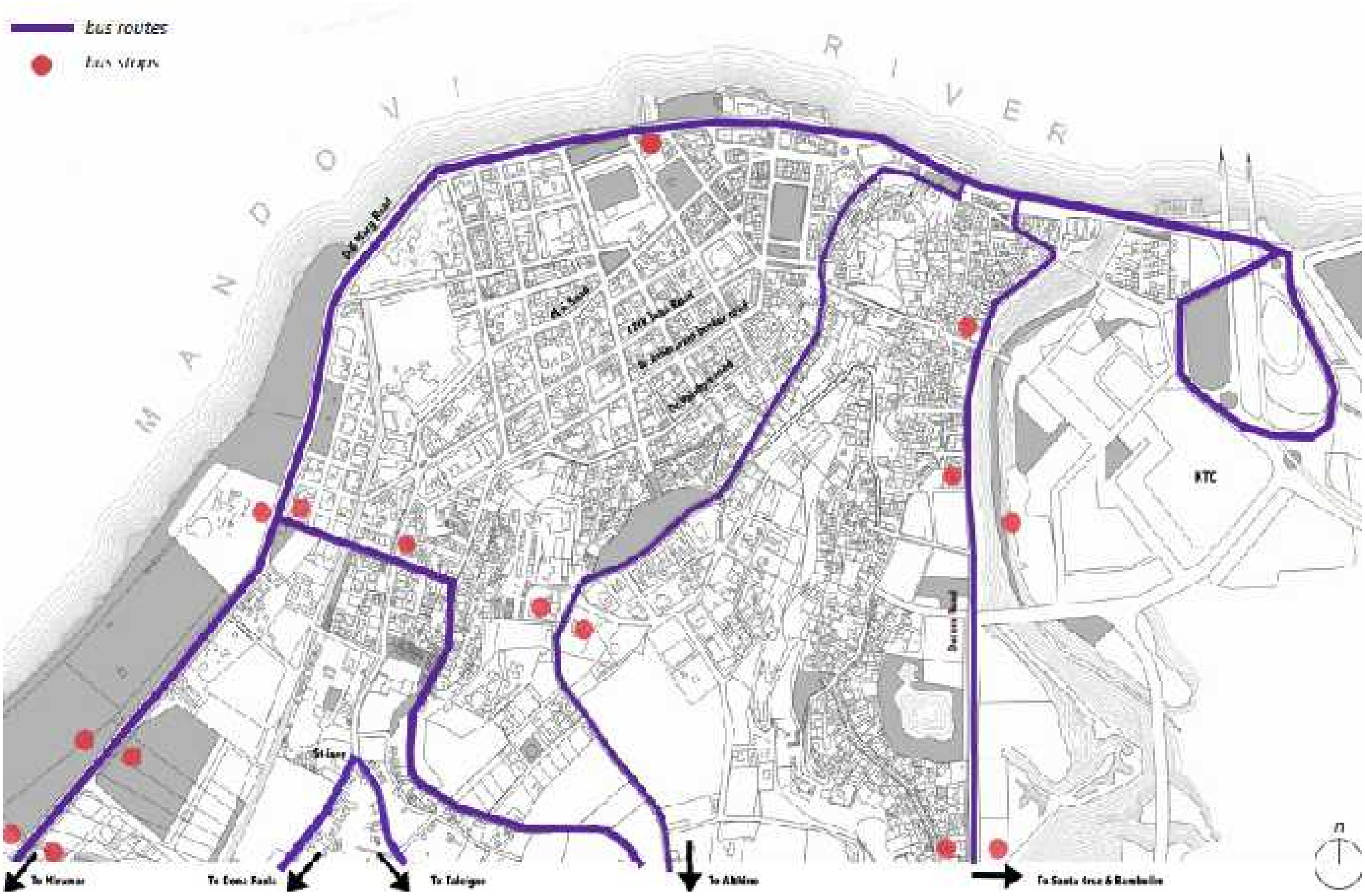


Figure 7: Bus Routes in Panaji (Source: Proposed Decongestion Model for Panjim City Centre, )

This has led to a large number of people shifting to private motor vehicles i.e. 2 wheelers and Cars. This trend continues because of the poor public transport services. The exponential increase in vehicles combined with the slow increase in road capacity has led to traffic problems across the city. According to a JNNURM report on Panaji "There is only one major road available in the city i.e. Dayanand Bandodkar road for all the traffic."

The predominance of private vehicle use in Panaji has led to significant on-street parking in Panaji. This has reduced the effective width of roads in the city, resulting in increased congestion. The large number of one-way roads has also lead to an increase in trip lengths for many private vehicle users, in turn increasing the overall vehicle kilometres travelled. Finally, the intermingling of intra-city and inter-city traffic has further exacerbated problems of congestion.

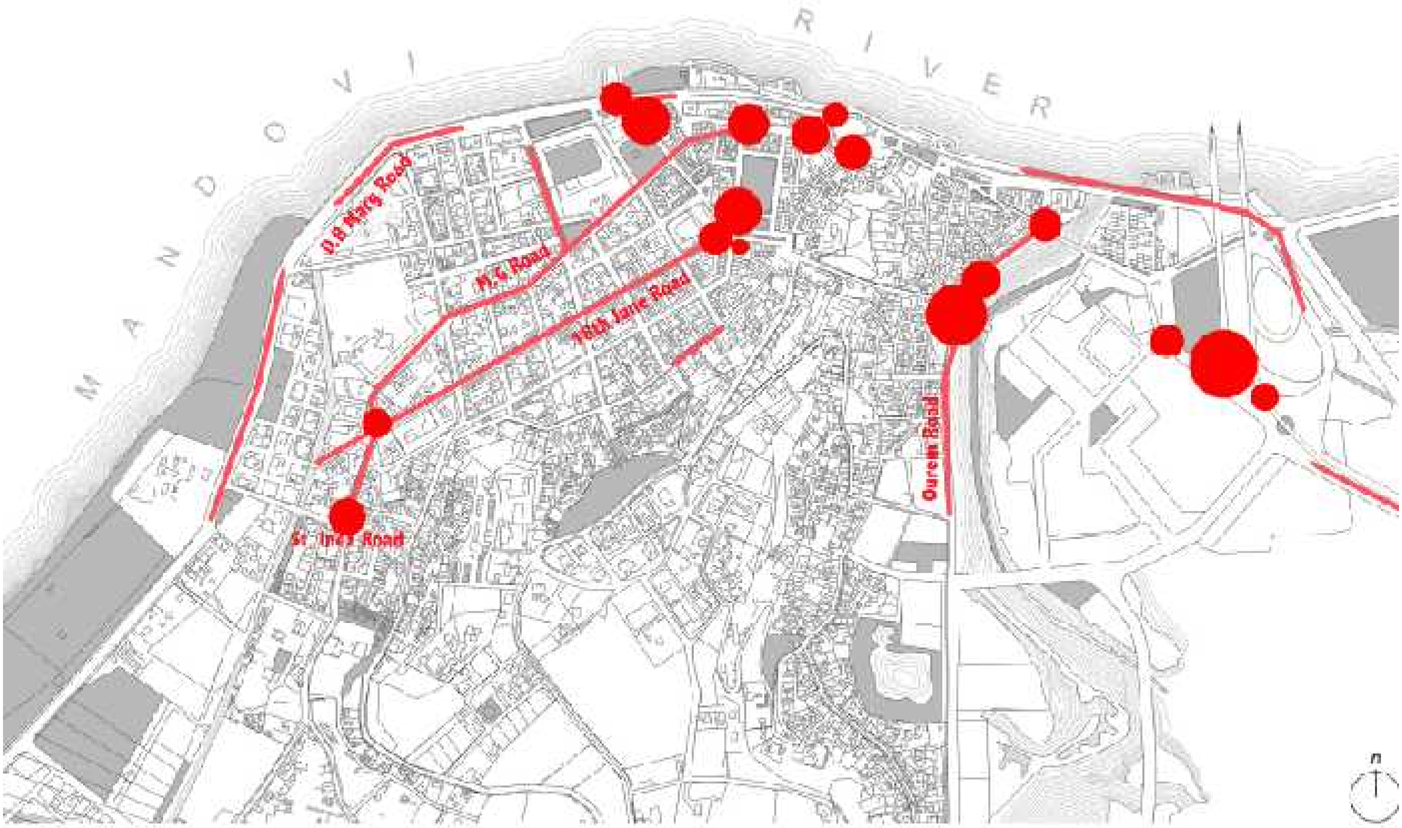


Figure 8: Congested Roads & junctions (Source: Proposed Decongestion Model for Panaji City Centre)

The effect of road congestion can be directly seen in the low average speed of vehicles on different roads in the city as given in Table 2 below.

**Table 2: Speed and Delay on Panaji Roads (Source: Comprehensive Mobility Plan CMP under the JNNURM)**

| S. No | Name of the Road | Direction | Distance covered (km) | Average Journey Time | Average Journey Speed |
|---|---|---|---|---|---|
| 1 | 18th June Road | SW to NE | 0.85 | 4.70 min | 10.88 km/ hr |
| 2 | Atma MITI Borkar Road | NE to SW | 0.70 | 2.93 min | 14.37 km/hr |
| 3 | Dr. Dada Vaidhva Road | SW to NE | 0-80 | 3.22 min | 14.99 km/hr |
| | | NE to SW | 0.80 | 3.90 min | 12.32 km/hr |
| 4 | Mahatma Gandhi Road | SW to NE | 1.30 | 4.73 min | 16.51 km/hr |
| | | NE to SW | 1.30 | 4.65 min | 16.94 km/hr |

The road accident data for the city is also given below.

**Table 3: Accident Data Panaji 2003-07 (Source: Directorate for Transport, Goa)**

| S. No | Particulars | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| 1 | Total Accidents | 256 | 363 | 326 | 274 | 315 |
| 2 | Fatal Accidents | 12 | 13 | 9 | 11 | 10 |
| 3 | Grievous Accidents | 4 | 5 | 9 | 15 | 12 |
| 4 | Minor Accidents | 63 | 57 | 71 | 59 | 44 |
| 5 | Non-Injury Accidents | 177 | 288 | 237 | 189 | 249 |
| 6 | Persons Killed | 13 | 15 | 9 | 11 | 10 |
| 7 | Grievous Iniury | 6 | 5 | 14 | 21 | 15 |
| 8 | Minor Injury | 84 | 96 | 98 | 86 | 61 |

# Section 3: PBS in Panaji

## Project Definition and Scope

### Study Objective

The objective of the DPR is to plan a Public Bicycle Share (PBS) system for the city of Panaji. The city of Panaji is defined as the area under the jurisdiction of Corporation of the City of Panaji in this study. This is an area of 8.12 sq.km.

The target audience of the system will be the residents of the city whose travel distances are less than 5 kms and tourists in the city. While the residents will become regular users of the system, using the bike share for either end to end connectivity or for last mile connectivity, the tourists will become casual users of the system and be able to use the system to visit the various points of tourist attraction in the city, through multiple short trips in a day. The system proposed will have to be planned keeping this target audience in mind.

### Scope of the study

The scope of the study is

a. Studying public bicycle systems, understanding its various planning, engineering, operational, management and financial models and

b. Making Recommendation for Panaji on
   - Location and Density of stations
   - Size of the system and stations
   - System Technology
   - Fare Structure
   - Cost
   - Business & Finance Model
   - Phasing of the project

- Institutional Structure

Some of the steps involved for the same are Field Investigations, Planning, Financial Analysis and Stakeholder Consultations.

# PBS Components and Design

This section will detail out the various components of PBS systems and make recommendations for the design of the PBS system for Panaji. The features of each component and the pros and cons of different design options, where available, are compared to make a recommendation for Panaji.

## Automatic v/s Manual System

Station Automation defines the basic design and operation of the system.

Automatic Systems make extensive use of IT for all functions of the system. Users check out and check in cycles using Smartcards or Smart keys. They subscribe, make payments and get system information via terminal consoles attached to stations. Automatic Systems are marked by the extensive use of data for system management, oversight and planning. For example, combining data from smartcards and stations, such systems can identify which exact user has rented a given cycle at any point in time, thus increasing accountability and reducing the chances of theft. System usage is also often monitored in real time from a central control room, which enables the operator to track the availability of cycles at every station in the system and plan the redistribution of cycles accordingly. In the long run, the ability to run advanced analytics on the data generated by automatic systems allows for accurate planning for system expansion or redesign.

It is with the advent of automatic systems/ 3rd generation IT enabled systems cycle sharing grew in popularity. The ability to track all the system assets like cycles along with its users and real time data sharing across stations and with customer service platforms, helped in increasing the efficiency of the system and helped in creating successful city wide systems.

Automatic Systems are Capital Cost intensive but tend to have much lower Operating Costs. Examples: Barclays Cycle Hire, London; Citibikes, New York; Velib, Paris.

Figure 9: BIXI, Montreal's Fully Automated System

**Manual Systems** utilise station attendants who manage each station. The attendants are in charge of multiple functions like recording user information, checking in and checking out of cycles, accepting payments and giving information to customers.

Manual Systems are less capital intensive, but tend to have high operating costs. Manual systems also tend to result in lower speeds for checking in and checking out of cycles (especially during peak hours) and higher chances of theft. The user experience in Manual Systems is highly dependent on the quality of staff at stations. The complexity of aggregating system usage data in Manual Systems also limits the capacity for long term system planning, and makes accurate redistribution of cycles more difficult.

There are a few examples of manual systems which have successfully scaled up and provided user experience. Buenos Aires is a well quoted example but expansion plan of even this system involves developing a hybrid system which will have both Automatic and manual stations.

Figure 10: Ecobici, Manual PBS system of Buenos Aires

**Recommendation for Panaji- Automated System**

It is recommended that Panaji adopt a **fully automated PBS System**. This will ensure that the system is efficient, reliable, has a better public image and does not experience high rates of theft and vandalism.

It is, however, recommended that the city hire station attendants to man every station in the city for the first six months of operations. This help the residents of the city to get used to the automated system and will also help increase the popularity of the system.

## *Bicycles*

Custom-designed bicycles are essential to the success of PBS systems. Due to the nature of use of bicycles in PBS systems, regular "off-the-rack" cycles cannot be used. PBS cycles tend be used far more frequently than a regular bicycle, necessitating special design features which will maximise durability and minimise maintenance requirements and damage. PBS cycles must also appeal to both men and women, be easily usable by people of varying physical characteristics, and exhibit a unique design both for system identity purposes and to prevent theft.

Some of the special design features required of a PBS bicycle as recommended in different guides[1] are as follows:

a. Easy to use and adaptable to various users. Seat height should be adjustable and the cycle should have a unisex, step-through frame. This will ensure that the cycle is compatible with people of all heights and types of clothing.

b. Sturdy design, heavier than regular bicycles, typically weighing between 16 and 23 kgs. The weight makes the bicycles stable and hence easy to ride.

c. Front basket to carry personal items.

d. Enclosed chain and other components to prevent breakage.

e. Designed to prevent carrying a second person.

f. Sturdy tyres which are puncture resistant. Helps in reducing the frequency of maintenance.

g. Reflective strips on the wheels, integrated front and rear lights, frame colour which is bright and reflective and a bell to ensure safety of the cyclist.

h. Drum brakes in the front and the back because it is easier to maintain.

i. Equipped with a GPS device and a RFID tag which will help in fleet management and recovering lost or stolen cycles. Some systems provide portable locks whereas most other do not, to ensure that cycles are only used to commute from one station to another, discouraging other destinations.

j. Designed with unique parts which are incompatible with regular bicycles to deter theft. It is also designed to make impossible dismantling parts of the bicycle using standard cycle tools.

k. Designed to provide advertisement space on the frame and both the wheels

[1] ITDP "Bicycle share planning guide" and UN "Bicycle-Sharing Schemes: Enhancing Sustainable Mobility in urban areas"

l. Gears, especially in cities with hilly terrain. 3- 6 speed gear with internal hub is the standard recommendation.

Given below is an example of a PBS cycle designed keeping in mind the principles stated above.


Figure 11: Custom Made PBS Cycle Design (Source: Bay Area Bicycle Share)

## Recommendation for Panaji- Custom Built Bicycles

It is recommended that the Panaji PBS system make use of custom built bicycles which follow the following design principles:

- Easy to use
- Adaptable to different users
- Sturdy and Durable
- At least 3 gears
- Personal Storage space/ basket
- Mechanical reliability
- Unique Design for Branding & Prevention of theft
- Design to ensure safety of user
- Attractive
- Space for Advertisement

### *Bicycle Stations*

Bicycle stations are the most visible component of the PBS system and are the point where the system is introduced to the users. Stations are comprised of multiple components like the docking units and terminals. There are two types of stations: Permanent & Modular. The choice between the two defines the flexibility of the system in terms of station location and size.

**Permanent stations** use infrastructure that is installed directly into the ground or pavement. The more prevalent model, these units are fixed at predetermined locations in the city. The source of power for these stations are the regular electricity lines, thus requiring excavation before the stations are installed. The location of the stations once fixed cannot be changed. The same rigidity holds even for changing the size of an existing station especially when the decision is to downsize the station. Example: Velib in Paris is comprised of Permanent stations.

**Mobile stations** make use of infrastructure which can just be bolted to the asphalt or concrete. Introduced by Montreal Bixi in 2009, these portable modular units have now been installed in many cities incuding New York. These stations are solar powered and are wirelessly connected making redundant the need to excavate a site to install a station. Since there is no excavation involved, the time required to install stations is reduced significantly. These stations also provide flexibility in change of location. The operator can, depending on the demand, easily change the location of station, increase the size of the station or even downsize the station to ensure maximum efficiency of the system. Example: Bixi, Montreal and Citibike, New York.

It is to be noted that while Permanent stations can also be designed to be Modular, it is easier done on a system with mobile stations, which easily allows for modularity given its design and installation process.

**Figure 12: Modular stations placed at location pre-determined in New York & Excavation and trenching required for fixed stations (Source: "Bicycle Share opportunities in New York city", NYPCPD)**

**Recommendation for Panaji- Modular Bicycle Stations**

It is recommended that the Panaji PBS system make use of Modular Stations in the city. This will help the city at a later stage, when the location and size of the stations may have to be changed because of a change in travel demand in the city.

## *Docking Unit/ Cycle parking Area*

Docking unit/ parking areas are the points in the system where bicycles are docked or parked. This is part of the station infrastructure. The users are required to swipe their smart cards at the docking units to unlock their cycles. It is recommended that docking units have intuitive locking, making it easier for the user to understand when the cycle has been locked in properly while returning cycles. The locking mechanism should also be designed to ensure that a thief cannot break the lock without breaking the cycle itself. Since the cycles are heavy, a "roll in" lock mechanism is recommended over a "lift in" mechanism.

There are three types of docking units: Docking bars, Individual Docking Units and Parking Areas. The various options are discussed below.

**Docking Bars** consists of a single bar where multiple cycles can be docked.
The number of cycles and the point on the bar where each cycle can be locked is pre-defined. This model is cheaper than individual docking units.

They however face the operational disadvantage that a technical problem with a docking bar would mean that the whole station will be rendered useless.

Figure 13: Docking station- Example 1 (Source: Wikimedia Commons)

In an **Individual Docking Unit**, there is a separate unit for docking each cycle. The amount of space taken for parking/ docking each cycle is more than the other options but the design results in stations that blend in better with the cityscape. It also provides the maximum operational efficiency of all three models given the independence of each docking unit.

Figure 14: Individual Docking Unit (Source: Wikimedia.org)

**Bicycle Parking Areas** are used for large stations with 50 or more cycles. For stations with such a large number of cycles, it is better to provide a bicycle parking area than a docking station because, this will allow for more bicycles to be parked per sq. ft of area.

Figure 15: Bicycle parking area at Beijing (Source: blogs.ft.com)

At such stations, a user enters the cycle parking area through a turnstile entry where the smart card/ key is

swiped.

Figure 16: Shanghai - Turnstile entry to bicycle parking (Source: cyclesharing.in)

## Recommendation for Panaji- Individual Docking Unit +Parking

It is recommended that the Panaji PBS system use Individual Docking units at all stations except for the large stations where Cycle Parking areas are recommended

It is also recommended that Panaji opt for a model where the docks themselves are designed to lock and unlock each cycle, rather than the terminal handling this function.

### *Terminal/ kiosk*

A bicycle station will also have a terminal or kiosk along with the docking units/ parking areas. This is an important part of the PBS management system. Features of a kiosk as recommended in various guides[2] are given below:

a. Advertising space for revenue augmentation
b. Touch-sensitive screen for user interface.
c. Purchase of subscriptions/ top up of smart cards using Credit/ Debit card
d. Information on how to use the system (available in multiple languages/ info-graphics)
e. Information on bicycle and parking space availability at other stations in the network
f. Key card reader- Giving information of membership/ subscriptions or balance on smart card for existing users.
g. Card dispenser- Dispenses smart card for first time users
h. Provision for staff to enter details on station maintenance
i. Provision for users to report problems with the system

[2] Transport Canada's "Bicycle Sharing Guide", ITDP "Bicycle share planning guide" and UN "Bicycle-Sharing Schemes: Enhancing Sustainable Mobility in urban areas"

Figure 17: Examples of PBS system terminals from China and France (Source: bicycle-sharing-blogspot.org & Wikipedia)

## *Advertisement space*

A station should also dedicate space for advertisement. Stations provide more area for advertisement in the system as compared to other components like bicycles and terminals. Advertisements are a major source of revenue in PBS systems.

Figure 18: Advertisement Boards in Cycle stations (*Source: cityphile.com & divvybicycles.com)*

## *Bicycle Redistribution System*

Given the large number of stations in a city-wide PBS system, there is always a possibility of asymmetry of demand across stations. Bicycles usually tend to accumulate at stations near a public transport stop or at stations downhill (in cases where the city has a hilly terrain) or near popular destinations in the city. Conversely, stations in residential or low-demand areas often tend to become empty at certain times of the day.

To ensure that the cycles are consistently available across all stations in the PBS system throughout the day, it is necessary to have a robust system for the redistribution of cycles from stations where they are over-crowded to other stations where there is a shortage of cycles. This is usually accomplished through the use of custom-built redistribution vehicles.

The redistribution is guided by the information management system of the PBS system which helps keeps track of the number of cycles at various locations in the city. The redistribution often takes place multiple times in a day, especially in the peak hours when more rentals happen. This continuous redistribution is necessary to ensure smooth operation of the system.

Montreal's BIXI makes use of trucks which are equipped with on board station trackers, which give information of which stations are over-crowded and which are empty. Paris's Velib also uses vehicles which run on natural gas for redistribution

Figure 19: Redistribution vehicle used in Paris (Source: www.intechopen.com)

## *Data Management System*

IT-enabled data management is the back bone of any PBS system. This critical component is what defines the third generation of PBS systems. It provides for real time monitoring and transmission of system usage data making the management and operation of the system smooth. It consists of the central control room, the smart card infrastructure and the software for data transmission and management.

Each station in the system is connected to a central control room, providing the PBS operator with real-time information about system usage. This enables the operator to efficiently manage the PBS system. System data can, in turn, be transmitted to users through station terminals, websites and smart phone apps. Each of the components are discussed below.

a. The central control room: This is where all the data of the system is gathered and analysed. The real time monitoring of cycles and stations using GPS/RFID devices helps staff in the control room track the position of cycles and pass on the relevant information which would assist in the day to day operation of the system like redistribution of cycles between stations. The data gathered can also be used to make long term planning decisions like the decisions on change in location of existing stations; increasing or decreasing size of existing stations and expansion of the system to new areas.

b. IT/ Software system: This plays a major role in both the front end and back end. On the back end, where "*the implementing agency and operator receive the information required to run and manage the system, the software needs to support station monitoring, redistribution of bicycles, defect and maintenance issues, billing, and customer data.*" (ITDP, 2009). Data is transferred from the stations to the central control room using wires, optical fibres or GPRS.
In the front end the software is supposed to manage the interactions of the system with its users. This is done using the terminals at the stations, the website and smart phone apps.

c. Smart Card: Smart Card technology is used in most systems for the users to access the system. The access cards are issued to users in return for some refundable security deposit and a copy of ID proof. Regular users can top up their smart card with a certain amount of money which will be deducted based on use of the bicycles. The cards are equipped with RFID technology, making it easy for the system to track the exact user borrowing the cycle from the system. This helps in reducing the occurrence of theft.

The docking stations/ parking areas are equipped with smart card readers which lets the user unlock the cycle using the card. The authorisation device on the docking station is connected to the central control room through the IT system which helps in authentication of the user and also in identifying on return the amount the user needs to be charged



**Figure 20: Examples of Smart Card in Denver and Smart Key in New York (Source: gizmodo.com& mashable.com**

## *Payment Mechanism*

Terminals at the stations are only equipped to handle card transactions. Considering that a large number of transactions in India are done through cash, it is necessary to look at options on how cash transactions could be handled in an automatic system. Panaji should look at forming a network of existing retail outlets, which can handle these cash transactions. The retail outlets should be equipped to register users, accept payments (registration & card recharge) and issue smart cards to the users.

### Recommendation for Panaji- Payment system with Cash & Card

It is recommended that the operator and CCP in Panaji ensure that the payment system can handle not just card transactions but also cash transactions.

It is recommended the city formed a network of existing retail outlets which can handle the cash transactions that the terminals at the stations cannot handle.

## *Maintenance Centre*

Though the system will require the cycles to be regularly inspected and serviced at the station itself on a regular basis, there are certain times when the cycles are damaged beyond an on-site repair. In these cases it is necessary to have a maintenance centre where trained staff repair the cycle. These maintenance centres would also hold the extra cycles of the system, which will replace the damaged cycles when they are being repaired.

## Planning PBS for Panaji

There are planning guidelines to be followed to ensure that the PBS is well integrated with the city and runs successfully. These guidelines have been sourced from multiple guides and examples of PBS systems in cities across the world. The key planning decisions can be classified into four categories:

a. Size of the system
b. Station Density
c. Location of Stations
d. Placement of stations

### Size of the system

The size of the system or the number of bicycles is determined by the population of the city. It is recommended that there be 10-30 cycles for every 1000 people in the city. Examples from a few PBS systems around the world are given below.

Table 4: Size of system in different cities

| City | New York | Washington | London | Paris | Hangzhou |
|---|---|---|---|---|---|
| No of Bicycles | 6,000 | 1,500 | 8,000 | 17,000 | 60,600 |
| Population/ bicycle | 638 | 550 | 978 | 129 | 112 |
| Coverage | Part of the city | Part of the city | Part of the city | Whole city | Whole city |

It is also recommended that the PBS system have more docks than the number of cycles. This is to handle the peak hour demands when cycles get redistributed unevenly across stations. Excess number of docks will ensure that there are a few empty docks always available for users who may want to drop cycles at stations which have to perform at a higher capacity during peak hours. PBS stations in New York generally have 16 bicycles and 24 docking units.

## Recommendation for Panaji- Size of the System

It is recommended that the Panaji PBS system provide 1 bicycle every 100 people in the city, for a total of 1040 cycles in the system.
It is also recommended that the city provides 1.5 docks/ cycle, resulting in 1545 docks system wide.

## *Station Density*

Stations should ideally be placed at an average distance of 250- 300 meters from each other. This would amount to about 10-16 stations per square kilometre or 28-30 stations per square mile. This is to ensure that the user will not have to walk long distances to access the system and, in cases where users are not able to find cycles at one station, another station is easily accessible nearby.

Even if the PBS programme is launched in phases it is necessary that the first phase is dense enough to make the system attractive from a usability standpoint. The stations need to be placed such that the overall network of stations is dense enough to provide convenience for its user

Figure 21: PBS Stations in Washington & Miami respectively

## Recommendation for Panaji- Station Density

It is recommended that the Panaji PBS system should plan the stations such that the average distance between stations is 250m. The density could be higher in the major commercial centres of the city

### *Coverage area*

When a PBS is being planned for a large city where it is not possible to provide a system which will cover the entire city in a single phase, it is recommended that the first phase of the system is wide enough to provide connectivity between adequate number of origins and destinations in order to prove useful for users. The following phasing guidelines have been given by *New York Department of City Planning*:

Phase 1: The first phase should be launched in the densest regions of the city where there is high traffic.

Phase 2 & 3: The subsequent phases can be launched in other dense regions in the city which could benefit from a PBS but would not be able to sustain the programme all by itself.

A small city like Panjim does not face such a problem. A small system of about 1000 cycles spread over 66 stations is large enough to cover the entire city. However the city could follow a phased approach in implementation with the first phase being located in dense regions and the second phase in other parts of the city could be launched soon after within a time frame of 6 months.

### *Location of Stations*

The location of the station plays a major role in the popularity and use of the system. Station location is a function of the transport demand in the city. Location of the stations is ideally determined by Origin-Destination surveys

It is recommended that stations are placed in high demand generating areas like market areas, business districts, and popular cultural and tourist points in the city.

Figure 22: PBS stations near a beach


Figure 23: PBS station near a movie hall

In addition to high-demand areas like office areas, markets and public transport stops, it is also important to place stations in some low-demand areas where trips often originate or end. Examples of such locations include the residential areas of the city. Unless PBS stations are located in such areas, the system will fail to provide true city-wide connectivity.

It is also necessary to locate PBS stations near existing public transport stops. This helps in providing last mile connectivity and thus improving the service area of traditional public transport systems in the city.

**Figure 24: PBS stations adjacent to a BRT stop in Guangzhou (Source: www.transportphoto.net)**

The exact station location is also determined by the objective of the system. Some potential objectives of bicycle shares are:

a. Complement the services provided by other public transport services by providing last mile connectivity. Example: Bicycle Stations placed near metro and bus stations
b. Short trips in the city should be completed on Non-motorised transport by replacing Motor vehicles. Example: Bicycle stations placed in residential localities and market areas around it.
c. Improve the use of cycling infrastructure and the image of cycling. Example: Bicycle stations placed near existing cycle lanes and highways in the city
d. Make a certain part of the city motor vehicle free. Example: Densely placed bicycle stations within the historical part of the city.

## *Station location for Panaji*

66 Stations have been identified for Panaji. These stations are spread across the 8.12sqkm area of the city. The station density is higher in the Central Business District (Central Panaji), Panaji Market and St.Inez area than the rest of the city. On an average there is at least one station every 250m in the city.

The criteria when deciding the station location for Panjim was:

a. Ensuring that the core city centre where most of the commercial establishments and popular tourist attractions are well connected using the system. Maximum density is provided in this zone.
b. Major Residential localities are connected to ensure that there is end to end connectivity
c. Major Public transport stations are connected to provide the last mile connectivity which is necessary to improve the connectivity and coverage of existing public transport system by providing last mile connectivity.
d. Stations are spread evenly within zones (core commercial zones, sparse residential localities, hilly terrain, etc.)

The maps and table given below depict the location, size and coverage of the stations proposed for Panjim

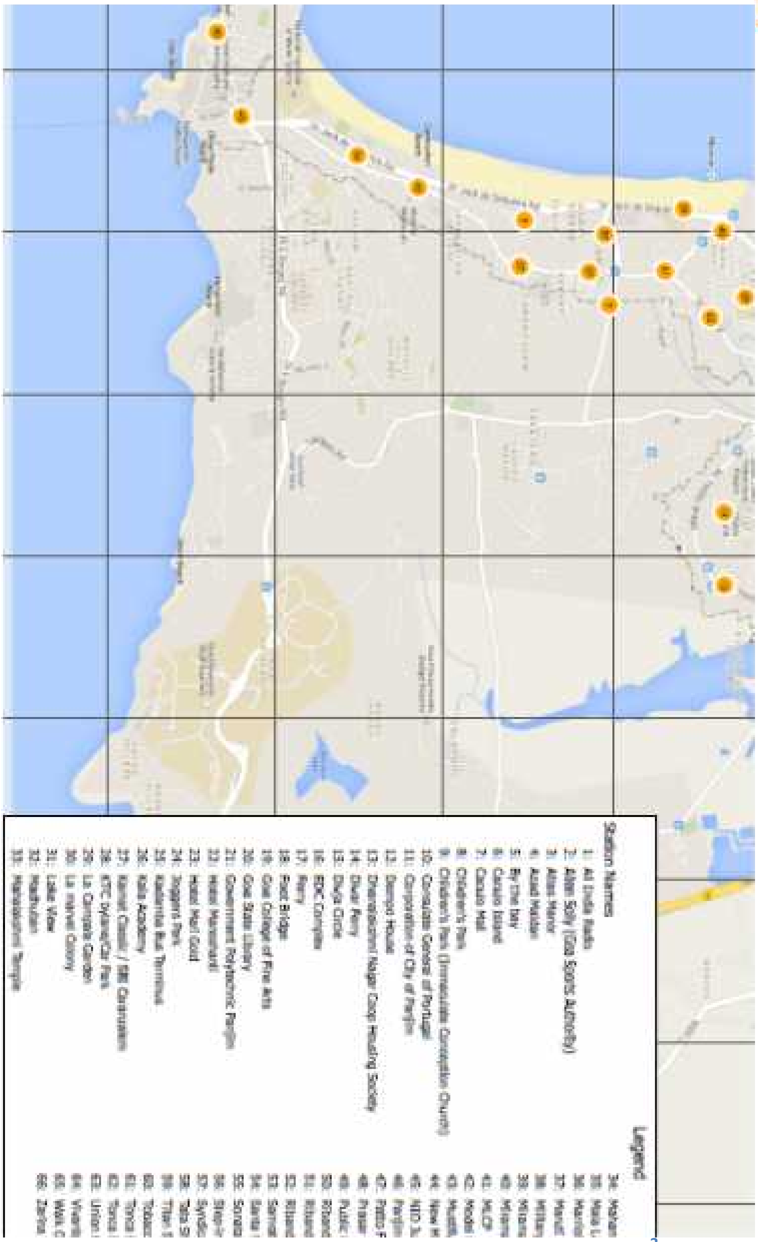

Figure 25: Station Location- Panaji PBS[3]

[3] Higher resolution picture in page 75

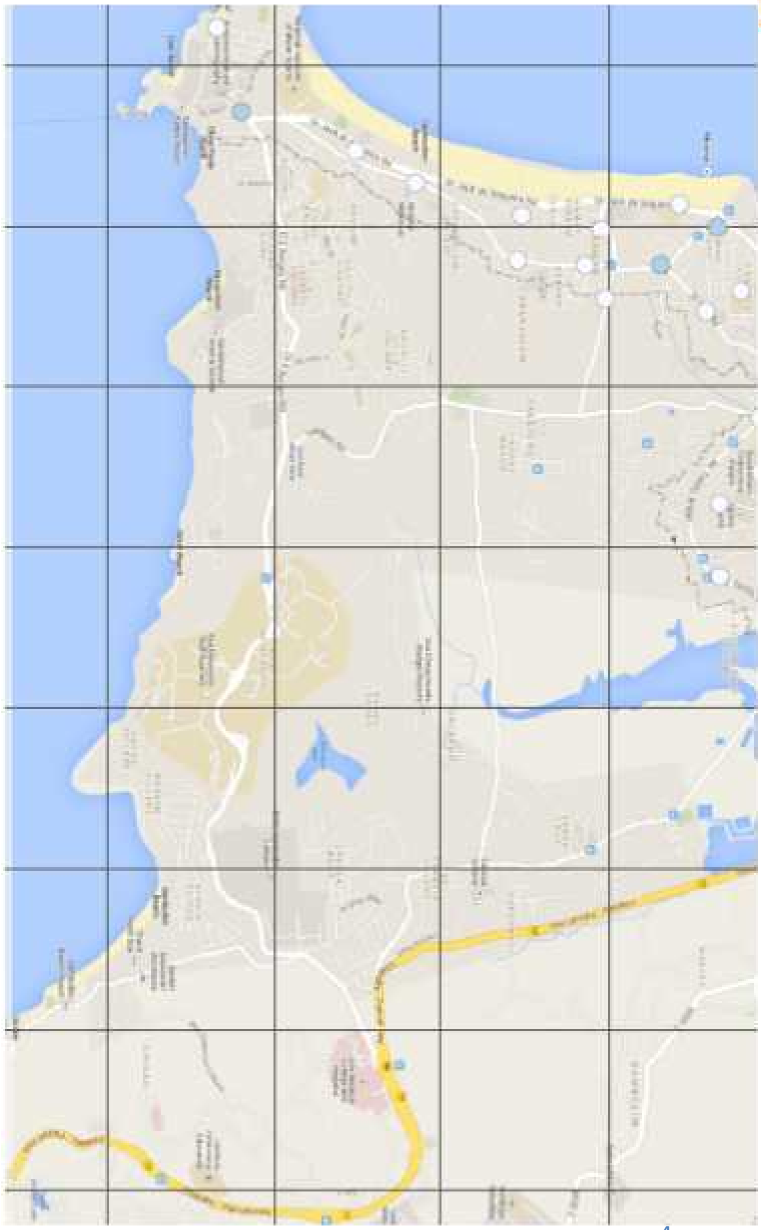

Figure 26: PBS Stations classified by Size[4]

**Table 5: Size of Proposed Panjim PBS Stations**

| S. No: | Station | No: Of Cycles | No: of Docks |
|---|---|---|---|
| 1 | CCP | 15 | 23 |
| 2 | Tobacco Square | 10 | 15 |
| 3 | Consulate General of Portugal | 10 | 15 |
| 4 | All India Radio | 10 | 15 |
| 5 | Government Polytechnic Panjim | 15 | 23 |
| 6 | Goa College of Fine Arts | 15 | 23 |
| 7 | New Market | 40 | 60 |
| 8 | Panjim Inn | 10 | 15 |
| 9 | Caculo Mall | 20 | 30 |

[4] Higher resolution picture in page 76

| | | | |
|---|---|---|---|
| 10 | Military | 20 | 30 |
| 11 | Walk Over | 20 | 30 |
| 12 | Foot Bridge | 15 | 23 |
| 13 | KTC bylane/Car Park | 20 | 30 |
| 14 | EDC Complex | 20 | 30 |
| 15 | Titan Shop | 20 | 30 |
| 16 | NIO Junction | 20 | 30 |
| 17 | Miramar Temple | 20 | 30 |
| 18 | Kala Academy | 20 | 30 |
| 19 | Samrat Ashok Theatre | 15 | 23 |
| 20 | Azad Maidan near Charcoal Shop | 10 | 15 |
| 21 | Childrens Park near Immaculate Conception Church | 30 | 45 |
| 22 | Maruti Temple | 10 | 15 |
| 23 | Union Bank near St Inez Church | 10 | 15 |
| 24 | Goa State Library | 10 | 15 |
| 25 | Mahalakshmi Temple | 15 | 23 |
| 26 | Ribandar Village | 10 | 15 |
| 27 | Allen Solly | 15 | 23 |
| 28 | Opposite Public Café | 15 | 23 |
| 29 | Children's Park | 15 | 23 |
| 30 | Marriott / TOI Junction | 10 | 15 |
| 31 | Vivanta Hotel & Resorts | 10 | 15 |
| 32 | La marvel Colony | 10 | 15 |
| 33 | Near Hotel Marigold/ Ruchi | 15 | 23 |
| 34 | Dhanalakshmi Nagar Coop Housing Society | 10 | 15 |
| 35 | Joggers Park | 10 | 15 |
| 36 | Mustifund School in Mala | 10 | 15 |
| 37 | Hotel Manoshanti | 10 | 15 |
| 38 | Model Millenium | 15 | 23 |
| 39 | La Campala Garden | 10 | 15 |
| 40 | Prasar Bharathi/ Doordarshan Residential Locality | 10 | 15 |
| 41 | Mala Lake / Jairam Complex | 15 | 23 |
| 42 | Kamat Classic / SBI Caranzalem | 15 | 23 |
| 43 | Syndicate Bank Junction | 15 | 23 |
| 44 | Step- in Super market | 15 | 23 |
| 45 | Sonata | 15 | 23 |
| 46 | By the bay | 15 | 23 |
| 47 | Zarina Towers / Kamat Arcade | 15 | 23 |
| 48 | Kadamba Bus Terminus | 40 | 60 |
| 49 | Patto Footbridge | 20 | 30 |
| 50 | Tonca Bus Stop | 20 | 30 |

| | | | |
|---|---|---|---|
| 51 | Ferry | 30 | 45 |
| 52 | Ribander Ferry Point | 10 | 15 |
| 53 | Ribander Patto | 20 | 30 |
| 54 | Tata Showroom | 10 | 15 |
| 55 | MLCP | 30 | 45 |
| 56 | Opposite Mhamai Kamat House | 20 | 30 |
| 57 | Dempo House | 40 | 60 |
| 58 | Caculo Island | 10 | 15 |
| 59 | Madhuban | 10 | 15 |
| 60 | Divja circle | 20 | 30 |
| 61 | Lake View | 10 | 15 |
| 62 | Tonca Pillar | 10 | 15 |
| 63 | Atlas Manor | 10 | 15 |
| 64 | Divar ferry | 10 | 15 |
| 65 | Miramar Bhel Puri | 10 | 15 |
| 66 | Santa Monica | 10 | 15 |
| **Total** | | **1040** | **1560** |

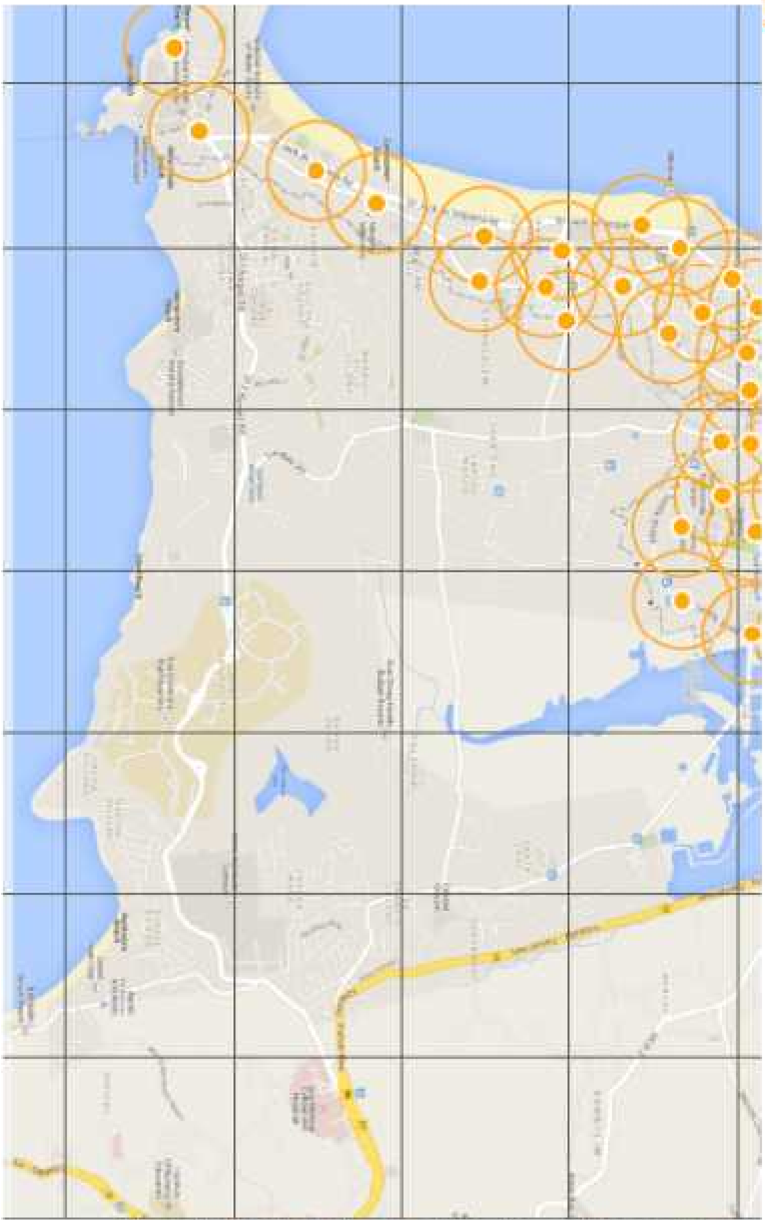

Figure 27: 250m Buffer Zone (Service area) for each station

## *Placement of Stations*

Once the general location of the station has been determined, the next step is to figure exactly where the station would be placed in a given location.

A station's placement is largely determined by two factors: high visibility and the availability of space. The stations should merge with the urban fabric of the city. That is, the stations should not obstruct the activities that currently take place in the city and should complement the current structure of the city.

Some station placement options recommended in few guides[5] along with existing examples of each option are given below:

### a. On-street parking spaces

A large number of cities have placed cycle stations in car parking areas. This is the most popular option across the world. Examples of cities which have adopted this strategy include Barcelona, Paris and New York. The space occupied by one car can be occupied by up to 10 cycles, depending on the PBS station design.

Figure 28: Bicycle station in Boston (Source: www.cityphile.com)

### b. Vacant space in roadside landscaping strips

[5] Transport Canada's "Bicycle Sharing Guide", ITDP "Bicycle share planning guide" and UN "Bicycle-Sharing Schemes: Enhancing Sustainable Mobility in urban areas


Figure 29: Bicycle station in New York (Source: Wikimedia.org)

### c. Areas beneath flyovers and foot over-bridges

Though this is good use of space that would remain unused otherwise, the location is not ideal in terms of visibility or safety of users, especially at night.

Figure 30: Bicycle station in Guangzhou (Source: *bicyclesharing101.com)*

### *d. Footpaths*

Stations should not be placed on footpaths unless adequate space for the pedestrians as mentioned in the IRC guidelines (2.5m) is available. Placement of stations should never lead to obstruction of pedestrians.

## Recommendation for Panaji- PBS Station Placement

It is recommended that Panaji installs all its stations in existing on-street car parking spaces, considering that on-street parking space is available in plenty at all locations identified for PBS stations. Care should be taken to replace car parking and not two wheeler parking as far as possible so that fewer vehicles are displaced.

At a few stations like the one proposed outside Kala academy, it is proposed that the station be placed on the footpath, as it is wide enough to accommodate a PBS station, without interrupting pedestrian flow.

**Figure 31: Bicycle station in Paris (Source: thehindu.com)**

# Project Costs and Revenue- Financial Viability

This section will explain the potential cost of the system and the potential revenue streams. This will help in evaluating how much viability gap funding is required for installing and operating the system.

## Project Cost

This section details the capital cost that will be incurred in procuring and installing the system and the operating expenses that will incurred in running the system for the first six years.

### Capital Cost

The initial capital cost that will be incurred on the system proposed in the DPR is detailed in Table 5 below.

**Table 6: Capital Cost of PBS Panaji**

| Component | Number | Rate* | Amount |
|---|---|---|---|
| **Cycles** | 1144[6] | 25,500 | 291,72,000 |
| **Docks** | 1560 | 40,800 | 636,48,000 |
| **Terminal** | 66 | 2,63,500 | 173,910500 |
| **Installation** | 66 | 2,00,000 | 132,00,000 |
| **Spare parts Bicycle s / year** | 1040 | 5,100 | 53,04,000 |
| **Spare parts stations** | 66 | 52,700 | 34,78,200 |
| **Shifting vehicles** | 5 | 8,00,000 | 40,00,000 |
| **Maintenance Centre** | 3 | 15,00,000 | 45,00,000 |
| **Control centre** | 1 | 50,00,000 | 50,00,000 |
| **Software** | 1 | 48,00,000 | 48,00,000 |
| **Access Cards** | 1 | 2,00,000 | 2,00,000 |
| **Website +Mobile Phone app** | 1 | 10,00,000 | 10,00,000 |
| **Other Costs** | 66 | 50,000 | 33,00,000 |
| **Marketing Costs** | 1 | 45,00,000 | 45,00,000 |
| **Total Cost** | **15,94,93,200** | | |
| **Cost/ Cycle** | **1,53,358** | | |

*Source: ITDP; Corporation of Chennai (COC)

[6] 1144= 1040 + 10% (1040).
10% is the recommended number of backup cycles which needs to be maintained by the operator.

The capital cost has been calculated for procuring 1144 cycles (1040 cycles with 10% extra cycles as back up) and installing 1560 docks (1.5 times 1040 cycles) at 66 stations.

The cost of spare parts for the bikes and stations are also accounted for in the capital costs. This is because there is a possibility that the components of the system are sourced from a different country. In such a scenario, it is best to procure, right at the very beginning, spare parts for the Bicycles and stations. This will ensure that there are no delays or hitches during operations because of unavailability of spare parts for the components which need to be repaired.

The number of redistribution vehicles for this calculation has been fixed at 5, but the operator may decide to operate lesser or more redistribution vehicles depending on on-ground operational factors. Similar is the case with the number of maintenance centre in the system.

The cost of the website and the mobile phone app has been clubbed together. This is because both the website and apps will be tied to each other and hence would be given to the same external agency to develop.

Marketing cost mentioned is the cost of marketing that has to be incurred on launching the system. This will be larger than the marketing functions that the operator will undertake during regular monthly operations. An external organisation should be hired to undertake the marketing function during the operation of the PBS system beyond the initial few months.

The total capital cost estimated for the system proposed is approximately **Rs. 16 crores**.

### *Operating Costs*

The cost in running the system for a period of 6 years has been calculated based on certain assumptions. The assumptions used to calculate the operating expenses are given in Annexe 1. The operating costs are detailed in Table 6 below.

**Table 7: Operating Costs Panaji PBS – 6 years**

| Component | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Total |
|---|---|---|---|---|---|---|
| **Station Infrastructure** | 44,57,145 | 49,02,860 | 53,93,145 | 59,32,460 | 65,25,706 | 312,63,266 |
| **Bicycles** | 16,04,460 | 17,64,906 | 19,41,397 | 21,35,536 | 23,49,090 | 112,53,989 |
| **Shifting vehicle** | 3,01,125 | 3,31,238 | 3,64,361 | 4,00,797 | 4,40,877 | 21,12,148 |
| **Control centre + Maintenance centre** | 15,67,500 | 17,24,250 | 18,96,675 | 20,86,343 | 22,94,977 | 109,94,744 |
| **Manpower Costs** | 33,19,800 | 36,51,780 | 40,16,958 | 44,18,654 | 48,60,519 | 307,31,711 |
| **Cost of Lease Rent** | 9,50,400 | 10,45,440 | 11,49,984 | 12,64,982 | 13,91,481 | 66,66,287 |
| **Recurring marketing cost** | 7,46,013 | 8,20,615 | 9,02,676 | 9,92,944 | 10,92,238 | 52,32,680 |
| **Operators Margin** | 37,30,066 | 41,03,073 | 45,13,380 | 49,64,718 | 54,61,190 | 261,63,398 |
| **Total** | 166,76,510 | 183,44,161 | 201,78,577 | 221,96,434 | 244,16,078 | 1244,18,223 |

*Source: ITDP; COC

Since the recommendation is to man all 66 stations for the first six months, to get the system popular, the man power costs in the first year will be more than the other years. The calculation of Manpower costs for the first year is given in Table 4 below.

**Table 8: Man Power Costs- Year 1**

| Man Power Costs | Persons | Shifts | Salary | Total |
|---|---|---|---|---|
| Centre Manager | 1 | 2 | 50,000 | 1,00,000 |
| Technical Manager | 3 | 2 | 25,000 | 1,50,000 |
| Accounts Manager | 1 | 1 | 15,000 | 15,000 |
| Telecommunication | 2 | 2 | 10,000 | 40,000 |
| Maintenance Staff | 15 | 1 | 7,000 | 1,05,000 |
| Station Attendants | 66 | 2 | 7,000 | 9,24,000 |
| Total Monthly | | | | 13,34,000 |
| Total Annual | | | | 1,04,64,000 |

Similar is the case with the marketing expenses in the first year. The initial expenses will have to more. Once the system stabilises, the marketing costs can be reduced. The rule of thumb followed on all other components is a 10% increase in the cost incurred every year.

The total operating expenses estimated for the system is **Rs. 12.44 crores** for a period of 6 years.

**The total of Capital and Operating cost calculated for a period of 6 years is Rs. 28.4 crores. This averages out to Rs. 125/ cycle/ day.**

## *Project Revenue sources*

There are two main sources of revenue for PBS systems: Fare Box revenue and Advertisements/Sponsorships.

**Table 9: Sources of Revenue**

| Revenue Sources | |
|---|---|
| Fare Box Revenue | Subscription Fees |
| | User Fees/ Rental Charges |
| Other Sources | Advertisements |
| | Sponsorships |

### *Fare Box Revenue*

Fare Box Structure for the Panaji bike share will consist of four parts- Security Deposit, Subscription fees, Processing fee and Cycle rental fee.

The fare/ pricing is structured such that regular users will find it lucrative to become members of the system by subscription. Subscriptions are aimed at residents of the city who would use the system on a regular basis either for point to point travel or as a means of last mile connectivity. Users, who will not use the system regularly or are not convinced whether the system would be suitable to their travel patterns, can access the system even without being a subscriber to the system. Non subscription model is aimed at tourists or first time users from the city.

Such a fare structure is different from most other systems where all users are required to subscribe to the system to gain access. The difference is proposed because bicycle shares are still an untested model in India. A large number of people would shy away from using the system if the use of the system was tied to subscription. This initial investment would put off a large number of potential users from giving the system a try and understanding its benefits. The proposed fare structure is detailed out below:

a. Refundable Security Deposit- This is a safety net for the system operator in the rare case that the cycle is not returned by the user back to the system. In other cases, the security deposit is returned to the user either at the end of their subscription period or at the point that the user decides to return their smart card to the system.

   It is suggested that the refundable security deposit is linked to the cost of insurance for the system.

b. Subscription Fees – Subscription Fees are for becoming members of the system. It is not compulsory for all users to subscribe and become a member of the system. Subscribers are entitled to an unlimited number of free sub-30 minute rentals throughout the validity period of their subscription. three types of subscription models should be made available for potential users:

   - One Year Membership
   - Three Month Membership

- One Month Membership

**Table 10: Subscription Fees for Panaji PBS**

| Subscription Type | Fee (Rs.) |
|---|---|
| **One Year Membership** | 999 |
| **Three Month Membership** | 299 |
| **One Month Membership** | 149 |

The subscription fee has been so devised such that it is cheaper for a regular user to subscribe to the system and benefit from the free half an hour rides, than be a casual user and pay for each ride.. The subscription rates are also structured such that it is more lucrative to take a membership for a longer period than a shorter period when the cost of subscription per day to the user is calculated.

c. Processing Fee- This is the fee charged by the system to issue the smart card to users. This amount is charged to ensure that users attach value to the smart card. This amount is non-refundable even when the card is returned back to the system by a user, at which time the refundable security deposit and any leftover balance amount is credited back to the user. Processing fee is waived off for users who opt for long-term subscriptions.

d. Cycle Rental Fee- This is the charge that is applicable on the user for hiring cycles from the system. This fee is time based and progressive in nature. The fare for every additional pre-determined unit of time is more than the previous unit. This type of fare structure encourages people to return the cycle to the system as soon as their ride is complete. Users need to be discouraged from holding cycles for long periods in between distinct trips – the cycles should ideally be returned to the nearest cycle station as soon as one trip is over, and another cycle should be borrowed later for subsequent trips. This will ensure the maximum availability of cycles for all users of the system. The User Fee structure followed in the Velib system in Paris is given below

**Table 11: Velib User Fee structure: Progressive Tariff (Source: GIZ)**

| Time | 0:30 h | 1:00 h | 1:30 h | 2:00 h | 5:00 h | 10:00 h | 20:00 h |
|---|---|---|---|---|---|---|---|
| Rate | Free | EUR 1 | EUR 3 | EUR 7 | EUR 31 | EUR 71 | EUR 511 |

Certain systems make a distinction in the cycle rental charges for long-term subscribers compared to casual users. The proposed user fee structure for the Panaji PBS system follows this principle and is given below:

**Table 12: Cycle Rental Fee**

| Cycle Rental Period | Subscriber (Rs.) | Casual User (Rs.) |
|---|---|---|
| 0- 30 mins | 0 | 5 |
| 30 mins- 1 hours | 10 | |
| 1 hour- 2 hours | 25 | |
| 2 hours- 3 hours | 50 | |
| 3 hours- 4 hours | 100 | |
| 4 hours- 6 hours | 200 | |
| 6 hours- 8 hours | 300 | |
| 8 hours- 12 hours | 500 | |
| 12 hours- 24 hours | 750 | |

Users will be required to top up their smart cards with a minimum of Rs. 100, which will then be deducted based on their use of the system. The card member will also have to recharge their smart card every time the top up balance is exhausted to continue using the system.

The fare structure of the Panaji Bicycle Share System as explained above is summarised in the table below.

**Table 13: Panaji Fare Structure**

| Type | Subscriber | Casual User |
|---|---|---|
| **Refundable Security Deposit** | Rs. 999 | Rs. 999 |
| **Subscription Fee** | Rs 149 – One Month<br>Rs. 299 – Three Months<br>Rs. 999 – One Year | Nil |
| **Processing Fee** | Nil | Rs. 50 |

| | | |
|---|---|---|
| **Minimum Top-up** | Rs. 100 or more | Rs. 100 or more |
| **Cycle Rental Charge** | Free for first 30 mins | No Free Rental Period |

The Revenue expected from the Fare structure described above, will be from three sources- The Subscription fees, Cycle Rental fees and Processing Fees[7]

**Table 14: Expected Annual Revenue from Subscription Fees**

| Subscription Type | Fee (Rs.) | Subscription Number [8] | Revenue (Rs.) |
|---|---|---|---|
| One year | 999 | 6,864 | 68,57,136 |
| Three Months | 299 | 4,576 | 13,68,284 |
| One Month | 149 | 4,576 | 6,81,854 |
| **Total** | | | **89,07,274** |

The revenue expected for Panaji from user fees is given below:

**Table 15: Expected Annual Revenue from Cycle Rental Fees**

| Parameters | Mxembers | x |
|---|---|---|
| Number of Users | 16016[9] | 12784[10] |
| % of Trips below 30 mins | 90% | 90% |
| User Fee for 30 mins (Rs.) | 0 | 5 |
| % of Trips below 1 hour | 10% | 10% |
| User Fee for 1 hour (Rs.) | 10 | 10 |
| User Fees (Rs.) | 16016 | 70312 |
| **Grand Total (Rs.)** | **86,328** | |

7 The security deposit is refundable, hence will not account as revenue for the system
8 The assumptions for calculation of Subscription numbers is given in the Annexe B
9 Members= Total of: One year, Three month & One month subscription numbers= 6874+4576+4576= 16016
10 The assumptions for calculation of Non- member numbers is given in Annexe B

The Annual Revenue Expected from Processing Fee is given below

Table 16: Annual Revenue from Processing Fee

| | |
|---|---|
| **Number of Casual Users (units)** | 12,784 |
| **Processing Fee (Rs.)** | 50 |
| **Revenue from Processing Fees (Rs.)** | 6,39,200 |

The total annual fare box revenue from all sources combined is given in the table below

Table 17: Total Annual Fare Box Revenue/ year

| Type | Amount (Rs.) |
|---|---|
| **Subscription Fees** | 89,07,274 |
| **User Fees** | 86,328 |
| **Processing Fee** | 6,39,200 |
| **Grand Total** | **96,32,802** |

### *Other sources of Revenue*

There are two other sources of revenue which have been tapped by PBS systems across the world: Advertisement Revenue and Sponsorships.

The model that is proposed for this project is to give out a sponsorship deal that will give naming rights to the PBS system, along with advertisement space on all cycles and cards. A separate advertisement deal will be given out for the ad space available at the stations.

### Advertisement revenue

Advertisement Revenue can be earned from the ad space that is provided at each of the PBS stations. The system has a total of 66 stations. The annual ad revenue that is expected from these ad rights are given in table below.

Table 18: Annual Ad Revenue from PBS stations/ year

| Type of Stations | No: of stations | Area(sq. ft)/ station | Ad Revenue/ sq. ft | Total Revenue |
|---|---|---|---|---|
| Prime Stations | 10 | 10 | 400 | 480000 |
| Other Important Stations | 25 | 10 | 215 | 645000 |
| Other Stations | 31 | 10 | 150 | 558000 |

| | |
|---|---|
| Total Ad Revenue | 16,83,000 |

## Sponsorship

Sponsorships can be of various degrees. Certain systems give out sponsorships to a single organisation, in which case the external organisation is given naming and branding rights to the entire PBS project. In other cases, sponsorships comes from various different organisations, in which case each sponsor is given the right to display their logo and name on a certain number of stations and cycles of the system.

In Panaji, a title sponsorship is proposed, in which the sponsor is given rights to brand and name the system and advertise of all the cycle and smart cards used in the system. The name of the sponsor will also be mentioned at each station along with their logo.

**The revenue expected from the system sponsorship is Rs. 50 lakhs/ year.**

## *Financial Assessment*

An overall financial assessment which compares the expected cost and revenue from the system is shown in the table below.

**Table 19: Net Cost to CCP/ year**

| S. No. | Items | Amount (Rs.) | Calculation |
|---|---|---|---|
| **A** | **Revenue** | | |
| A.1 | Total Revenue from Subscription Fees | 89,07,274 | |
| A.2 | Total Revenue from User Fees | 86,328 | |
| A.3 | Total Revenue from Processing Fees | 6,39,200 | |
| **A.4** | **Total revenue from Fare Box** | **96,32,802** | **A.1 + A.2 + A.3** |
| A.5 | Total Revenue from Ads | 16,04,880 | |
| A.6 | Total Revenue from Sponsorship | 50,00,000 | |
| **A.7** | **Total Revenue from Other Sources** | **66,04,880** | **A.4 + A.5** |
| **A.8** | **Total revenue from All Sources** | **163,15,802** | **A.3 + A.6** |
| **B** | **Cost** | | |
| B.1 | Service charge per cycle per day | 125 | |
| B.2 | Gross Cost per year | 474,50,000.00 | **B.1 * 1040*365** |
| | | | |
| **C** | **Net cost to CCP per year** | **3,11,34,198.00** | **A.7 – B.3** |

# Potential Business Models

This section discusses the four business models that are being followed by various Bicycle shares across the world.

## Government owned and operated system

The local government or transport authority owns and installs the PBS in the city and also is in charge of the operations. All the capital and running costs of the system are the responsibility of the government agency. Approximately 30% of all systems worldwide in the year 2012 were run on this model. Chinese cities have mostly followed this model.

Pros: The government have complete control over the operations and planning of the system. The placement of stations is not just based on profits but on improvement of transport infrastructure in the city.

Cons: The government is completely responsible for the system and will have to bear the risk of operations.

Example: Hangzhou Public Bicycle system is run by Hangzhou Bicycle Company, which is an affiliate of the Public Transportation Group. The company is responsible for construction, operation and maintenance of the system.

## Government Owned, Private operated system

The local government or the transport authority pays the initial capital investment for the system and hence owns it. The operations are however contracted to a private player by the government agency. The private player is paid a certain amount of money as fees for their services. Revenues may be kept by the operator, shared between the operator and the government, or kept entirely by the government.

In this kind of PPP, the role of the private player is smaller than that of the government body. Some of the private players involve in these models are Onroll Spain, Centroibici Spain, Clear Channel USA and ITCL Spain. About 28% of all systems worldwide run on this model.

Pros: The government still has a large control over the system but the responsibility of operations are handled by another agency.

Cons: The government will have to invest all the capital costs incurred on the project upfront. Since PBS components exhibit proprietary designs, often the same entity serves as the component supplier and operator. However, since the capital costs account for a majority of total system costs, the upfront payment of capital costs mean that the private entity makes the majority of its profit in the initial procurement phase. In such cases, the service quality provided by the private entity in the operations phase may be poor.

Example: Bicing Barcelona. The system is owned by the municipal authority but the operations have been contracted to Clear Channel.

## Annuity Concession Model

An external agency is responsible for procurement, installation of the system and then the operation and maintenance of the system for a specified numbers of years. This agency is paid by the government on a per day per bicycle basis. Any revenue generated by the system is kept by the government.

No separate or upfront amount is paid by the government under this model. The government pays a regular amount based on the number of days of operations and number of bicycles. There are service level standards which are defined to ensure quality of service. The private agency is charged a fine or awarded incentives based on their performance measured against the benchmarks set at the beginning.

Pros: No upfront cost to the government. Amount to be paid is spread over a 5-6 year period. The financing, installing and operating risks are on the private player. Since payment is based on operations performance, this model relieves the government of the responsibility of oversight during installation and ensures accountability from the private operator.

More importantly this business model removes the moral hazard that could occur if the contract is divided between a procurement contract and operations contract. Since more profits are to be made in the procurement contract it will lead to moral hazard. A business entity once it has made its profits on capital costs, may not see the financial rational in efficiently operating the system since there is little or no profit to be made in operations of a PBS system.

Cons: The revenue risk is completely with the government. The Performance measurement and incentive structure need to be clearly defined to ensure that the system is operated efficiently.

## Ad Agency (Private) Owned and Operated with Government support

The system is installed and operated by an advertisement company who makes the initial capital investment and also takes care of the operation expenses. The government awards the private player advertisement rights on street furniture like bus stations, Terminals and billboards, which are not part of the Bicycle share infrastructure, in return for their services. The government also provides support by acquiring land for the stations. The location and size of the stations are pre-determined by the government agency. In case the system is able to make profit, it is split with the government.

3 large advertisement agencies have been involved in these models: SmartBicycle by Clear Channel in US, Cyclocity by JCDecauz in France and Bicincitta by Cemusa in Spain. 205 of all PBS systems as of 2012 ran on this model.

Pros: No risk of operation is on the government. This system does not cost the tax payers too much money. The only money that the government incurs is the advertisement revenue forgone.

Cons: If revenue from the advertisement rights is very high or revenue from the PBS system is very low, the operator may not invest the effort in operating a high quality PBS system. Moral Hazard is a problem with this model.

Example: Velib Paris has been installed and operated by JCDecaux, who has been awarded advertisement rights by the city.

## *For-Profit Owned and Operated system*

A for-profit private organisation installs and operates the system with no support from the government. This is a pure entrepreneurial venture where the government is not involved. Revenue is generated from user registration, fees and ad revenue from the system. Nextbicycle Germany, Forever Bicycle Company are some of the players in this model.

Pros: Works best in cities where the local government can't afford to launch and run a PBS programme.

Cons: Bicycle shares are generally not financially sustainable by itself. It is necessary to tap in money from other sources to run the system. This could be in the form of cross subsidies, advertisement rights or grants from government. Example: OV-Fiets Netherlands, Nextbicycle Berlin

## *Not for- Profit Owned and Operated System with Government Support*

Systems are installed and operated by a non-profit which has been established solely for this purpose or an existing non-profit. The systems are installed and operated by this organisation with some support from the government in the form of grants. They can also access funds from other sources. All the money made from the registration and user charges are pumped back into the system.

Pros: Can have access to other sources of funding from external agencies as it is a non- profit. Not just dependent on the government for funding

Cons: Since funding comes from no regular source, there is quite a bit of uncertainty about the system's financial position. Also, a significant portion of employee time is spent looking for funding.

Example: Bycyklen Denmark is run by a non-profit, CityBicycle Foundation of Copenhagen, Denver B-Cycle

## Recommendation for Panaji- Business Model

It is recommended that Panaji choose an Annuity Concession Model for operations. While the revenue risk is on CCP, other risks related to Financing, Installation and Operations to the private sector.

The Performance evaluation structure for the contractor should be as given in Annexe C.

Given the cost calculations, the total cost per cycle per day for the government will be around Rs. 125 (based on cost calculations).

## Institutional Framework

The Public Bicycle Scheme in Panaji will be run on a PPP. This will be based on a 6 year long concession agreement between the CCP and a private party. The agreement will specify the quality and performance standards that need to be met by the private party. These performance standards will have a direct impact on the quality of service.

To ensure that the quality of service specified is being provided by the concessionaire, it is necessary that the service levels are regularly monitored and evaluated. This monitoring and evaluation should happen in two different stages: Procurement and Installation Stage; Operations and Maintenance stage.

Though the responsibility of installation, operation and maintenance is with the concessionaire, the government is responsible for a number of functions like procuring or provision of land for the stations, getting the required permits for installation and operation of the system.

This section explains the institutional structure that will oversee the system and help in monitoring and evaluation of Public Bicycle scheme.

## Project implementation Cell

This cell is responsible for monitoring the procurement and installation of the public bicycle scheme. The various functions of this cell would include: review; inspection and monitoring of installation works; examining the design and features of all the components to ensure for their conformity with the concession agreement and conducting tests and issuing completion certificates during the construction period. The Implementation cell is expected to identify delays and lapses that require action for enforcing the terms of the agreement.

The cell is also responsible for ensuring provision of land for PBS stations, preparing inventory of the site, granting the required licenses to the concessionaire, procuring all available permits relating to installation and operation of the system, payment of damages for delay in granting required space or permits.

For the success of the project, it is necessary that CCP gets the support of other relevant departments like the Traffic Police and Public Transport Authority to be part of the system.

The project implementation cell will have a board of directors, who will act as the supervisory board and an executive committee who is responsible for the day to day operations. The executive committee will regularly report progress to the board for approval.

The Board of directors which will be headed by the Commissioner, CCP will also have a representative from the Traffic Police, one representative from the Public Transport Authority, one representative of the State Government of Goa and one member from the Civil Society. The executive committee who will monitor the installation process will be headed by a Superintend Engineer.

## *Project Monitoring Unit*

This unit will be responsible for monitoring the quality of operations of the PBS to ensure that the terms of the concession agreement are met with[11]. The PMU should have sufficient capacity, resources and skills to oversee and monitor implementation of the PBS contract assigned to it. It may hire consultants to provide the requisite assistance as necessary.

Similar to the Project Implementation Cell, the PMU would also have a Board of directors who will supervise the Executive body, who will be involved in day to day operations.

The Board of Directors should consist of the Commissioner CCP, Mayor of Panaji, representative from Traffic Police, representative for Public Transport Authority, representative of the State government and representatives from Civil society.

The Executive body should consist of at least three officers. At least one of whom is from the finance discipline. The PMU should be headed by an officer of, at least, the rank of a Director/Deputy Secretary/Superintendent Engineer. The other two personnel could either be officers or consultants. It should be ensured that the personnel of PPP PMU spend at least two days at the project site during every two months and must interact with user representatives during such visits.

The PMU is responsible to make a report on the performance of PBS every 15 days, which will be evaluated by the Board. The Report should give details which include:

(a) Compliance with the conditions in the concession agreement.
(b) Adherence to time lines and other obligations specified in the agreement
(c) Assessment of performance against the laid down standards
(d) Remedial measures and action plan for curing defaults, especially when performance standards are not fulfilled;
(e) Imposition of penalties in the event of default;
(f) Levy and collection of user charges based on approved principles;
(g) Progress of on-going disputes and arbitration proceedings, if any; and
(h) Compliance with the instructions of the project authority

There could be a quarterly review on the format in which the review reports are to be prepared by the executive to ensure streamlining of reporting.

To ensure smooth transition of duties from the Project Implementation cell to Project Monitoring Unit, it should be ensured at least two members of the Board and two members of the executive are common to both the bodies.

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[11] The structure and functions of PMU is based on "Guidelines on Institutional Mechanism for Monitoring of PPP Projects", Planning Commission, GOI

## *Project Implementation Plan*

The tentative implementation plan is given below in Table 19

**Table 20: Project Timelines**

| Sr.No | Task Name | Duration (days) |
|---|---|---|
| **A** | **Tendering** | |
| 1 | Budget allocation for the project | |
| 2 | Preparation  of tender document | |
| | Setting up of RFP Evaluation Committee | |
| 3 | Notice inviting tender through paper/e-procurement | |
| 4 | Issue of RFP document | |
| 5 | Receipt of queries | |
| 6 | Pre bid meeting | |
| 7 | Clarification of Queries and Final RFP with Addendums | |
| 7 | Closing of Receipt of bids | |
| 8 | Opening of technical proposal | |
| **B** | **Issue, respond and evaluate RFP's** | |
| 9 | Opening of Pre bid Document | |
| 10 | Announcement of Qualified Bidders | |
| 11 | Date of Opening of Technical Bids | |
| 12 | Technical Bid Presentation Starts | |
| 13 | Technical Bid Presentation Ends | |
| 14 | Last Date for Clarification of Bids | |
| 15 | Short listing the bidders as per eligibility | |
| 16 | Putting up the short listing bidders to committee | |
| 17 | Approvals | |
| 18 | Intimation to qualified bidders | |
| 19 | Presenting the views of bidders | |
| 20 | Opening the financials - qualified bidders | |
| 21 | Announcing L1, L2, L3 based on cost quote | |
| 22 | Informing L1, whether the bidder is willing to do the work | |
| **C** | **Issue Contract with Operator** | |
| 23 | Issuing Letter of acceptance of work | |
| 24 | Agreement between parties | |

| | | |
|---|---|---|
| 25 | Submission of bank guarantee for the work | |
| 26 | Issue of work order | |
| 27 | Start of Fabrication work | |
| 28 | Completion date of work | |
| **D** | **Preparation** | |
| 29 | Site feasibility according to DPR | |
| 30 | Detailed Project Report submission to client | |
| 31 | Approvals from high end officials | |
| 32 | Site preparation/Dismantling works | |
| 33 | Civil works | |
| 34 | Preparation of foundation, Road Markings, Signages & Safety devices | |
| **E** | **Launch** | |
| 35 | Marketing | |
| 38 | Inauguration | |
| | **Total Days Required** | |

# Annexe 1

Assumptions for calculating operating expenses for the system

| Component | Assumptions | Amount- Year 1 |
|---|---|---|
| Station Infrastructure | 5% of total capital costs on docks+ terminals | 40,51,950 |
| Bicycles | 5% of total capital costs on bicycles | 14,58,600 |
| Shifting vehicle | Rs.15/km * 10 km/ vehicle * 5 vehicles * 365 days | 2,73,750 |
| Control centre | 15% of total cap cost | 14,25,000 |
| Maintenance centre | | |
| Manpower Costs | As calculated in Table 4 | 104,64,000 |
| Lease Rent | Rs. 100/ sq ft * 1000 sq ft* 12 months | 8,64,000 |
| Recurring marketing cost | 3% of Operating Costs | 6,78,194 |
| Operators Margin | 15% of operating costs | 33,90,970 |

A ten percent increment has been annually calculated on all expenses for every subsequent year.

# Annexe 2

Assumptions for calculating subscription numbers are given below:

| Subscription Type | Subscription Number* | Assumption |
| --- | --- | --- |
| Members, annual | 6,864 | 6% of 114,405 residents in Panaji Metropolitan region |
| Members, monthly | 4,576 | 2% of 114,405 residents in Panaji Metropolitan region on an average take memberships 2 times a year |
| Members, Three month | 4,576 | 2% of 114,405 residents in Panaji Metropolitan region on an average take memberships 2 times a year |
| Non- Members/ Casual Users | 12784 | 4% of 319,589 annual tourists in the Panaji Metropolitan region |