# A Process Oriented Approach to Waiting Line Management in a Large Pilgrimage Center in India: A Case Study

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## Abstract

This article documents an innovative approach to manage waiting line in the largest pilgrimage center in the world. By a judicious combination of process orientation and advances in Information Technology, the pilgrimage center's management has been able to dramatically change the pilgrims waiting experience.

The pilgrimage location under study is Tirumala located in Andhra Pradesh state in India. The number of visitors to this important location has been steadily increasing over time. As of 2005, the location attracted approximately 16 million visitors a year.

The primary objective of a pilgrim visiting Tirumala is to have darshan of the principle deity in the temple. The secondary objectives include tonsure (shaving head as a mark of respect), offering donations, prasad collection, local sight seeing and shopping.

The immense popularity of the temple and its location poses significant challenges to the management of the system. This temple is a tradition bound Institution. Therefore, some alternatives to resolve pilgrim waiting time are feasible and some are not. There are some hard constraints which may not stand the test of logic.

The ability to manage the traffic volume is a function of processing rate (darshan duration) at the temple and darshan time available per day.

This case study is an example of improving operational effectiveness by using formal management methods in addressing an important real life problem in an under researched area.

## The Context

This documentation is about an innovative approach to manage waiting line in an important pilgrimage center in India. This center is located in the extension of Western Ghats and is popularly known as Tirumala. This is a hill station. It is considered to be the abode of Lord Vishnu[@] in the form of Venkateswara. This center attracts a large number of visitors (16 million a year) from all over the country irrespective of their caste, religion, belief, social status and professional affiliation.

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[@] According to Hindu mythology there are three principle deities, Siva (incharge of destruction), Vishnu (incharge of protection) and Brahma (incharge of creation)

Venkatadhri (another name for Tirumala), the hillock residing place of Lord Venkateswara is probably one of the oldest religious institutions in India. It is known to exist for over a period of 2000 years. It has a recorded history of thousand years. Several South Indian kings have liberally donated wealth to enrich and maintain the temple and the town. On occasions of need, they have protected the temple from invasion. Based on the recorded history, the rituals and daily routines in this sacred temple are being performed without a break for more than 1000 years.

Over a period of time Venkatadhri has evolved as an epicenter of Vaishnavism. Several prominent Hindu religious institutions either have established a presence in Venkatadhri or have made this as place of their administrative headquarters. Today, Venkatadhri is not only a religious institution, but it has also evolved as a social institution. It supports financially a group of thirty (higher) educational institutions. Its mission is to systematically promote the study of Vedas and Sanskrit literature. The temple also provides generous financial support for construction of similar temples (Venkateswara) elsewhere in the country.

Over a period of 40 years, the number of visitors to the temple and the town has increased by eight fold. [1960 (2 million), 1970 (4 million), 1980 (7 million), 1990 (11 million), 2000 (16 million)].

Such a huge traffic generates tremendous stress on the social and physical infrastructure of the temple down (Tirumala and Tirupati). Being a tradition bound organization, certain modifications (on procedure, layout etc.) are not acceptable. The devotees (exposed to modern social norms) who come to the temple expect a better service quality and shorter waiting time. Thus, the managerial challenge is to balance the tradition, operational efficiency and increasing customer expectations.

Activities in the temple and the town and their management need to be also seen from a religious perspective. There is a divine dispensation in the institution, which may not be tinkered with in whatever modification(s) that are made in the facilities redesign and management of activities.

## The product and its delivery

Pilgrims from all over the country arrive in the temple town. Usually they reach the foothill which is known as Tirupati. The mode of transport is rail, road (public or private transport) and air. Having reached Tirupati, those who have their own transport proceed directly to Tirumala. Some spend a few hours in sight seeing and visiting other temples and religious locations in and around Tirupati.

The distance between Tirupati and Tirumala is 19 Kms. Andhra Pradesh State Road Transport Corporation (APSRTC) operates regular services between Tirumala and Tirupati. The round trip is about 2½ hours including waiting time at both the boarding points.

Having reached Tirumala, the pilgrims look for a suitable accommodation. There are about 5000 cottages owned and managed by TTD for pilgrim's convenience. After (a brief) resting, pilgrims go for tonsure (there are 500 barbers who operate on a 3 shift basis; 15,000 tonsures are done in a day). The annual revenue from export of hair (from tonsure) is Rs. 100 million. Following tonsure pilgrims go for a wash and bath in the holy tank in the middle of the temple town and then join the queue for darshan. Some pilgrims on arrival at Tirumala directly join the darshan queue and

after the darshan visit the tonsure centre, take a bath in the holy tank and departure to their place of residence.

There are 32 waiting compartments to house pilgrims while they await darshan. The average capacity of these compartments is 500. About 17,000 pilgrims can be held in waiting at any time. The average waiting time for darshan can vary between 2-12 hours depending on the day and season. There is tremendous uncertainty as when darshan would happen. There is also anxiety as how long is the wait. There is no (accurate) information to the pilgrims on what is ahead. Because of the commitment to the pilgrimage process, individual pilgrims go through this tedious experience with reverence and patience.

Finally on a FIFO, pilgrims arrive in front of the deity. The actual darshan lasts for about 1½ to 2 seconds. However, the pilgrims can have a view of the deity from a distance of 30 meters from the main entrance. The travel time is about 45 seconds. Actually, the passage towards darshan admits a file of 6 or 7 columns of pilgrims to go through the darshan process simultaneously.

After the darshan the pilgrims donate money at the Hundi, equivalent of donation box, located inside as well as outside the temple and then leave the temple premises. The Hundi collection is about Rs. 2000 million a year. Often, they stand in another queue to buy laddu (there are several counters that sell laddu @ Rs. 5/- per piece based on prior payment). Approximately, 75,000 laddus are sold in a day. In view of demand and supply gap, there is rationing and restrictions on how many laddus a pilgrim can buy.

Tirumala Tirupati Devasthanam (TTD) the administrative agency incharge of this temple provides free meal to about 25,000 persons in a day. After receipt of laddu(s) and a meal, the pilgrim returns to his cottage or wait for a transport to go Tirupati and subsequently to his place of residence.

Based on the description above the TTD activity profile includes:

- Plan, monitor and execute a (transfer) road transportation network
- Managing a large hotel with 5,000 rooms and multiple guests
- Managing a large barber shop
- Handling a large restaurant which feeds 25,000 people every day
- The management of wait and orderly darshan of devotees.
- Managing a sweet shop which can produce and sell 75,000 units every day

Apart from specific requirements that have been mentioned and identified above, maintain public order, sanitation upkeep in the hill station, pilgrims safety are also the responsibilities of the TTD management. For example, the water in the tank need to be constantly purified and recirculated in view of large number of visitors to the tank every day.

## The value chain

For a pilgrim, the core value proposal that TTD can offer is an enjoyable darshan experience. While the duration spend by a pilgrim in front of the deity cannot be increased, it is possible to consider several methods by which the passage to the pilgrimage center may be made more enjoyable. There are several associated elements of the value proposal, viz. (a) better management of tonsure facilities, (b) easy access to donation boxes, (c) simplified procedures to purchase

(unlimited quantities) of laddus and (d) convenient access to free boarding facilities, (e) well organized and managed cottage reservation facilities.

At the next level, a pilgrimage would expect a convenient transfer from the base camp to the hill top, safety and devotional ambiance. In order to positively respond to the pilgrimage aspirations, TTD has decided to transform itself as a pilgrim friendly organization. After a detailed consultation with the employees, the management and the trustees of the organization, the following vision statement was formulated.

- Maintain and sustain the age old tradition of the temple
- Preserve and propagate the ancient culture associated with the temple
- Make the administration as much pilgrim friendly as possible
- Manage educational and health institutions of TTD with a distinctive devotional framework
- Communicate constantly to all stakeholders that the divine ambiance is fundamental to all that is done at TTD

TTD on its own based on select consultation with academician has designed a dramatically different way of managing the waiting line in the temple complex. In the remaining part of this document, we detail the specific aspects of this solution and its implementation. A brief discussion on the support services and a possible approach to enhance their efficiency is the subject matter of the next section.

## Approaches to managing the support systems

**Transfer services:** The transfer service is the first interface between the pilgrim and TTD. Since there is an opportunity to visit various religious sites, the criticality of managing this facility with rapid response time is relatively low. Pilgrims arrive by road and rail. Every train will bring pilgrims.

The transfer services buses have a fixed capacity of 50. Assuming a turnaround time of 2½ hours and 20 hours of operation a day, 8 round trips are possible in a day to transfer 400 (8 x 50) pilgrims. Given a fleet size (say 100), the system can handle about 40,000 pilgrims a day. It is fairly easy to add more fleet and increase transfer capacity based on actual traffic conditions. Since the journey time is short, roadway is dedicated, (there are two separate roads for up and down traffic), and no major difficulties are envisaged. Of course, the upkeep of fleet in terms of maintenance, uptime and replacement of spares on time are extremely critical.

**Tonsure Centre:** No bottlenecks are reported in the tonsure center. There is enough capacity. The activity duration is 10 minutes. The ambiance and process flow ensures acceptable response time. It is a well known practice that in this center, a barber would begin a head shave with a visitor, leave him in the middle, attend to another and come back to the first person again. In a way, no client is waiting. They are in service. This has evolved as an acceptable tradition in Tirumala.

**Hundi:** The donation offering process is more broad based. For example, it is now possible to directly remit donation(s) to (Venkateswara or Balaji) temple account by using e-hundi*. This provides customized instantaneous access to those interested to offer donations.

**Cottages:** The management of cottages (there are several categories) and reservations is possible by using web as well as manual operations. The reservation is on FIFO basis in a category. The large number of guesthouses (owned by commercial establishments and religious institutions) provide flexible capacity needed to respond to seasonal peak traffic. The major managerial decision is to monitor the traffic flow and plan for long term capacity.

**Laddu(s):** The laddu making process (which used to be manual) is now automated. There is a shortage in capacity and consequently rationing is resorted to. The price of Laddu at Rs. 5/- a piece is very attractive to a pilgrim. Purely on economic considerations, there is scope to increase this price. However, temple management is unlikely to accept this based on sentiments associated with prasad and its price. Capacity enhancement is a critical need so that rationing may not be resorted to in laddu distribution.

**Free Meal:** The free meal service requires running a large community kitchen. No capacity bottlenecks are envisaged. There are broadly two options. Operate a centralized kitchen (with a capacity of 25,000 meals a day) and distribute food in various places like the dormitories etc. Alternatively, a well designed and closely monitored (quality) contract system would provide volume flexibility and shorter response time.

## Management of Darshan Queue

We next describe the content and constraints related to the management of main darshan queue. Darshan is the prime purpose for which a pilgrim visits the temple. The output per day is fixed and is a combination of the processing rate and the darshan duration available. The current processing rate of 40 pilgrims per minute translates to 2,400 pilgrims an hour. At a stretch, darshan may be kept open for 22 hours (2 hours reserved for daily maintenance and other mandatory rituals). This would provide a processing capacity of 52,800 per day. It may be noticed that the output rate is constant and arrival process is stochastic. When the number of arrivals per hour is larger than 2,400 wait would occur. The actual waiting time would be proportional to the number in the queue. The waiting time duration in days would be the number in the queue divided by a daily output of 52,800. The number waiting in the system would decrease proportionately when the arrival rate is less than 2,400 in an hour.

The greatest disadvantage of the current system is that a typical pilgrim did not know how long it will take him to reach the head of the queue, how many individuals are ahead, and should there be a disruption in service (how long and why). Because of the divine dispensation and tolerance required in undertaking such pilgrimages in India the public at large is willing to undergo the inordinate (unexplained) delay.

The annual capacity of the system is (52800 x 365) = 19.272 million a year. It is well known that the pilgrim arrival process is stochastic and follows specific peaks. There are peak weeks and peak days. The consequence of this is inordinate and unpredictable waiting time for darshan. In

* Ref: http://www.tirumala_tirupati.com . This is a web based facility to donate (fund transfer). The website also provides options to book accommodation and reserve certain paid darshan services.

relatively short periods of time varying between 5 to 15 days the waiting time would range from 12 hours to 2 hours based on reduced traffic after the peak arrival pattern. Should the arrival continue at a higher rate, the inordinate waiting time would constantly increase.

At an abstract level, the queuing system can be modeled by a G / D / 1 queue, with stochastic arrival and deterministic service time. The waiting time is a consequence of stochastic arrival. Unlike other queuing models, the number of servers (here) cannot be increased. Therefore, the waiting time cannot be influenced by the management. Only the process of waiting can be made enjoyable. This is the central idea of the proposed solution.

The TTD management was aware of the significant delay to the pilgrims due to stochastic demand and constant service rate. To help pilgrims in reducing the difficulty associated with waiting time, number of (32 of them) compartments (waiting area) were constructed. Facilities like sanitary infrastructure, bathing facilities, access to food and beverages was made available in these compartments. This was a useful measure. But, as expected this would not resolve the fundamental problem of increase in waiting time. Actually, this approach has created a buffer of about 17,000 pilgrims in the system.

Concerned by the long waiting time and the associated hardships to the pilgrims TTD management conducted several brainstorming sessions to find an alternate arrangement. Suggestions like changing the structure of the temple entrance, keeping the idol in an open area and longer ramp for darshan were considered but could not be accepted in view of the traditional practices and the unique nature of the organization.

Subsequently, the TTD management decided to convert the physical queue to an electronic queue. The following are the essential features of the new system.

- Every pilgrim on arrival either at Tirumala or Tirupati would report to a registration counter and register his arrival. Several such counters would be located in several convenient locations in the temple town area.
- Based on the number in the system and the processing rate, the application software computes the actual waiting time in the system (If there are 40,000 people in the system and the processing rate is 2400, it is expected waiting time is 16 ⅔ hours).
- Based on the actual time of reporting and the schedule of activities for religious function the actual darshan time is computed. It would obviously be larger than 16 ⅔ of an hour in the situation mentioned above.
- The pilgrim is expected to report at the temple main entrance ½ an hour before the scheduled darshan time.
- A bar code generated at the time of registration is produced as a wristband to the pilgrim. The pilgrims' access to the temple is decided on the condition to present the wristband for appropriate (bar code) identification and verification of darshan time.

The major advantages of the proposed system are:

- There is no physical queue. There is only a virtual queue. This queue discipline is clearly and strictly FIFO. This is a fair and transparent system. The pilgrims can be anywhere in the town but still maintain their priority in the system.
- There is no uncertainty on the waiting time. There is no anxiety. The pilgrims can plan other activities to suit their specific need based on the proposed darshan time.

- The data available as a consequence of pilgrim registration process can be used to improve vehicle scheduling for return journey, plan for food and beverages, and improve cottage reservation etc.
- The biggest advantage of the new system is customer waiting time is better managed. From the TTD management point of view, the core process is taken care of. The complimentary aspects of the value chain are not constrained by resources. They are now independent and effectively managed.

## Implementation Strategy

There are several dimensions to the implementation strategy of this project. The critical aspects are listed below.

- The choice of an appropriate hardware, a procedure to compute waiting time was the core to the system. The reliability of the system was important and critical. The use of bar code, data compatibility etc. were essential.
- The wristband used in the system should be capable of printing a bar code on it. It should be machine-readable. It should be inexpensive and withstand the use and abuse of the product. Once the pilgrim started wearing the wristband they never wanted to remove it. Most of them went for bath before darshan with a wristband. Several pilgrims used to retain the wristband as a souvenir.
- The implementation strategy was gradual. Several shareholders did not understand the implications. Patient hearing, information sharing and persuasion were used to implement the revised system.
- The vendors who used to sell food and beverages at premium prices in the waiting compartments were upset because they thought they lost an important commercial opportunity and livelihood. They needed to be reassured, that the need for their service still exists. After all the pilgrims are in anyway in Tirumala. They may not now get premium price, but may have to conduct business on market price.
- The employees who managed the waiting compartments felt their power and importance is lost. They needed to be persuaded that the real power is not necessarily control based, but is derived from rendering service to pilgrims. The divine dispensation is more important than individual power positions was the core message to the employees.
- There was an argument that since the pilgrims are all over, estate management, house keeping, sanitation and law and order conditions may become challenging in the temple town. A massive education and information program was launched to manage the challenges arising out of the proposed (new) system.
- Many argued that since the pilgrims now have more time at their disposal before darshan, they may spend all their cash on shopping and social events. Therefore, the revenue to the temple (Hundi) may come down. However, by real data and monitoring it was shown that revenue to the temple did not suffer. Actually it increased by 10%. In addition, the temples nearby recorded a revenue increase of 12% as the pilgrims were moving around with peace of mind (no anxiety on darshan time) and hence they visited several nearby temples.
- The system was introduced gradually starting with 5000 wristbands a day. At every stage, feedback was obtained and necessary corrective steps implemented. Finally, when the system stabilized the old waiting line system was dispensed with.

## Learnings and Conclusion

We have documented a successful implementation of a process improvement initiative in an important real life context. This example shows several features that are common and useful in manufacturing context are equally applicable in service environment as well. The entire solution procedure evolved by a desire to be pilgrim (customer) centric rather than system oriented or resource based.

The proposed model dramatically redefined the concept of queues from manual to virtual. The revised system is information technology enabled and it addresses the principle and critical component of the value chain. The support services are insulated from consideration based on their merit for subsequent efficient management. The implementation methodology was brilliant. It was gradual. It addressed the concerns of all the stakeholders in the system. Data based approach was used to evolve new ideas and support and modify the changes made.

The pilgrim friendly new system would provide adequate data, energy and opportunity to the TTD management to fine tune the efficiency of other support systems and services. Such an effort would transform the Tirumala pilgrimage as a rewarding and enriching experience to a common man.

From a general management perspective, there are several important lessons that can be abstracted from this experience.

**Customer Centric:** The process was triggered by the desire to be customer centric and transform the waiting experience from constraint to convenience.

**Formal Methods:** Simple queuing model concepts (G / D / 1) have dramatic use and applicability in this case. This again illustrates the cardinal principle that if a problem is well formulated and identified, effective solutions would follow.

**Process orientation:** Instead of optimizing the main queuing model or formulating a detailed supply chain optimization model, the present approach is process oriented. It addressed the core issue in totality within the constraints of the context. The stakeholders concern was effectively addressed because of the process orientation.

**Use of IT:** The heart of the solution is technology enabled. The computation of waiting time, the access to the counter at various locations, the identification of pilgrims at the entrance of the temple are technology enabled. There is neither overdose of technology nor its potential untapped. This is a perfect example of blending technology and process to achieve optimal results.

**Change management:** There are three important aspects related to change management in this context. The first is change is gradual, data based, feedback oriented. The second is all stakeholders concerns were effectively addressed. The third aspect was the focus on the core issue. The combination of the three steps may well be a receipe for any successful change management initiative.

**Prioritize action areas:** Top management has clearly identified in the value chain as what segment is critical and what is core. The solution procedure addressed the main concern of waiting in the queue. The efficiency in other areas are complimentary and they can be dealt with

independently. This insulation of the main challenges from the rest is a fundamental operations research idea. The appropriateness of the solution is a consequence of this brilliant orientation.

**End Note(s)**

- The opinions and conclusions expressed in this document are solely the authors in their individual capacity. They do not represent the view of the Institution (TTD / IIMA) or Government.
- We have used indicative data for our discussion from the report by G. Raghuram and T.Madhavan. This is gratefully acknowledged.
- This article has evolved from the material used in the presentations made by Subba Rao at IIM, Ahmedabad. The article on BPR captures the spirit of the solution procedure. The basic texts on queues would add theoretical insights. The book on service industry can be used to evolve an alternate frame.
- The articles on queuing theory and waiting time experience provide a need to address this important problem. The Little's formula is inherently used in the solution procedure.

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**Fig. 1: Flow Chart of a typical pilgrim to Tirumala**