
Human Queue Management System

Nandishgouda R D¹, Prajwal Manegar², Kartik M Shiralashetti³,
Manjunath Maleppanavar⁴ and Roshan Shetty¹¹

*Department of Electronics and Communication Engineering, Alvas Institute of
Engineering & Technology, Moodbidri, Mangalore, Karnataka, India*
Emails: nandishg965@gmail.com, Prajwalmanegar8@gmail.com,
Kartikshetty170@gmail.com, maleppanavarmanju@gmail.com, roshans@aiet.org.in

Abstract.

This paper reviews recent work in the improvement of QMS by deploying different modern technologies like IoT, AI, and WSN. These queue management systems range from physical queues to sophisticated digital ones that can handle optimality of time spent waiting, enhancement of customer experience, and efficiency of services in various sectors like healthcare, banking, and public services. Further, this review examines several technological approaches applied in QMS, involving RFID-based tracking, computer vision integration, cloud-based solutions, and AI-based predictive models. The paper outlines the challenges faced in queue management, including congestion control, real-time monitoring, and adaptive routing algorithms. Further, the impact of QMS on service quality, customer satisfaction, and operational efficiency is also presented. Finally, this review concludes with future research directions and potential improvements in queue management systems, with an emphasis on the integration of emerging technologies into more intelligent and responsive queue solutions.

Keywords. Queue Management System, IoT, RFID, Computer Vision, Cloud Computing, Artificial Intelligence, Customer Experience..

1. INTRODUCTION

"Queue management" is an important part of service delivery systems in different industries such as healthcare, banking, retail, and government. The conventional system of queue management results in customer discontent, inefficient allocation of resources, and operational delays. With the emergence of technology, "queue management" has undergone a dramatic change from a traditional waiting line to an advanced digital system focusing on efficient service delivery with better customer satisfaction [1, 2].

Current Queue Management Systems (QMS) employ technology such as Internet of Things (IoT), Artificial Intelligence, Computer Vision, and Cloud Computing to provide smarter solutions for minimizing waiting time and increasing service effectiveness. QMS finds widespread application in healthcare because patient service can have a direct impact influence both service quality and outcomes for individual patients [3], [4]. The

combination of RFID technology with computer vision, as exemplified in Paraiso et al., facilitates real-time tracking and dynamic routing of customers in order to improve queuing efficiency and alleviate waiting times [1].

2. TECHNOLOGICAL FOUNDATIONS OF QUEUE MANAGEMENT SYSTEMS

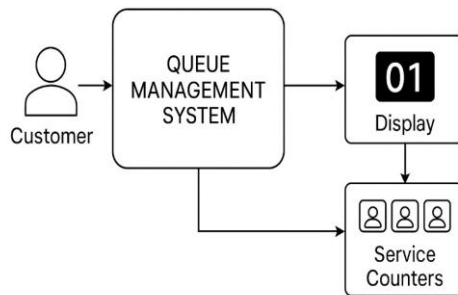


Figure 2.1. Typical Architecture of a Modern Queue Management System

The QMS is highly advanced today as compared to the original walk-in line waiting process. Queue Management Systems are technologically advanced and employ many technological features. We will categorize the technology-oriented QMS into the following seven categories: IoT-featured QMS, RFID technology utilization, computer vision usage, cloud computing solutions, and artificial intelligence solutions.

IoT-based QMS utilize sensor networks and connected devices to track queue status in real-time. These systems usually utilize wireless sensor networks (WSN) to find out how customers are moving, and how long queues are, so that service resources can be dynamically recalibrated [1], [6]. In addition, the interoperability provided by the MQTT (Message Queueing Telemetry Transport) protocol allows system parts to communicate easily, allowing for reliable data transmission and processing [1]. IoT solutions have shown major improvements in the efficiency of queues, and they have been more successful in healthcare when seen through the lens of effective patient flow management [6].

3. METHODOLOGIES

Queue management systems use various strategies and approaches to allow the provision of service delivery and enhanced customer experience. Broadly these can be categorized into the following approaches: traditional queue management; technology based queue management and other hybrids, which may incorporate elements from multiple strategies.

1.1. A. Traditional Queue Management Techniques

Standard queue management methods mainly use physical organization of queues and basic scheduling rules. Standard queue management systems such as first-come-first-served (FCFS) systems, priority-based queuing systems, and similar multi-server queue systems use simple queue bay design. While these approaches are straightforward to employ, traditional queue management concepts have limited capability of operational efficiency and customer satisfaction when facing dynamic flows of customers and variable service times [3], [9].

Queueing theory has established a rigorous mathematical underpinning for the analysis and optimization of traditional queue systems. They find their application in modeling queue systems and optimizing resource usage, such as M/M/1-a single server and M/M/c-a multiserver. However, all of these theoretical models are based on simplifying assumptions that cannot hold in real-world scenarios and hence limit their effectiveness in practice.

1.2. B. Technology-Enabled Queue Solutions

Recent developments in technology have enabled increasingly sophisticated ways of managing queues. As described by Paraiso et al., RFID-based systems make use of a dynamic source routing algorithm that assists in guiding customers through queues and hence reduces waiting time [1]. In an RFID-based queue management system, RFID tracking is integrated with computer vision for queue monitoring and management.

The second most important technological advantage comes from cloud-based queue management systems. A cloud-based system, such as AQyu, offers generic queue management with functionality through mobile applications, Web applications, and the ability for customers to join a queue remotely and get real-time status updates according to. REST APIs generally integrate the systems in cloud queue management platforms and utilize a cloud database for storing data that can be scaled.

1.3. Mobile queuing is becoming common, especially in healthcare contexts. With a mobile application, the patients can take a place in queues from any other location by being informed of wait times and notifications that they are about to reach the front. This approach reduces the time spent physically queuing and enhances patient satisfaction significantly.

1.4. C. AI-Powered Queue Optimization

New technologies enabled by artificial intelligence are providing sophisticated options for queue management. Machine learning algorithms are now able to model queue lengths and waiting times based on historical patterns, alongside real-time data [5]. Predictive models can be used to allocate resources through recognizing variances in demand requiring change in service capacity.

Reinforcement learning has also been used in queue management issues where systems can continually learn optimal routing policies that consider the ongoing interaction with the service environment [7]. These adaptive systems are dynamic and perform optimally based on contingent feedback.

REFERENCES

- [1] C. J. C. Paraiso, M. J. A. Mejia, M. D. P. Pagatpatan, C. K. A. Remo, and J. V. Apan, "Design of an rfid-based smart queueing system integrated with computer vision utilizing dynamic source routing algorithm," in *TENCON 2024 - 2024 IEEE Region 10 Conference (TENCON)*, 2024, pp. 649–652.
- [2] E. D. Handoyo, S. Santoso, and D. J. Surjawan, "A-qyu general purpose cloud-based queue management," in *2023 1st IEEE International Conference on Smart Technology (ICE-SMARTec)*, 2023, pp. 178–183.
- [3] S. Abdul Halim, M. Othman, A. G. Buja, N. Rashid, A. Sharip, and S. Zain, "C19-smartq: Applying real-time multi-organization queueing management system using predictive model to maintain social distancing," *International Journal of Interactive Mobile Technologies (IJIM)*, vol. 15, p. 108, 03 2021.
- [4] M. Ghazal, R. Hamouda, and S. Ali, "An iot smart queue management system with real-time queue tracking," *2015 Fifth International Conference on e-Learning (econf)*, pp. 257–262, 2015. [Online]. Available: <https://api.semanticscholar.org/CorpusID:34558152>
- [5] C. Nwogu, U. Nwaiwu, E. Ukachukwu, and V. Udo, "Development of queue management model for effective service delivery in automobile repair shops," *Nigerian Journal of Technology*, vol. 42, pp. 339–346, 09 2023.
- [6] P. N. Titarmare and P. A. Yerlekar, "A survey on patient queue management system," *International Journal of Advanced Engineering, Management and Science*, vol. 4, no. 4, 4 2018.
- [7] E. Guarte, F. Elsayed, and S. Khalil, "Effect of queue management system on quality of nursing care and patient satisfaction," *Benha Journal of Applied Sciences*, vol. 7, pp. 181–192, 04 2022.
- [8] J. Ndiaye, O. Sow, Y. Traore, M. Diop, A. Faye, and A. Diop, "Electronic system using artificial intelligence for queue management," *Open Journal of Applied Sciences*, vol. 12, pp. 2019–2036, 01 2022.

Biographies



Name : Nandishgouda R D
USN : 4AL22EC052
Email : nandishg965@gmail.com
Mobile : 8123265329

Areas of Interest: He is currently pursuing a Bachelor's degree in Electronics and Communication Engineering at Alva's Institute of Engineering and Technology (AIET), affiliated with Visvesvaraya Technological University (VTU) in Karnataka. His academic journey reflects a strong interest in core and emerging electronics domains such as PCB Desing, Embedded Systems, VLSI Design, Digital Signal Processing (DSP), Microcontrollers, and Semiconductor Devices.



Name : Prajwal N Manegar
USN : 4AL22EC063
Email : prajwalmanegar8@gmail.com
Mobile : 7975068207

Areas of Interest: He is currently pursuing a Bachelor's degree in Electronics and Communication Engineering at Alva's Institute of Engineering and Technology (AIET), affiliated with Visvesvaraya Technological University (VTU) in Karnataka. His academic path portrays a passion for traditional and upcoming domains in electronics such as Embedded Systems, VLSI Design, Digital Signal Processing, Microcontrollers, Wireless Communications, and Semiconductor Devices.



Name : Kartik M Shiralashetti
USN : 4AL23EC402
Email : kartikshetty170@gmail.com
Mobile : 900875822

Areas of Interest: He is currently pursuing a Bachelor's degree in Electronics and Communication Engineering at Alva's Institute of Engineering and Technology (AIET), affiliated with Visvesvaraya Technological University (VTU) in Karnataka. His academic journey reflects a strong interest in core and emerging electronics domains such as Embedded Systems, VLSI Design, Digital Signal Processing (DSP), Microcontrollers, Wireless Communication and Semiconductor Devices.



Name : Manjunath Maleppanavar
USN : 4AL23EC403
Email : maleppanavarmanju@gmail.com
Mobile : 8861390393

Areas of Interest: He is currently pursuing a Bachelor's degree in Electronics and Communication Engineering at Alva's Institute of Engineering and Technology (AIET), affiliated with Visvesvaraya Technological University (VTU) in Karnataka. His academic path portrays a passion for traditional and upcoming domains in electronics such as Embedded Systems, VLSI Design, Digital Signal Processing, Microcontrollers, Wireless Communications, and Semiconductor Devices.



Name : Roshan Shetty
Designation : Associate Professor (Project Guide)
Email ID : roshans@aiet.org.in
Mobile Number : 9538176004

Areas of Interest : As a Associate professor in the Department of Electronics and Communication Engineering at Alva's Institute of Engineering and Technology (AIET), affiliated with Visvesvaraya Technological University (VTU) in Karnataka.