GAUTRAIN MANAGEMENT AGENCY

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GMA CASE STUDY – SERVICE CAPACITY

PROVISION OF SERVICE CAPACITY IN RESPONSE TO ACTUAL SERVICE DEMAND FOR THE GAUTRAIN

The purpose of the case study is to demonstrate the know-how of proactively responding to actual demand relative to predicted demand and actual supply relative to predicted supply in the provision of sufficient service capacity for the Gautrain Rapid Rail Link.

LEARNING OUTCOME

To illustrate the methodology that was developed and adapted to model demand for the different services and to align demand and supply in order to deploy available resources in the most cost-effective manner for the Gautrain Rapid Rail Link.

BUSINESS OBJECTIVE

To meet current demand and facilitate demand growth into the future, by deploying available resources in the most cost-effective way in order to provide sufficient service capacity for the Gautrain Rapid Rail Link.

1. BACKGROUND

The Gautrain Rapid Rail Link is the first rapid rail link in Africa. It is a modern rapid rail link system in South Africa linking Johannesburg, Tshwane and OR Tambo International Airport (ORTIA). The network consists of ten stations and 80 km of railway lines. Phase one of the project, linking Sandton and the airport, was completed just prior to the 2010 FIFA World Cup. The second and final phase, the Hatfield-Park link, was completed in June 2012. The Gautrain is the largest project procured on the continent by means of a Public Private Partnership (PPP). The Gauteng Provincial Government (the Province) is the public partner and the primary promoter of the project. Other key public partner role players are the Gauteng Department of Roads and Transport (Gautrans), the National Treasury and its PPP Unit and the Gautrain Management Agency (GMA). The private partner is the Bombela Concession Company (Pty) Ltd (the Concessionaire). Bombela holds a 19.5 year concession for the construction, operation and maintenance of the Gautrain.

The Gautrain Project was formally announced in February 2000 by the then Gauteng Premier Mbazima Shilowa as one of ten Spatial Development Initiatives, which later became known as Blue IQ Projects.

The novelty of the Project (being the first of its kind on the continent) and the scale of the Project (constituting the largest PPP project on the continent) created challenges to providing sufficient service capacity. The case study sets out the methodology that was followed in order to overcome the challenges.

In particular, the case study discusses how the provision of service capacity was dealt with pro-actively in response to actual service demand as applicable to the Gautrain system during the period 2010 to 2014. The case study discusses how demand modelling methods were used to adapt to changes in actual demand measurements from the system relative to predicted demand, and to determine what service responses were required as a result.

Although the aspect of service resourcing was paramount, other aspects like the use of service convenience factors and demand management tools, inclusive of fare adjustments, are also discussed. In the final analysis it was found that reliable and comprehensive demand measurement systems are crucial in measuring and managing capacity utilisation.

2. PROBLEM STATEMENT AND EARLY FINDINGS

The first step in the provision of sufficient service capacity for the Gautrain Project was to determine the expected demand for the service. Determining demand in the initial stages was complicated by the novelty and scale of the Gautrain Project. Scepticism among potential users about the feasibility of the Project militated against the use of a simple demand model to determine demand. It was therefore necessary to develop a comprehesive methodology to model demand for the different services and to align demand and supply in order to deploy available resources in the most cost-effective manner.

2.1 Methodology/Solution Statement

The following methodology was followed:

- **Demand modelling** was done in order to determine the expected service demand during the 15-year operational concession period.

"Soon after implementation of the service it was clear that demand grew faster than originally anticipated by the demand modelling and that more high-capacity vehicles had to be deployed."

- Minimum **service delivery frequencies** were determined for the different time periods, i.e. weekday peak and off-peak periods as well as weekend and public holidays based on the demand modelling.
- The **service resourcing** was then developed as a response to the demand modelling as well as the minimum service delivery frequencies in order to ensure the most cost-effective utilisation of resources.

- **Service convenience** factors were identified as add-ons to the service in order to provide additional value to customers.
- **Demand management** tools were deployed to assist with demand management during peak period high demand periods.
- **Measurement of service capacity utilisation** was undertaken in order to determine any corrective action required.

2.2 Why and How the Methodology/Solution was Developed

The methodologies above were developed for the following reasons and in the following ways:

Demand modelling

Demand modelling was done in order to determine customer demand for the different services at different times of day, week and year.

During the development period, prior to any operations, demand modelling was done by both the Province and the Concessionaire in order to come to an operational contract arrangement. Generally accepted transport demand modelling methods were used.

Available household travel surveys were consulted. Travel demand modelling was developed by studying private car and public transport travel patterns along the different corridors. In addition, land-use development patterns in the vicinity of the service corridors were taken into account.

The target markets size and the market share were then estimated. This was done with due consideration of off-peak, weekend and public holiday demand levels. Demand was then estimated for the different segments on the service network in order to determine the level and location of maximum demand during a one-hour peak period in a given direction. The contractual arrangement allows for an annually updated five-year Concessionaire's Demand Forecast from the second contract year onwards.

Planned service delivery frequencies

Minimum service delivery frequencies were determined to ensure acceptable service levels for the different times of day, week and year. Service frequencies of existing local and international services were studied. The intended service quality and style were taken into account to determine what service delivery frequencies would be acceptable to the target market. The acceptability of average waiting times as a result of service delivery frequencies was determined.

It was decided that a 12-minute service delivery frequency during both the morning (am) and afternoon (pm) peak periods would be acceptable to the customer. (In future this would change to 10-minutes as service demand increases.) During off-peak periods a 20-minute service delivery frequency was assumed to be acceptable. (In future this would increase to 15 minutes as demand increases.) During weekend days and public holidays a 30-minute service delivery frequency was assumed to be acceptable to the customer.

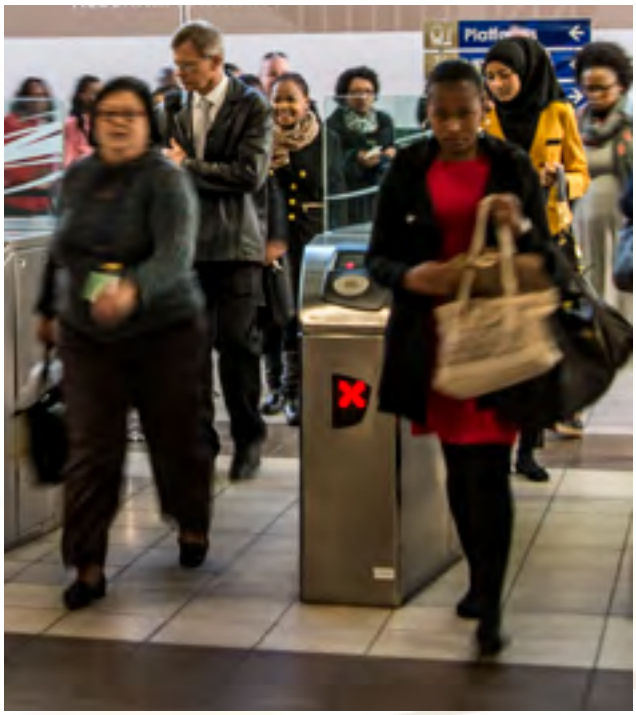
Planned service resourcing

Minimum service resourcing levels were determined to limit the number of resources deployed in the most cost-effective way.

The planned service delivery frequency for the time period was divided into the maximum link load demand for the system to determine the appropriate vehicle size for the service frequency. In the case of Gautrain two different vehicle sizes are available, i.e. four-car and eight-car train set configurations, of which the latter have double the capacity of the former. The outcome of the abovementioned calculation determined the number of larger versus smaller vehicle sizes that would be required to meet the maximum customer need during a specific peak hour.

Service convenience

A number of service conveniences were identified as value-adds to the customer in order to make the service delivery frequency and service resourcing more attractive to customers. These conveniences were unfortunately not fully developed before service introduction.



Demand management tools

On most transport services (as well as other services like cellphone, electricity, use of roads, etc.) the available capacity is under pressure during peak hours of demand. During such periods demand management tools are used to convince the customer to change their usage patterns if possible (flexible users are usually able to).

Different fare products were allowed for in the ticketing system of the Gautrain system. Provision was made for period products (monthly and weekly products) to benefit regular service users and to promote customer loyalty. Provision was also made for different categories of customers so that concessionary products could later be introduced to such categories. The system allows for fares to be differentiated during different times of the day and week.

Measurement of service capacity utilisation

Measurement of service capacity utilisation takes place on a daily basis in order to identify the need for changes in the service supply.

When customers use the Gautrain system all entries and exits (in the case of buses only entries) are recorded and registered against an individual's contactless smart card (CSC). These entries and exits are used to determine the fares that should be deducted from the customer's CSC.

The points and times of entries recorded on the computer system provide daily travel information in terms of origin and destination numbers summarised in 15-minute intervals. From the entries and exits the number of customers using the different services in each direction is calculated for an hourly period for each of the line segments (between two adjacent stations). The service available (in terms of frequency and resourcing) is calculated for the same hourly periods.

A calculation of the number of customers divided by the service supplied for the same period in the same direction then provides the capacity utilisation. Cases where the utilisation exceeds the available capacity are measured and handled in terms of contractual agreements between the Concessionaire and the Province for overcrowding. A quarterly Service Capacity Utilisation Management Plan is produced by the Concessionaire where all overcrowding incidents over a quarter are analysed to determine whether it was a once-off incident or of a repetitive nature.

If it is decided that additional service capacity is required, the resourcing of the service plan is reviewed. If it is clear that resourcing would not address the issue, changes are required in the service frequency. This is then investigated for possible changes to the service timetable.

3. ANALYSIS OF ISSUES

The following risks were identified, which required appropriate mitigation:

Demand modelling

There was a risk that actual service demand would differ from demand modelling to such an extent that the service provided was not relevant to the actual need.

Differences between modelled and actual demand were recorded once actual operations started. This was mitigated by deciding to use the actual demand as the base of post-implementation modelling.

Planned service delivery frequencies

There was a risk that the minimum service delivery frequencies would be insufficient at some times of the day, week and year and would result in overcrowding which could in turn stifle customer growth into the future.

It was found that the afternoon peak period and its higher frequency started too late and that the higher service frequency was required earlier. This was mitigated by moving the period of the pm peak earlier by one hour.

It was furthermore found that insufficient service frequencies were available to customers from the airport, especially on Sunday afternoons and Monday mornings. This was mitigated by introducing an increased frequency on the airport service from 14:00 on Sunday afternoons as well as an extension of the am morning peak frequency on Monday mornings until 10:30 to meet the actual needs of customers.

The service on the core of the North-South service is currently under pressure and requires intervention. An investigation was commissioned to determine whether additional service frequency could be introduced over this section. This could have the benefit that resource utilisation of vehicles could improve. The technical viability of this intervention is currently being awaited.

Planned service resourcing

There was a risk that the minimum service resourcing levels were insufficient at certain times of the day, week and year and would therefore result in overcrowding.

It was important to ensure that the deployment of the higher capacity vehicles was in the appropriate time slots where required by demonstrated demand. It was found that the originally planned resourcing was correct and that the correct time slots were used.

Soon after implementation of the service it was clear that demand grew faster than originally anticipated by the demand modelling and that more high-capacity vehicles had to be deployed. This was mitigated by studying the service utilisation of all consecutive trains in the most critical line segment between two stations to determine best slots.

As service is operated in two directions and vehicles are applied to operate cycles in both directions, providing sufficient capacity in one direction might lead to oversupply in the opposite direction and hence under-utilisation.

A further risk was that in the response to actual demand customer patterns could develop which would in future become difficult to manage. By way of mitigation, it was therefore decided to introduce higher capacity vehicles on every second train. This would enable the widening of the peak period in the first place, to be followed later by infilling of the slots skipped in the earlier rounds of capacity increase.

Service convenience

There was a risk that customers would find it inconvenient to transfer between North-South and East-West services if the transfer times were not attractive.

The original design of the system would have restricted transfers to and from the airport to all take place at Sandton. This was identified as an inconvenience to customers from the North (Pretoria side). This was mitigated by allowing transfers between the North and the airport to take place at Marlboro Station. This also had the benefit that capacity was not unnecessarily taken up on the system between Marlboro and Sandton.

It was found that especially off-peak weekday transfer times at Marlboro Station were unrealistically long. This was mitigated by measuring the required transfer times at the station, followed by a change in the timetable to get an improved positioning of trains in such a way to improve transfer time to acceptable levels.

It was furthermore found that customers are not always aware how their behaviour influences the service capacity availability. It was decided to use in-service announcements to inform them of higher capacity services, how to use on-board capacity effectively by using seats for people and not luggage, as well as standing where it does not negatively impact on customer convenience.

Demand management tools

A risk was identified that customer demand could result in a service demand that is so concentrated around a desired arrival time at work that the system would run out of capacity to deliver it.

It was found that the off-peak service demand was relatively low compared to the peak period demand. As mitigation, an off-peak discount fare was introduced to attract more customers to outside the peak periods as well as make it attractive for non-users to start using the system during off-peak periods (at a discount). This was later classified as the GREEN fare.

It was furthermore found that the off-peak discounted fare did not have the desired effect on the am peak customer demand that was wished for, although it did attract additional off-peak users. The am peak hour south- and westbound service demand was so concentrated that some further intervention was required. Congestion pricing was therefore applied to the am peak hour for all customer entries into the system between 06:30 and 07:30. A 20% higher fare was applied to pay-as-you-go customers for travelling in this period. This was classified as the RED fare.

Measurement of service capacity utilisation

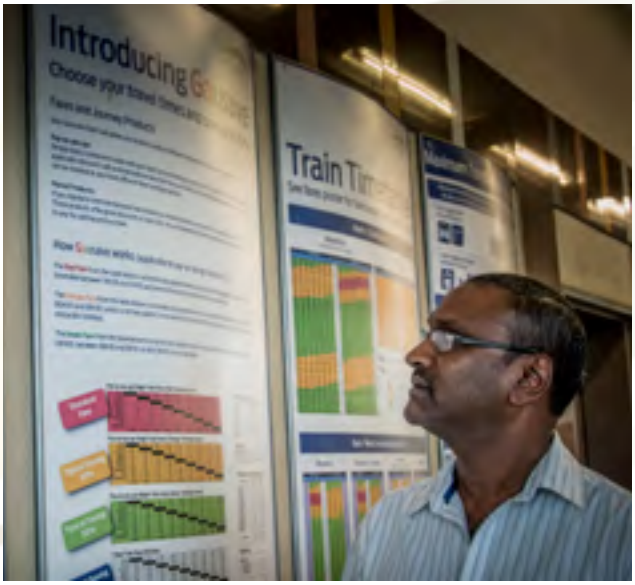
There was a risk that the measurement of service capacity utilisation was too coarse to correct capacity on individual services during any hour period. There was also the risk that the overcrowding thresholds were so high that customers would find the overcrowding unattractive, resulting in a loss in customers and a reactive response to overcrowding.

It was found that hourly capacity utilisation measurements could give the impression that capacity utilisation was acceptable on average, but that it did not deal with variations around that average during the specific hour period. This was mitigated by measuring the utilisation on a train-for-train basis during the day in order to make visible which individual trains are overcrowded. This had the additional benefit of targeting a service in a specific time slot for additional capacity.

There was a risk that the quarterly overcrowding measurements would lead to slow response times at a point where rapid customer growth was still experienced. This was mitigated by introducing bi-weekly capacity meetings where monitoring of service capacity utilisation and pro-active service responses were discussed and actioned.

A risk was identified that the service network and its components could run out of capacity at some point in the future. This was based on the fact that it was found that some services were already operating at the predicted year 13 capacity levels although the service was only in its second year of operation. To mitigate this risk, a long-term system capacity assessment was introduced, which is updated on an annual basis. This assessment takes into account the highest historical demand levels and projects it into the future, using growth assumptions based on past experience and realistic future growth expectations.

From the demand a peak period service level together with its resourcing is calculated. All of this determines when different system components like the number of vehicles, line capacity, junction capacity, platform capacity, etc. would reach its bottlenecks into the future. The benefit of this is that it assists in decision making as it takes a long term view.



4. LESSONS LEARNT

The following represent some of the lessons learnt in the different activity areas as well as some recommendations relevant to the lessons learnt. It should not be seen as an exhaustive list, but as a brief summary.

Demand modelling

- Demand modelling early during the planning phase of a project has its limitations and cannot allow for all possible eventualities.
- The more local and relevant experience is available to your demand modellers, the higher the quality and relevance of the demand estimate outcomes.
- It is recommended that actual demand numbers should be used as early as possible to remodel the future based on real-life experience.

Planned service delivery frequencies

- Assuming acceptable service frequencies based on what is already in the market place could be risky as it limits the extent to which one can distinguish your service.
- Current weekend service frequencies could limit the attractiveness of the service and higher demand could possibly be attracted with a more regular service frequency.
- It is recommended that customer surveys could be used after the service has been introduced for some time to determine where and when improved service frequencies are required.

Planned service resourcing

- Appropriate resourcing of a service has a major cost implication. In the case of Gautrain, running long trains, when shorter trains could be deployed, has an impact on energy cost, labour cost as well as maintenance cost.

- It is therefore recommended that the resourcing should be as close as possible to the real demand.
- In the case of Gautrain, it is not easy to change a longer train into a short train at short notice. It is therefore recommended that resourcing should have flexibility built into it. Gautrain is now considering automatic couplers that would allow for the subdivision of a long train within a few seconds. The network should also have sufficient storage facilities for unused vehicle resources. Gautrain could have benefitted from additional staging lines where unused vehicles could be stored when not in use instead of running all vehicles back to the central maintenance facility during off-peaks and again back to terminal points on the network when the peak periods start.

Service convenience

- Service convenience can easily be seen as an after-thought.
- It is recommended that this issue be dealt with proactively and that it then be refined once a service is operational for some time in order to continuously improve convenience to the customer.

Demand management tools

- Demand management tools are available to the service industry, but a one-size-fits-all approach could be dangerous.
- It was found that customers do not always behave as expected.
- It is recommended that demand management measures be introduced in small incremental steps and over a period of time (one year apart was found to work best) and that the customer response to these be studied before the next step is introduced.
- The service provider should also ensure that some of its products are not in conflict with its demand management tools. In the case of Gautrain, the period fare products still make it attractive for customers to travel during peak periods as only the pay-as-you-go fares can currently be charged with congestion charging.
- Gautrain is in the process of moving towards a backoffice-centric fare system that would allow for more rules and fare products to reduce conflicting products in future.

Measurement of service capacity utilisation

- Working with people always remains a challenge. It is therefore important to have systems that measure how your service is consumed.
- The more timeous, comprehensive and trustworthy your information, the more you can respond to changes in customer demand and behaviour.
- Proactive analysis of customer travel patterns and behaviour could improve the match between demand and supply in the most mutually beneficial way. It is recommended that service providers make every effort to maximise the use of information already available to them and to continuously add to and improve on this.

General comment

Contractual arrangements could result in a reactive approach to capacity management, whereas customers expect a more proactive response to capacity. It is therefore recommended that demand thresholds (overcrowding in case of Gautrain) be selected in such a way that it guides a proactive response. This should prevent capacity utilisation from reaching unbearable levels, resulting in loss of some customers, before additional service capacity is added.

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