

Data-Driven Crowd Management and Demand Forecasting for Enhancing Pilgrim Safety at a Religious Organisation

Venkataramanaiah Saddikuti

Professor of Operations and Supply Chain Management
Indian Institute of Management-Lucknow
Noida Campus, Noida, Uttar Pradesh, India
svenkat@iiml.ac.in

Phanindranath Reddy Pyreddy

Indian Institute of Management Lucknow
Lucknow, Uttar Pradesh, India
ipmx19031@iiml.ac.in

Abstract

Tirumala Tirupati Devasthanams (TTD) administers one of the world's largest recurring religious gatherings, receiving on average 60,000 to 80,000 pilgrims daily and substantially higher volumes during festivals, when footfall can exceed 100,000 in a single day. Managing pilgrim movement, queue systems, and public safety at this scale is a complex operations management challenge involving uncertain demand, constrained capacity, and high service expectations. This study examines crowd management and demand forecasting at TTD through an Industrial Engineering and Operations Management lens, drawing on field practices, queue-complex data, and command-control records. The objective is to develop an integrated, data-driven framework that improves crowd estimation, queue management, force deployment, and safety planning for mass pilgrim gatherings. The approach combines operations management tools, including time-series demand forecasting (moving average, seasonal indexing, and trend projection), capacity and process-flow analysis of the Vaikuntam Queue Complex(VQC), bottleneck identification, and technology-supported real-time monitoring through an integrated command-control centre using AI-based density prediction and CCTV analytics. Zone-and-sector deployment, standardized operating procedures, and rehearsal drills are analysed as coordination mechanisms. Expected contributions include reduced pilgrim waiting time, improved staff and route planning, earlier pre-positioning of resources, and strengthened emergency preparedness, thereby lowering crowd-safety risk. The findings offer practical recommendations for temple administration, public-safety departments, and organizers of large religious and public events, demonstrating how established operations management methods can enhance service efficiency and safety in religious mass-gathering environments. The framework is transferable to comparable high-density pilgrimage and event settings worldwide.

Keywords

Crowd management, Demand forecasting, Queue management, Pilgrim safety and Operations management.