# BHOPAL BUS RAPID TRANSIT SYSTEM (BRTS) CASE STUDY

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The case study is developed as part of the Project Management Capacity Building program initiated by Madhya Pradesh Agency for Promotion of Information Technology (MAP-IT) with an objective to facilitate practitioners to understand the Bhopal Rapid Transit System (BRTS) E-Governance project intricate features, issues and challenges faced by project implementers along with the feasible solutions.

It may not hold all historical facts related to the project.

# BHOPAL BUS RAPID TRANSIT SYSTEM

## INTRODUCTION

Bhopal's Bus Rapid Transit System (BRTS) aims to develop a high quality, high capacity public transport system oriented to offer fast, comfortable and low cost urban mobility to its users. BRTS coordinates improvements in transit system infrastructure, equipment, operations and technology. It promotes seamless traffic across the city by evaluating the accessibility, comfort, reliability, fare, travel time, safety, and customer services factors.

The Ministry of Urban Development (MoUD) and Government of India (GoI) under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) undertook this initiative in 2006. The project is financed by GoI under JNNURM holding 50 percent stake, Government of Madhya Pradesh (GoMP) with 20 percent and Bhopal Municipal Corporation (BMC) with 30 percent stake respectively.

BRTS connects sub-urban parts of the city to 77 bus stops and 4 major routes supported by Trunk, Standard, Complimentary and Intermediate Para Transit (IPT) routes. The existing complimentary and IPT routes provide transport services to passengers from inmost residential areas to BRTS routes along with the feeder connectivity of city bus services running on standard routes. The construction of pilot corridor from Misrod to Bairagarh comprising of 24 kilometres started in 2009. The Bus service in BRTS corridor commenced in 2013.

Bhopal City Link Limited (BCLL), Bhopal Municipal Corporation (BMC) with initial assistance from Madhya Pradesh Road Development Corporation Limited (MPRDC) put through the initial project related studies for DPR (Detailed Project Report).

BRTS is operated through service providers on a revenue sharing basis under Public Private Partnership (PPP) model. Under this, the responsibility of delivery, performance and operation of buses on BRTS and city bus operation lies with the bus operator.

The case study analyses the aspects of project management practices implemented in BRTS project. It maps four project phases namely: Inception, Planning and Design, Implementation and Post-Implementation with five project management process groups and ten project management knowledge areas as prescribed by PMI's A Guide to the Project Management Body of Knowledge (PMBOK® Guide (Fifth Edition)). Within each project phase, the performed activities are discussed, as appropriate. The case study is structured to allow an evaluation of the appropriate processes project management knowledge areas at the end.

The inception phase emphasizes on project background and high-level scope. The planning and design phase talks about the overall project plan with further stage-wise decomposition of it. The implementation phase addresses the development and the execution aspects of the project. Finally, the post implementation phase talks about project support and its current status.

## INCEPTION PHASE

The population of Bhopal city is approximately 1,798,218 (Census 2014). Out of which around 28 percent use private vehicles for commuting, and the remaining rely on public transport. Bhopal public transportation system comprises of buses, mini-buses, tempos, autos and private vehicles and, is operated by unorganized sectors leading to poor quality of public transport facilities. Vehicle over-loading, non-standard fares, unqualified drivers and staff and unscheduled movements are some major causes of inconvenience and risky commute.

Urban transportation development was being neglected for a long time and the increasing number of vehicles on roads led to massive traffic congestion in the city.

An objective to address the urgent need of improved and effective public system to control the rise in traffic congestion, conceptualized into Bhopal BRTS project. The project scope was approved in 14th Central Sanctioning and Monitoring Committee (CSMC) in 2006. BMC was appointed as the implementing agency in 2008 with the sanctioned amount being, subsequently transferred to them. The tenders for the BRTS corridor were floated in 2009 and a revised DPR was approved in the 97th CSMC in 2011. The construction of 24 km corridor from Misrod to Sant Hirdaram Nagar (Bairagarh) was completed and BRTS operation commenced on 27th Sep 2013.

Bhopal City Link Limited (BCLL), GoMP appointed Egis BCEOM International, France in Joint venture with Egis India Consulting Engineers Pvt. Ltd., New Delhi and in association with Infrastructure Development Consultants (IDC) Bhopal as consultants for "Detailed Study on Bus Rapid Transit System Phase-1 in Bhopal", on 11th June 2007. The purpose was to understand the existing environment, identify the challenges and develop a strategy to extenuate it.

Preliminary analysis keyed out the bottlenecks in the existing system as follows:

- Existing traffic pattern (Severe congestion and mixed traffic)
- Inadequate infrastructure
- Land acquisition
- Lack of integration between land use and transport
- Concentration of activities in core areas of the city
- Lack of effective utilization of existing road system
- Lack of public transportation system
- High growth rate of vehicle
- Lack of traffic control and regulation and
- Citizens' resistance to change.

The city infrastructure and the transport system being interlinked, the scope of the BRTS project was not only restricted to exclusive bus operations but also to improve city infrastructure. Subsequently, a paradigm change in the user perception for bus based transport system was called for.

Considering the above factors, the high level operational and administrative requirements were categorized as - BRT Infrastructure (running ways, stations & platforms), BRT Vehicle Configuration and Design (size, floor height and body type), BRT Intelligent Transport System (ITS), BRT Support Facilities and Services (infrastructure and fleet), BRT

Marketing and Branding (identity and image), BRT Integration and BRT Infrastructure providers, BRT operators and BRT Planning and Regulatory agency.

However, not all requirements were implemented initially. The feasibility study highlighted the "Must Have" features/ functions and therefore requirements related to "operations management", and "bus and passenger information at bus stations" were given the utmost priority. The stringent timelines enforced team to divide corridor into two sub-stages: Misrod to Board office; SBI square to Sant Hirdaram nagar (Bairagarh end); and Board office to SBI square for speedy implementation two separate tender process and contract agreements were done for the above mentioned stretches and two agencies were appointed for the BRTS corridor work to avoid delay and speedy construction. The end-to-end framework needed:-

- Construction of flyovers at GAD and Railway over Bridge (RoB) at Habibganj railway crossing
- Around seventy seven staggered kerb side bus stops (on both sides)
- Bus terminals and depot with all amenities and
- Utility ducts, covered drains and cross drainage state at electric poles

BRT services and operational strategy demanded BRTS to be treated as the primary network and others (mini bus and tempo services) as feeder services to it. Moreover, the BRTS design elements like running ways, bus platform, corridors, etc. were specifically designed for BRTS buses where height of platform kept at 900 millimeters above the road was one such instance. Mini bus owners were welcome to join the BRT System by conforming to system requirements but they were not able to confirm the same.

The strategy to make BRTS economical and sustainable focused on delivering value to citizens. The aim was to provide

- safe & secure
- comfortable
- reliable
- affordable and
- environment friendly commute

During this phase, multifaceted study encompassing accessibility, comfort, reliability, fare, travel time, safety, customer services and frequency began.

The historical information, sampling surveys and metrics were identified as tools and techniques to measure the variances. A complete study of user priorities ensured continuous increase in the quality of the delivered transit services.

The complexity and magnitude of the project initiated various innovative approaches to success. The PPP model ensured sharing of revenue generated from smart passes between bus operator and BCLL at 80-20 ratio. This fostered growth and facilitated project to become sustainable.

An elaborate and systematic change management plan was drafted to manage all the change requests, coming from various sources in the BRTS project. However, changes had to mandatorily go through MIC and Parishad approval of BMC, State Level Steering Committee (SLSC) at state level and central sanctioning and monitoring Committee (CSMC) at Central level.

The process of identifying key stakeholders and their engagement levels also began at this stage. Stakeholders' roles and responsibilities were clearly defined keeping in mind the objective of the project and its anticipated changes. Sessions with stakeholders were initiated. The multiple rounds of meetings, bearing timely information proved instrumental in obtaining stakeholder's buy in. However, stakeholder co-ordination in terms of getting every stakeholder on-board was missing during the project implementation phase.

The radical requirements of the project raised the level of expertise needed within the project team. In this project, all the team members of the respective departments were involved and committed to the delivery of the project.

The teams instituted strict controls for measuring, updating and solving problems throughout the project. Proactive measures were taken to mitigate strategic risks that helped achieve targets faster.

List of major benefits anticipated from the BRTS initiative:

- Increased integrated public mode of transport
- Efficient, reliable and frequent services
- A safe and secure public transport system
- Universal design
- A decrease in road congestion
- Decreased energy consumption and vehicle emissions
- Enhanced urban environment
- Recapitalization of the public transport fleet
- Capital cost effectiveness
- Direct and indirect job creation in both transportation and construction industries
- Transit and supportive land development

BRTS has been integrated with the city bus operation so as to revamp the existing public transport system.

## PLANNING AND DESIGN PHASE

Most of the procurement and contract jobs typically occurred in the planning stage of the project. The detailed exercise of defining scope was initiated for Corridor 1: Misrod to Bairagarh in 2009. Based on the joint planning report provided by BCLL, IDC and Egis BCEOM, BMC carried out the task of detailed planning and route rationalization.

BMC deputed specialist transport consultant firm (M/S EGIS BCEOM International JV with EGIS India, Consulting Engineers Pvt Ltd.) as quality control consultants to supervise execution and implementation of BRTS operation. Requirements stated setting up of exclusive bus lane operations, improved infrastructure, signalized pedestrian crossing, access to BRT stations, bus priority signals in openings & intersections, vehicle scheduling, ITS technology, traffic safety and information systems.

Initial stages outlined the BRTS framework and non-technical infrastructure. This phase was extensively devoted to surveys, studies and analysis to:-

- Access the capacity of the existing public transport system of the city
- Discover the various drawbacks in the existing system and
- Identify the factors on which the public transport demand depended.

The methodology adapted involved conducting literature survey, field survey, document review and gap analysis to draw conclusions and aligning with the scope of work. The following parameters helped in finalizing the project size and scope:

- Study of existing traffic and travel patterns by carrying out primary surveys to find out the existing model.
  - Studying routes and existing infrastructure to gather road pavement details, existing pavement conditions, traffic movement, cross drainage structure, intersections and crossings, locations of historical monuments and institutions.
  - Socio economic profile study to understand topography, soil condition, climate condition, demographic and social profiles, population growth trends, income levels and economic base.
  - Traffic movements of the city were studied based on parameters like "origin-destination" survey, "boarding–alighting" survey (to assess passenger arrival pattern, hourly variation), opinion surveys, parking and pedestrian surveys. Around 5600 passengers were interviewed from 76 bus stops.
- Analyzing the data collected through surveys and determining the future demand for improvised public transport.
- Measuring the efficiency of existing public transport system to cater the current demands of public.
- Identifying and categorizing various factors and parameters, which affect the public transport demands.

The tools and techniques used for collection of data included interviews, peak time / hourly basis observations and statistical sampling.

During this phase, the size and criticality of the data initiated an innovative approach for analysis. Phase 1 corridor area was categorized into two groups: Influence Area and Immediate Influence Area. City area was termed as Influence area of the corridor and, zones adjoining to corridor were termed as Immediate Influence area.

In order to examine the traffic pattern, study area i.e. project influence area (PIA) was divided into multiple contiguous zones. These were called Traffic Analysis Zones (TAZs). The wards, which are administrative zones in the city, were broadly considered as TAZs and the larger wards were subdivided further for analysis purpose. The entire city was divided into three broad zones as below:

- Central Area i.e. core city area including old city
- Intermediate City Area i.e. new Bhopal and areas adjoining core city
- Outer City Area i.e. fringe areas

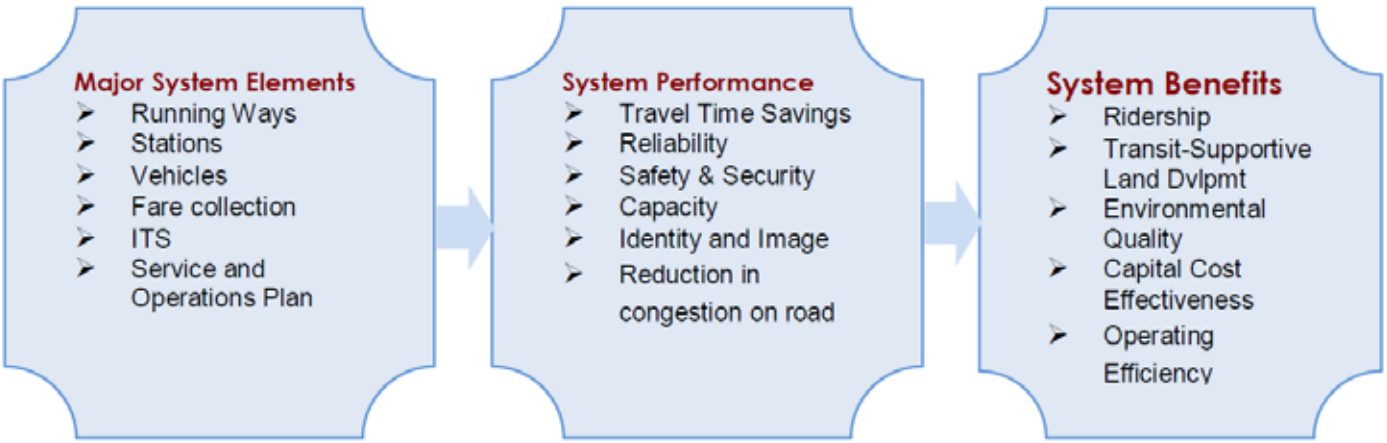
In all, PIA was divided into 113 zones for analysis.Infrastructure survey centred upon engineering and highway designs, road and pavement inventory, bridge and cross drainage structures, road conditions, other structures, pavement investigation and material investigation. The surveys were carried out (on the project corridors) as per MOSRT&H and IRC Specifications/Codes[4]. This helped in generating adequate database for rehabilitation and upgrade of existing roads.

During this phase, pavement designs were examined to introduce bus lanes and upgrade road geometrics accordingly. Furthermore, various structure design alternatives, specifications for pavement layers and materials were judged. The accepted method of investigations, design and specification approach is as per the guidelines of the Indian Roads Congress (IRC) and the MORT&H specifications for roads and bridges[4].

Environmental Impact Assessment (EIA) was initiated to identify the extent of BRTS project's impact on the environment. This information helped the team to understand the existing civic infrastructure and suggested mitigation measures to minimize pollution, environmental disturbance during project implementation phase[5].

As stated earlier, around 28 percent of city population uses public transport for commuting. This statistics helped the authorities to go ahead and harmonize stakeholders' expectations by involving stakeholders at all the stages of the project. Design requirements were worked out as per the suggestions received from the stakeholder and experts abiding by the existing infrastructure and need of the city.

The data collected was compiled, simulated and analyzed. Based on the outcome, traffic demands were forecasted. This successively helped the team to identify long-term benefits like economic development in and around BRT operation areas. Since mobility and economy are closely related, improving mobility means improved economic growth and vice versa. A robust and scalable effective support system was designed to connect feeder system complementing the BRT services. The BRTS system design strategy covered major system elements, its performance and benefits as follows[2]:




Communication among teams was of extreme importance. Considering the project size and interest/involvement of stakeholders, communication plan was drawn and executed cautiously where issues were addressed effectively and the communication changes were mapped appropriately with the related departments.

At this stage, the process became highly interactive and the design, build, test and implementation phases became less distinct. Beyond inception, phases were indistinguishable. All teams involved, worked concurrently in repeated cycles of design – redesign, build - rebuild, and test – retest. The development and implementation phases faced tough challenges which the teams eventually overcame with a success.

## IMPLEMENTATION PHASE

During this phase, the project encountered several challenges especially due to sensitive design details. Stakeholder engagement and communication management were identified as the critical areas to deal with. For instance, cutting of trees involved, the forest department; construction near archaeological monuments involved, Archaeological Survey of India and State Archaeological Department. Several religious structures were successfully relocated. There was a huge list of stakeholders ranging from Bhopal Municipal Corporation, State and Central Government, Private Operators, Users and many more. Stakeholder co-ordination in terms of getting every stakeholder on-board was missing during the initial stage of this phase. However, with apt planning and timely involvement of stakeholders facilitated the team to manage them efficiently.

The requirements were captured through progressive elaboration and the scope document was submitted to the vendor to initiate work. Coordination among team members was through Single Point of Contact (SPoC). This ensured that the project development aligned with the planning document.

The BRTS encountered major hurdles when it was realized that infrastructure upgrade was necessary for the project success but had been missed out in the scope statement. The entire project was revisited (in 2009) for additional requirements/scope on city infrastructure. As per the norms, all the changes were routed to MIC and Parishad approval of BMC, State Level Steering Committee (SLSC) at state level and central sanctioning and monitoring Committee (CSMC) at Central level for approval. There was a significant time delay to get Go ahead from the departments.

Involvement of different state departments for approval, land acquisition processes, tender management, rehabilitation, convincing passenger for transition/switching from existing mode of transport and setting up of PPP model were the key challenges faced. Convergence of efforts through, active involvement of various stakeholders, transparency of the processes and high quality of service helped in accomplishing the intended purpose. However, there were certain modifications made in the initial DPR considering actual site conditions where a constraint was encountered – some road stretches were found out to be inadequate for construction. Subsequently, suggestions from the authority were called for. Also, because of the involvement of multiple agencies, delays were cascaded resulting in enhanced delay in the implementation of the entire project.

Infrastructure set up and selection of third party was done phase-wise. Also, the changes that showed up on progressively elaboration of scope were recorded in the change management plan. The project not only necessitated the changes in the existing infrastructure and administration but also aligned itself with the frequent changes in the government policies.

During this phase, coordination between multiple contractors was also very critical. The lack of awareness and coordination among various departments, added to the criticality of the project. The project also faced difficulties while clearing sites (religious or residential or commercial infrastructure) for the corridor. Getting approval from railway authorities for Habibganj over bridge and from National Highway Authority of India for Misrod to board office roadside stretch delayed the construction work further. The construction of the corridors created traffic woes at various locations. But with the strict implement of the traffic diversion plan prepared so resolved the issue and smoothen the traffic during construction. However, the strategy defined for project tracking and controlling was proactively monitored by administrative heads.

City bus operation started by BCLL in 2007 could not be introduced upfront because of the various factors. An operational issue was foreseen with the design of the buses. Rear bus engine is a new technology where engine is located at rear and back wheel drives the front wheel. The design involved changes in the gear and steering transmission systems as well.

BRTS buses being handed over to the private operators (who provided Operations and Maintenance subsidy), regular upkeep of buses and refurbishment of bus fleet was ignored. This was mainly due to lack of ownership by private operators.

The buses were procured by the bus operator themselves and operated under BCLL, but due to lack of route rationalization study and strong opposition from mini/local operator the city bus operation could not be sustained. There was also lack of co-ordination from traffic police/RTO as the concept of sustainable urban transport was not known to all. The incremental monitoring particularly in terms of co-ordination with the inter-city traffic was also missing.

Government of India under JNNURM scheme, initiated bus procurement and 225 low floor buses were sanctioned to BMC eventually. Subsequently comprehensive route rationalization study was done by Urban Mass Transit Company (UMTC) with the help of BCM/BCLL/traffic police/RTO/other stakeholders. The outcome saw route rationalization of multiple bus routes where trunk routes and standard routes were assigned to city buses and, complimentary route and intermediate para transit routes were assigned to mini buses, Tata magic and other IPT modes. However, the overlapping traffic conditions were to be analyzed during project planning phase and the project should be planned accordingly to avoid the ambiguity encountered during this phase.

Even though the feeder connectivity is possible now and all the modes of transport are operated in tandem, the feeder service should be developed along with feeder routes so as to ensure last mile connectivity.

At present, nearly 197 Tata Magic buses are plying on the route meant exclusively for BRTS resulting in loss of revenue for the project. No mini-buses, other illegal transport should ply on the routes exclusively proposed for Bhopal BRTS.

Availability of skilled manpower was always an issue. Finding expertise in key areas (project management, capacity building, information technology etc.) was always a challenge. To fix such issues, training portfolio was created and deployed by the BCLL to train resources on project management/information technology as well as to train the drivers and conductors of the city bus services. Technical and behavioral training program were conducted for driver and conductor by BCLL, Fuel efficiency training by World Bank. Continuous competency development programs were implemented for the staff to impart knowledge and skills, resulting in the effective development and implementation of the project.

The availability of customized MIS reports and status reports enabled government officials, auditors and senior stakeholders to keep a track of the project status. Through constant performance review on the basis of periodic MIS report, administration was able to ensure quick turnaround time for the service delivery.

The implementation ensured performance and service level adherence. Third party audits and government officials frequent field visit helped keep a check on project status and performance targets as planned. The stakeholders monitored these performance targets on periodic basis.

Before the start of commercial operations of the buses, BCLL/ BMC conducted as two month dry/trial run on the BRTS corridor running both air-conditioned as well as normal low-floor buses. The dry run started from 1st June, 2013 while trial runs began from 15th June 2013 in the completed portion of BRTS corridor from Misrod to AMPRI (RRL intersection) and subsequently in the other portions of the BRTS corridor. During trial runs, MyBus saw 20,000 passengers per day and with the launch of AC buses, the number of passengers increased tremendously.

Sound project management; adequate resources and stakeholders buy in; and parallel improvements in business procedures and practices supported by a suitable legal and regulatory framework was an integral part of this project's success.

## POST IMPLEMENTATION PHASE

The BRTS bus operation on the BRT corridor was successfully established from 27th September, 2013 as "MY Bus". The buses are operated by a private operator on Net–Cost Basis. The operator is liable to "operate and maintain" the entire fleet and assets under the project[3]. Initial payment of 30 percent of total cost of buses plus 8 percent taxes that include value added tax and entry tax were made. As per the agreement, insurance and road tax, also needed to be paid by the bus operator.

With legal documents and Service Level Agreement (SLA) in place, agencies could deliver quality services to commuters. Separate SLAs were created for each offered service and contracts were made with vendors in their respective areas. Accountants General Madhya Pradesh (AGMP) audit team conducted timely audits as well.

Separate Call Centre number was established for dealing with route/bus enquiry and day-to-day commuter related complaints.

In no time BRT bus services have become very popular in Bhopal city providing reliable, punctual and clean facilities. Presently around 40,000-45,000 passengers per day travel in MyBus on BRT corridors and almost 1.35 lakhs passengers per day are taking the other city routes provided by BCLL. The very increase in ridership indicates that the private mode has a shift towards public mode due to implementation of BRTS in Bhopal.

Several innovative measures are being taken by BCLL (Bhopal BRTS office initiatives) to ensure financial viability in city bus services through various sources for revenue generation. Advertising on bus, ticket rolls, inside bus etc. is one of them. The advertising contracts were offered to 5 different agencies from different parts of Bhopal. The selection of multiple agencies, and inefficient co-ordination amongst the agencies, project stakeholder and the advertising revenue providers (customers) had a cascading effect on enhancing project inefficiencies. Later, the advertising revenue providers also became reluctant to work with the Bhopal BRTS as they were not assured of visibility of target audience.

The successful implementation of the project assured-

- Increased accessibility: BRT being a flexible system runs on all kinds of routes connecting all sections of the society.
- Identity and image: BRTS has managed to create a unique identity for itself as well as for Bhopal through strong marketing and branding. System elements viz. running ways, stations, vehicles, fare collection, ITS, service and operating plans have played essential roles in image building of BRTS.
- Improved economic opportunities: BRT offer opportunities for more employment, education and work.
- Increased BRT passenger ridership
- Adaptive design to social realities
- Increased revenue
- Reduced congestion

## LESSONS LEARNT

- The design should be robust and flexible enough to incorporate the new complex requirements/changes with minimum alteration.
- Divide the sizable project into sub-projects / phase and plan accordingly.
- Active participation of all stakeholders (team work)
- Convincing resources to minimize stakeholder resistance.
- Marketing and branding is an important parameter, which should be rightly acknowledged.
- Integration and coordination with multiple agencies, systems take more time and raises lots of technical as well as human hassles.
- Provide adequate support to operator and be sensitive towards operators need.
- Representative from RTO should be a member of the Board of Directors of BCLL, SPV of the project for better co-ordination, monitoring and control.
- Bundling and packaging of inter-city transport with BRTS – Inter-city buses routes should have been aligned with BRTS routes so as to cross-subsidize the BRTS fares.
- Private operators should not be provided with Operation and Maintenance (O&M) subsidy, rather a capital investment in the form of Viability Gap Funding (VGF) should be provided to the project directly.
- Advertising activity of any BRTS project should be bundled together so as to ensure better co-ordination

## PROJECT ANALYSIS

1. Write down your understanding of the project in terms of project management knowledge areas.

| Project Management Areas | |
|---|---|
| Scope Management | |
| Time Management | |
| Cost Management | |
| Quality Management | |
| Human Resources Management | |
| Communications Management | |
| Risk Management | |
| Procurement Management | |
| Integration Management | |
| Stakeholder Management | |

2. Highlight the major areas of strength in this project.
3. Highlight the opportunities for improvement in this project.
4. Highlight challenges encountered and lessons learnt in this project.

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## ABBREVIATIONS

| BRTS | Bus Rapid Transit System |
|---|---|
| GoI | Government of India |
| GoMP | Government of Madhya Pradesh |
| MoUD | Ministry of Urban Development |
| JNNRUM | Jawaharlal Nehru National Urban Renewal Mission |
| PPP | Public Private Partnership |
| BRTS | Technical Support and Training Service Provider |
| BCLL | Bhopal City Link Limited |
| BMC | Bhopal Municipal Corporation |
| MPRDC | Madhya Pradesh Road Development Corporation |
| RoB | Railway over Bridge |
| CCB | Change Control Board |
| IDC | Infrastructure Development Consultant |
| PIA | Project Influence Zone |
| TAZ | Traffic Analysis Zone |
| IRC | Indian Roads Congress |
| EIA | Environmental Impact Assessment |
| RTO | Regional Transport Office |
| MIS | Management Information System |

# ANNEXURE 1

## BRTS CORRIDOR FACT SHEET

**The BRTS corridors developed as under:-**

| Corridor No. | Description | Length (Km) | Land-Use | Length as per Survey (Km) | Remarks |
|---|---|---|---|---|---|
| 1. | Misrod (Police Thana) to Sant. Hirdaram Nagar (Bairagarh) Sehore Naka. | 23.95 | Urban and Semi Urban | Main Road 23.95 and one way link Imami gate to Moti Masjid via Curfew Mata Mandir (0.720) | Starting point is 500m before Misrod Police Thana and Ends at Sehore Naka before BCLL bus Terminal at Bairagarh |

## ROUTE CLASSIFICATION

The routes under this project have been classified into the following four categories:

**Trunk routes (TR):** Connect major activity centers by bus rapid transit system. Farthest Activity center should be accessible within 45 minutes of journey time.

**Standard routes (SR):** Connect major origin and destination pairs of the city. These are replacement of mini bus routes.

**Complimentary routes (CR):** These are complementary to trunk and standard routes. Routes covering less dense public transit demand corridors.

**Intermediate Para Transit (IPT) Routes:** These are feeder service to all above-mentioned routes, mainly catering intra-zonal trips.

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# GUIDELINES TO MAP CASE STUDY WITH PROJECT PHASES, PROJECT MANAGEMENT PROCESS GROUPS AND KNOWLEDGE AREAS

## PROJECT PHASES

A project phase is a collection of logically related project activities that culminates in the completion of one or more deliverables. Different phases typically are completed sequentially, but can overlap in some project situations. Different phases generally have a different duration or effort. For project with more than one phase, these phases are generally sequential and defined by industry specific terminology. Collectively, these phases make an element of project life cycle. The project life cycle is a series of phases that a project passes through from its initiation to its closure. (A Guide to Project Management Book of Knowledge, Fifth Edition)

## PROJECT MANAGEMENT PROCESS GROUPS

Project management is accomplished through processes, using project management knowledge, skills, tools and techniques to meet the project requirements. Each project management process is characterized by its inputs, the tools and techniques that can be applied, and the resulting outputs. These processes are grouped into five categories known as project management process group (or process groups): initiating, planning, executing, monitoring and control and closing. The process groups are seldom either discrete or one-time events; they are overlapping activities that occur throughout the project. When a large or complex project is divided into phases, the process groups are used, to effectively drive the project to completion in a controlled manner. The project manager and his team are responsible for determining what processes from the defined process groups will be relevant and by whom will it be employed. The degree of rigor that will be applied to the execution of the processes to achieve the desired project objectives is also determined. In this case study, the project management process groups are imbedded within the phases.

## INCEPTION PHASE

This phase may also be called initiation, conception or preparation. In this phase project charter is created and authorized. It considers alignment of the project within the organization's overall strategy, architecture and priorities. It addresses business justification, business benefits to performing and operating organization. Project boundaries are defined. The key purpose of this phase is to align the stakeholder expectations with the project purpose, give them viability with the scope and objectives, and show how their participation can help the project. It discusses finalizing the project charter and obtaining approval to proceed with the project.

## PLANNING PHASE

This phase may also be called development, design, preparation or formulation. It determines whether the objectives stated in the project charter can be achieved as well as how the project will be accomplished. It considers development of project baseline and establishment of detailed project work and project management plan. It explores all aspects of scope, time, cost, quality, communications, human resources, risks, procurements and stakeholder engagement. It addresses problems that need to be accomplished and considers project concept, feasibility issues and possible alternative solutions.

## IMPLEMENTATION PHASE

This phase may also be called execution, implementation or deployment. It addresses the completion of the work defined in the master plan as per the project specifications. It involves coordinating people, resources, managing stakeholder expectations, as well as integrating and performing activities of the project in accordance with the project management plan. It may also address planning updates and re-baselining. It addresses resource management, interpersonal skill, conflict resolution, leadership and communication. It also looks into monitoring and controlling of variances in scheduled parameters.

## MONITORING AND CONTROLLING PHASE

This phase empowers project teams to identify variances, process issues, and execution issues and take appropriate corrective actions. It involves managing unplanned changes that occur to all the knowledge areas. It deals with integrated change control, project and enterprise metrics, earned value management and tracking, monitoring and reporting of project progress against the baselines.

This phase is coalesced with all other phases, hence not captured as a separate phase in the case study.

## CLOSING PHASE

This phase is executed at the end of the project. The closing is mandatory for the entire project. It may address acceptance testing, formal acceptance, implementation strategies, project documentation and post implementation audits. This step is complete with lessons learnt and implementing the same as best practices for future projects. It also looks into closeout team meetings to review and record the team's experiences.

Since the project is ongoing, this phase is not explicitly captured in the case study.

## POST IMPLEMENTATION PHASE

This phase may also be called operation, application maintenance and support. It addresses the responsibility of operations, maintenance, and support to the appropriate organizational unit or service. It frames the development of recommendation to support success in future projects.

## PROJECT MANAGEMENT KNOWLEDGE AREAS

The knowledge areas are specialized domains in which a project manager functions throughout the project life cycle. The ten knowledge areas are: integration management, scope management, time management, cost management, quality management, human resource management, communications management, risk management, procurement management and stakeholder management. In this case study, all the knowledge areas are utilized, as appropriate.

**Project Scope Management –** The broader scope of work includes improved and effective public transport system to control the rise in traffic congestion in the city. However, the scope got extended to include the requirements related to city infrastructure. During the due-diligence stage, it was seen that the city infrastructure was not as per the desired expectation. Requirements and estimating of project size were done through various surveys related to socio economic profile, traffic studies, travel demand and forecasting, corridor and highway design, infrastructure and pavements.

**Out of scope -** Existing public transport system revamp.
The primary aim of the project was maintaining sustainable urban transport, ensuring financial viability in city bus services and creating various sources for revenue generation. This could then be used for the upgrade of public transport facility and city bus services of Bhopal.

**Innovative measures taken by BCLL (Bhopal BRTS office initiatives):**

- Advertisement on BCLL buses as well as bus stops: The appointed agency provides fixed royalty for the advertisement on both.
- LED panels inside the buses: Electronic display panels are installed for entertainment of commuters.
- Subsidized smart passes: Subsidized smart passes known as "Mahapor Smart Pass" was launch by BCLL to give subsidy to various categories of commuters like student, senior citizens, handicapped people, government employees, & working women below poverty line.
- Advertisement on ticket rolls: While issuing paper tickets with hand held Electronic Ticket Vending Machine (ETVM) a large number of ticket rolls are consumed. The same is utilized to promote advertisements.
- Advertisement on BRTS railing in dedicated BRTS lanes. The appointed agency provides BCLL a fixed royalty.
- Public Bicycle Sharing (PBS): The PBS scheme has been introduced in Bhopal to promote non-motorized transport. An agency was shortlisted to design, procure, install, operate and maintain the cycle sharing systems in the city.
- Refurbishment of old buses for improvement in life span and comfort o commuters
- Proposal for procurement of Midi buses for feeder network on additional routes and connectivity to nearby cities in the cluster.
- Global Environmental Facility (GEF)-5 project: The GEF and the World Bank have initiated the project on "Efficient and Sustainable City Bus Services" (ESCBS) with focus on improvement of Bus Transport Infrastructure, Depot Modernization, Fleet Management and ITS/MIS Improvement. RFP has been floated for MIS consultant.

**Project Time management:**
Bhopal BRTS was introduced in 2013 on pilot corridor of total length of 24 kilometers. The project scope was approved in 2006 BMC was made responsible for implementation in 2008 and roads were transferred to BMC subsequently tender process initiated in 2009 by BMC, revisited (because of new identified requirements on infrastructure) in 2011 and implemented in 2013.

Considering the size and complexity of the project, the stringent checks were put against the performance and progress of the project.

**Project Cost Management:**
The project was financed through Government of India (GoI) under JNNURM and Government of Madhya Pradesh (GoMP). The entire initiative was funded by GoI (50%), GoMP (20%) and BMC (30%). The longest BRTS corridor

from Misrod to Sant Hirdaram nagar (Bairagarh end) connects the old and the new city from Sant Hirdaram nagar (Bairagarh end) –SBI Square – Board Office – Misrod. Project was finally sanctioned for an amount totaling to Rs. 357.20 Cr comprising of a length of 24.0 kilometers and 30 meter wide Right of Way (ROW) on the dedicated lane including all the components of BRTS.

**Project Quality Management:**
Third party audits and frequent field visits by government officials helped keep track of project status and performance as stated in the estimated plan.

**The Consultant**
Bhopal Municipal Corporation (BMC) in its role as "Employer" shortlisted and employed qualified Supervision and Quality Control Consultants (qualifying National Standards), with proven track records in implementing similar types of project, undertook supervision and contract management of the proposed construction package. The selected consultants' firm nominated a person to be the "Engineer's Representative". This person, called as team leader, was deputed at project site on a full-time basis throughout the period of the construction supervision services. He was in-charge of the consultants' firm on site, interacted with the City Engineer (Project), as well as with the corporate office on routine basis.

It was expected from the consultants to engage constructively as the proposed BRTS construction technology involved use of latest machinery and equipment, particularly the flexible pavement roads. As the project packages were substantially large, experience in project management of the proposed magnitude was also the essential requirement. The supervision and quality control consultants were responsible to handle all civil construction contract works.

The objectives of the supervision and quality control consultants' services were:

- To ensure that high quality construction is achieved and that all jobs are carried out in full compliance with the engineering design, technical specifications and other contract documents within the stipulated time period
- To demonstrate the efficacy of contract supervision by independent external agencies experienced in this field of work.

**Scope of supervision and quality control consultancy services:**
The scope of services for each of the major areas includes but was not limited to the following activities: - a) supervision of all construction jobs for both quality and quality
b) adherence to construction contracts
c) regular monitoring of project sites.

The supervision consultant took all measure and control to ensure quality and handled all engineering decisions promptly for the successful and timely implementation of construction contracts. They worked and took decisions independently. However, there were few exceptions for which engineer have to seek prior approval from the employer.

This included

- Issuing order to commence work
- Issuing/approving variation orders, which have financial implications; except in an emergency situation as reasonably determined by the supervision consultant, Issuing/approving variations in quantities of the contract value
- Issuing/approving/sanction of additional items, sum or costs and variation of rates and prices
- Approving subletting of any part of the work
- Approving any extension of contractual time limits and
- Sopping and/or termination of the contractor

The supervision consultant reviewed the detailed project report submitted by the design consultant along with the review of specifications, drawings and bill of quantities provided under the construction contracts to eliminate defects or omissions, which would compromise on the completeness or consistency of the design. On completion of review, the supervision consultant prepared a report, which listed out all the findings, defects, omissions and recommendations.

**Project Human Resources Management:**
Project Human Resource Management was taken care by the supervision and quality control consultancy

**Contract management framework**
A contract management framework (CMF) governed the execution of efforts. The main features of CMF include – The Commissioner; Bhopal Municipal Corporation was the Employer who administered contracts as per the advice and discussion with addl. Commissioner. The Chief Engineer, duly supported by city engineer and deputy city engineer, assistant engineer, sub engineers supervision, finance and accounts resources, headed the technical division overlooking the entire set of activities.

The technical division at the Project Office defines/re-defines the objectives of the project, ensures efficient procurement of work and guarantees execution of sub project(s) within the scope defined in especially on variations in work quantities on additional items of work and change requests. The technical division, in assistance with supervision consultants interacts with all the external departments in matters relating to administration and monitoring of project implementation as per the requirements.

The Supervision Consultant was part of the C.M.F. and assisted BMC in all matters pertaining to contract management, as required. The supervision team composed of highly qualified and experienced key expert, selected as per RFP. The relevant professional experience meant, hiring people from similar natured highway projects where quality of experience was given due weight age during technical evaluation.

There were expert positions like Team Leader, Senior Contract Specialist, Senior Pavement cum Material Engineer, Senior Bridge Engineer, Highway Engineer cum CADD Expert and Resident Engineer who had high knowledge of project design and drawings. Deployment of suitable personnel was considered essential for successful completion of the project, as it required strong technical base. Consultants were advised to field truly competent and experienced experts at these positions through reviews of project drawings and designs. In some instances, they were asked to redesign or prepare a revised drawing from evaluation purposes.

Principal responsibilities were to carry out all the duties of an engineer as specified in the construction contract documents, within the limitations specified therein, but not limited to the following. In case of any disparity, the stipulations made in the civil construction contract documents will prevail in the order of precedence mentioned therein.

- To approve the contractor's key superintendent personnel, construction mobilization programs and temporary land to be occupied by the contractor
- To approve contractor's work program including activity scheduling and resource programming
- Authority to commence work
- Ensure that the construction works are in accordance with the technical specifications, Environmental Management Plan and other stipulation of construction contract documents and the construction methods proposed by the contractor are in compliance with the above stipulations particularly, in relation to contractor's construction equipment and other resource deployment
- To approve layout and plan of work
- To verify and if necessary order correction of the drawings supplied by the contractor
- Ensure a system of Quality Assurance, approve materials and sources of materials, review all bituminous mix designs and concrete mix designs proposed by the contractor and approve/suggest modifications in the mix design, laying methods, sampling and testing procedure as well as quality control measures to ensure standard and consistency in quality, at the commencement of a task.
- Check the laboratory and field tests carried out by the contractor and develop a mechanism in consultation with employer to involve team leader/representative engineer to carry out adequate number of independent tests other than the regular testing done by laboratory personnel
- To order special tests of materials and/or completed work, order removal and substitution of improper materials and/or work as required
- To make independent measurements and check on its quantity along with calculations required for payment purpose to ensure that all measurements and calculations are carried out in a manner and at the frequencies specified in the contact documents
- To issue a working drawing or modify the existing drawing (preferably within one week on request of the contractor) or to supply a new/supplementary drawing which is not included in the contract, wherever required and to give instructions thereof in this connection to the contractor
- To control and appraise the progress of work or to order suspension and/or extension of work duration and to authorize with the employer's approval
- To monitor and check the day-to-day quality control and quantity of work, keep all measurement records as per the directions of the employer and issue monthly/interim payment certificates when the quality of the works is satisfactory and the quantities are correct
- To draw attention of the contractor in matters concerning construction safety as well as standard tasks like erection of temporary signs on road and if required, requesting the contractor to provide any necessary lights, guards, fencing, watchmen, etc.

- To make sure the contractor carries out all tasks with minimum risks and/or avoids emergency situations that might affect the safety of life or of adjoining property
- To direct the contractor to take necessary steps in protection of the environment on and off the site during construction
- To inspect work, during construction at regular intervals and record defects. Issue Defects Liability Certificates after rectification of errors and provide final payment certificates as well
- Issue interim certificates for monthly payments to contractors; specify completion of tasks (partial or total) and details of progress. Payments are to be recorded in the measurement book before issue of interim certificate.
- To verify and correct the as-is-built drawings supplied by the contractor
- To direct contractor to take all necessary steps to maintain the rate of progress of work as per the approved program of the contractor on monthly basis;
- To provide adequate supervision of contractor's work carried out in more than one shift thus matching the working hours to be the same as that of the contractor(s);
- To ensure timely completion of the project without diluting the quality standards envisaged and be fully accountable to the employer in this regard;
- Responsibility for maintaining smooth flow of existing traffic on concerned state highways
- Provide assistance to the employer in respect of contract implementation, claims and other matters
- Advise and assist the employer with respect to arbitration, litigation if so required
- Review and ensure continuity of contractor's services in approved formats
- Prepare quarterly cash flow for the project in a format acceptable to the employer. Cash flow should identify budget estimates for all outstanding work and Maintain records of all planned labor and materials used in the construction of work

**Project Communication Management:**

Project communication management processes, tool and techniques used while managing the project includes - Regular coordination and weekly project review meetings, monthly progress monitored by administrative heads. Informal as well as formal communication modes were open throughout the project life.

**Project Risk Management:**
Project risk management processes, tools and techniques used while managing the project includes -

Approvals from various authorities:

1. 8.7 kilometers stretch from Misrod to Board office square stretch was a part of NH-12 and comes under the purview of National Highways Authority of India (NHAI).
    - Another 3.2 kilometers stretch of road from Lalghati to GPO circle is under the jurisdiction of PWD (NH).
    - Several other stretches were also under the PWD authorities Similarly, the approvals were needed from railways to construct a bridge at Habibganj. The delays were mostly due to hindrance in obtaining necessary transfers and permissions.
2. Public Perception - Public had negative opinions regarding BRTS of Indore , which resulted for litigations of BRT in same terms that of BRTS Indore but the issue was resolved in the first hearing itself .
3. Delay in creating project tenders - Necessary approvals for tendering and implementation of model code of conduct during state elections.
4. Land Acquisition – Acquiring of land from various authorities that contributed to the delay in the project, especially land exchange issue from Railway authorities.
5. Lack of proper training and guidance to city officials - City engineers and other officials were not properly trained. They were not aware of similar problems existing elsewhere in the country.
6. Lack of co-ordination between government departments.
7. Slow regulatory sanctions and approvals and delay in release of funds.
8. Difficulty in removing encroachment.
9. Environmental clearances – Area based development that required extensive landscaping, ducting, trenching needed approvals from state environmental department.
10. Business process re-engineering and alignment of all processes with ISO standards.
11. Changing mindset of the stakeholder. (Passive attitude of staff as their discretion is minimized and accountability has gone up).
12. Civil, electrical and mechanical work at each site (passive infrastructure).

**Points to discuss:** Categories risks into various groups (technical, administrative, organizational, processes, regulatory) for better control and mitigation. All the risks could be recorded in risk register and, weekly meetings dedicated to risk could be conducted at regular intervals to review the same. The adding risk to risk register was an iterative process and, was carried out throughout the project tenure.

**Project Procurement Management:**
BRTS implementation is based on PPP model. During the construction of BRT, Bhopal started planning the revenue model of bus operation[9].

- Two types of models were prevalent at that time -gross cost and net-cost. Financial limitations led Bhopal to drop gross cost model.
- It was a difficult task to look for an operator on net-cost mode exclusively for BRTS. A unique tender document had to be drafted and floated for city bus along with BRT bus operation integrating all the routes.

**Roles & Responsibilities of SPV**

- All civil infrastructures like depots, bus stops and, all maintenance infrastructures like washing pits, inspection pits are provided by employer.
- Office, administrative and store buildings, safe covered parking spaces are all provided by employer.
- Live tracking facilities and control rooms are given by employer.

**Roles and Responsibilities of Operator**

City and BRT buses being operated by Private Bus Operators on Net-Cost Basis

- Certain fixed percent cost of the buses was shared by operator as upfront fees before taking over of buses for operation.
- Fixed average monthly royalty per bus paid by operator to BCLL.
- All taxes, insurances and other fees related to operation borne by operator.
- All wages related to recruited staff borne by operator.
- Maintenance of buses is responsibility of operator.
- All the revenue generated from ticketing to be collected by operator.
- Advertisement revenue of Rs 3000 per bus per month shared by bus operator and BCLL at 50-50 ratio.
- Revenue from passes shared by bus operator and BCLL at 80-20 ratio

Points to discuss: The procurement management followed all the steps defined in PMBOK® Guide as it falls under government norms. It was not just the Purchase Order that initiated the work.

Government procurement process for the States @ http://NiSG.com

**Project Stakeholder Management:**
Convincing passive stakeholders to impart time, get involved and provide approvals was a lengthy process. List of stakeholder is as follows:

- BCLL
- BMC
- External consultants (Egis BECOM International)
- IDC
- MPRDC
- Private contractors / operators
- Third party monitoring agency
- RTO
- Users / project staff / residents
- Traffic Police

Point to discuss: Stakeholder register, stakeholder engagement, stakeholder analysis