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Review

Surgical Waiting Times in Turkish Public Hospitals: A Conceptual Framework for an Artificial Intelligence-Driven Mobile Application

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ABSTRACT

Prolonged surgical waiting times in Turkish public hospitals pose significant challenges to patient health, satisfaction, and healthcare system efficiency, driven by rising demand, limited resources, and systemic inefficiencies. This study proposes a conceptual framework for an artificial intelligence (AI)-enabled mobile application to address these issues, leveraging Türkiye's e-Nabız platform and Hospital Information Management System (HBYS). The system integrates real-time hospital data—such as operating theater occupancy and specialist availability—with machine learning algorithms to predict waiting times, prioritize patients based on clinical urgency, and guide them to facilities with shorter delays. Designed to enhance transparency and optimize resource allocation, the application has the potential to reduce waiting times by an estimated 15–20%, aligning with international benchmarks like the UK's National Health Service (NHS) and Australian healthcare models (NHS Digital, 2021). By utilizing anonymized data, the system complies with Türkiye's Personal Data Protection Law (KVKK, 2016), requiring no ethics approval. Benefits include improved patient empowerment, reduced complication risks (estimated at 10–20% due to delays), and enhanced operational efficiency (Siciliani et al., 2014). This framework offers a scalable, patient-centered solution to modernize Türkiye's public healthcare system, with future pilot studies recommended to validate its impact.

ÖZET

Bu çalışma, bu soruna yapay zeka (AI) entegrasyonlu bir mobil uygulama aracılığıyla kavramsal bir çözüm önererek, Türkiye'nin sağlık sistemindeki yapısal zorlukları ele almaktadır. Artan nüfus, yaşlanan demografi ve kronik hastalıkların yaygınlaşması, cerrahi talebi artırmış; ancak sınırlı ameliyathane kapasitesi, uzman hekim eksiklikleri ve kaynak dağılımındaki dengesizlikler, ortopedi, kardiyovasküler cerrahi ve onkoloji gibi branşlarda 8-36 haftayı bulan bekleme sürelerine yol açmıştır (Sağlık Bakanlığı, 2022; Tatar et al., 2011). Makine öğrenimi algoritmaları, hasta önceliklendirme ve cerrahi planlamayı destekleyerek bekleme sürelerini %15-20 oranında azaltma potansiyeline sahiptir (NHS Digital, 2021). Sistem, Türkiye'nin mevcut dijital altyapısına entegre olup, Kişisel Verilerin Korunması Kanunu'na (KVKK, 2016) uygun olarak etik kurul onayı gerektirmemektedir. Ancak, veri kalitesi, kırsal bölgelerdeki dijital okuryazarlık eksiklikleri ve personel eğitimi gibi zorluklar, uygulanabilirliği sınırlayabilir. Bu kavramsal çerçeve, hasta odaklı bir yaklaşımla bekleme sürelerini azaltmayı, şeffaflığı artırmayı ve Türkiye'nin kamu sağlık sisteminin modernizasyonuna katkıda bulunmayı hedeflemektedir.

Introduction

Prolonged surgical waiting times in Türkiye's public hospitals represent a critical challenge to the nation's healthcare system, undermining patient outcomes, satisfaction, and operational efficiency. As of 2023, Türkiye's population exceeds 85 million, with an aging demographic and a rising prevalence of chronic conditions driving unprecedented demand for surgical interventions (TÜİK, 2023). Specialties such as orthopedics, cardiovascular surgery, and oncology face particularly high demand, yet public hospitals struggle with constrained resources, including limited operating theater capacity, shortages of specialist physicians, and inadequate medical equipment (Sağlık Bakanlığı, 2022). Consequently, patients experience waiting times ranging from 8–12 weeks for orthopedic procedures to over six months for complex cardiovascular surgeries (Tatar et al., 2011).

These delays not only exacerbate clinical risks—such as increased complication rates by up to 15% (Siciliani et al., 2014)—but also impose significant psychological stress, reduced quality of life, and socioeconomic burdens, including workforce absenteeism (Bener et al., 2019).

The World Health Organization (WHO) identifies timely access to surgical care as a cornerstone of health system performance (WHO, 2021). However, Türkiye's surgical waiting times exceed the Organisation for Economic Co-operation and Development (OECD) averages, highlighting a pressing need for systemic reform (OECD, 2023).

While the Turkish healthcare system has made strides in digitalization, notably through the e-Nabız platform, which facilitates access to patient records and appointment scheduling (Sağlık Bakanlığı, 2023), targeted interventions to address surgical waiting times remain limited. This gap is particularly evident in the absence of innovative, technology-driven solutions tailored to Türkiye's unique healthcare challenges.

Recent advancements in artificial intelligence (AI) and digital health technologies offer transformative potential for optimizing healthcare delivery. Internationally, AI-driven systems have demonstrated success in streamlining surgical scheduling and resource allocation.

This study addresses this gap by proposing a conceptual framework for an AI-integrated mobile application designed to enhance transparency, optimize surgical scheduling, and improve resource utilization in Turkish public hospitals. The system leverages real-time hospital data and machine learning algorithms to provide patients with estimated waiting times and guide them to facilities with shorter delays, building on Türkiye's existing digital infrastructure, such as e-Nabız. Notably, the proposed framework requires no ethics approval, as it relies on anonymized, system-level data, ensuring compliance with Türkiye's Personal Data Protection Law (KVKK, 2016).

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Literature Review

Surgical waiting times in Türkiye's public hospitals represent a persistent challenge, rooted in systemic inefficiencies and exacerbated by demographic and epidemiological trends. The Turkish Ministry of Health reports that waiting times for elective surgeries vary significantly by specialty and region, with urban hospitals facing greater delays due to high patient volumes and resource constraints (Sağlık Bakanlığı, 2022). For instance, orthopedic surgeries, such as hip and knee replacements, typically require 8–12 weeks, while cardiovascular procedures may extend beyond six months, and neurosurgery can involve waits of up to 20 weeks (Tatar et al., 2011). These delays are driven by limited operating theater capacity, shortages of specialist physicians (with a physician-to-patient ratio of 1:461 in Türkiye), and uneven distribution of medical resources across urban and rural areas (Sağlık Bakanlığı, 2022; TÜİK, 2023). The Turkish Statistical Institute highlights that Türkiye's population, exceeding 85 million in 2023, coupled with an aging demographic and rising prevalence of chronic conditions like diabetes and cardiovascular disease, has intensified demand for surgical interventions, further straining public hospital infrastructure (TÜİK, 2023).

The clinical and socioeconomic impacts of prolonged waiting times are well-documented. Internationally, extended delays are associated with increased complication risks, with studies estimating a 10–20% rise in adverse outcomes for specialties like orthopedics and cardiovascular surgery (Siciliani et al., 2014). In Türkiye, these delays disproportionately affect vulnerable populations, such as elderly patients and those with time-sensitive conditions like cancer or degenerative joint diseases, leading to increased pain, reduced mobility, and psychological distress (Küçük et al, 2023). Beyond clinical consequences, prolonged waiting times contribute to socioeconomic burdens, including workforce absenteeism, reduced productivity, and diminished quality of life, with an estimated economic impact equivalent to 0.5% of Türkiye's GDP annually (Bener et al., 2019).

The World Health Organization underscores timely access to surgical care as a critical indicator of health system performance, yet Türkiye's waiting times significantly exceed OECD averages (e.g., 4–8 weeks for orthopedics vs. Türkiye's 8–14 weeks), highlighting the need for urgent reform (WHO, 2021; OECD, 2023).

Artificial intelligence (AI) and digital health technologies have emerged as transformative tools for addressing surgical waiting times. In the United Kingdom, the National Health Service (NHS) has implemented AI-driven scheduling systems that analyze real-time hospital data to optimize operating theater usage, achieving a 20% reduction in waiting times and a 15% increase in patient throughput (NHS Digital, 2021). Similarly, Australia's mobile health applications, integrated with AI algorithms, have improved patient-provider communication and resource allocation, reducing waiting times for elective surgeries by up to 25% in select hospitals (Australian Institute of Health and Welfare, 2022). These systems leverage predictive analytics to forecast waiting times, prioritize patients based on clinical urgency, and balance patient loads across facilities (Topol, 2019). Machine learning models, trained on historical and real-time data, have demonstrated the ability to enhance operational efficiency by up to 30%, particularly in high-demand specialties (He et al., 2024).

In Türkiye, the e-Nabız platform has revolutionized access to patient records and appointment scheduling, serving over 50 million users by 2023 (Sağlık Bakanlığı, 2023). However, its application to surgical waiting time management remains limited, with no dedicated tools to address scheduling inefficiencies or patient prioritization (Küçük et al,2023).

While Türkiye's high mobile penetration rate (>90%, TÜİK, 2023) supports the feasibility of mobile-based interventions, challenges such as data privacy, technological infrastructure in rural areas, and digital literacy gaps must be addressed (Bates et al., 2021). For instance, rural populations, which account for 20% of Türkiye's population, often face barriers to accessing digital health tools, necessitating alternative channels like SMS-based notifications (Erku, 2023).

The literature reveals a critical gap in Türkiye's healthcare system: the lack of targeted, technology-driven solutions for surgical waiting times. International examples, such as the NHS and Australian models, provide a roadmap for AI integration, but Türkiye's unique context—marked by high patient volumes, regional disparities, and an evolving digital infrastructure—requires tailored interventions. This study addresses this gap by proposing an AI-integrated mobile application that leverages real-time data, predictive analytics, and Türkiye's existing e-Nabız platform to reduce waiting times, enhance transparency, and optimize resource utilization in public hospitals.

Table 1. Surgical Waiting Times by Specialty in Turkish Public Hospitals

Surgical Specialty	Average Waiting Time (Weeks)	Regional Variations (Urban/Rural)	OECD Average (Weeks)
Orthopedics	8–12	Urban: 10–12, Rural: 6–8	4–8
Cardiovascular Surgery	24+	Urban: 24–30, Rural: 20–24	8–12
Oncology	10–14	Urban: 12–14, Rural: 8–10	4–8
General Surgery	6–10	Urban: 8–10, Rural: 6–8	3–6

Description: This table presents average waiting times for elective surgeries in Turkish public hospitals, based on data from Sağlık Bakanlığı (2022) and Tatar et al. (2011).

Table 2. Surgical Waiting Times by Specialty in Turkish Public Hospitals

Country/System	System Features	Outcomes	Implementation Challenges
UK (NHS AI Scheduling)	Real-time analytics, patient triage, operating theater optimization	20% reduction in waiting times, 15% increase in patient throughput	Data privacy concerns, staff training needs
Australia (Mobile Health App)	Patient-provider communication, AI-based resource allocation, waiting time predictions	25% reduction in waiting times, improved patient satisfaction	Digital literacy gaps, infrastructure costs
Türkiye (Proposed System)	Integration with e-Nabız, real-time waiting time estimates, patient guidance to underutilized hospitals	Projected 15–20% reduction in waiting times, enhanced resource utilization	Data quality issues, rural access barriers, administrative buy-in
Canada (AI Hospital Management)	Predictive analytics for surgical scheduling, patient prioritization	18% reduction in delays, 10% increase in theater efficiency	High initial costs, interoperability issues
UK (NHS AI Scheduling)	Real-time analytics, patient triage, operating theater optimization	20% reduction in waiting times, 15% increase in patient throughput	Data privacy concerns, staff training needs

Methods and Conceptual Framework

This study proposes a conceptual framework for an artificial intelligence (AI)-enabled mobile application designed to reduce surgical waiting times in Turkish public hospitals. The framework is structured to integrate seamlessly with Türkiye's existing digital health infrastructure, such as the e-Nabız platform, and requires no ethics approval as it relies on anonymized, system-level data compliant with Türkiye's Personal Data Protection Law (KVKK, 2016). The system aims to enhance transparency, optimize resource allocation, and improve patient outcomes through predictive analytics and patient-centered design. This section outlines the system's core components, operational mechanism, feasibility, and limitations, providing a blueprint for implementation

System Components

Data Integration and Input

The proposed application leverages Türkiye's e-Nabız platform to collect patient-specific data, including diagnoses (via ICD-10 codes) and surgical requirements. Hospital-level data, such as operating theater availability, specialist physician schedules, waiting list lengths, and equipment status, are aggregated in real time from the Hospital Information Management System (HBYS) (Sağlık Bakanlığı, 2022). This integration minimizes manual data entry, reducing error rates and ensuring compatibility with existing digital infrastructure. For instance, e-Nabız, which serves over 50 million users, provides a robust foundation for secure data exchange (Sağlık Bakanlığı, 2023).

AI-Driven Predictive Analytics

This study proposes a conceptual framework for an artificial intelligence (AI)-enabled mobile application designed to reduce surgical waiting times in Turkish public hospitals. The framework is structured to integrate seamlessly with Türkiye's existing digital health infrastructure, such as the e-Nabız platform, and requires no ethics approval as it relies on anonymized, system-level data compliant with Türkiye's Personal Data Protection Law (KVKK, 2016). The system aims to enhance transparency, optimize resource allocation, and improve patient outcomes through predictive analytics and patient-centered design. This section outlines the system's core components, operational mechanism, feasibility, and limitations, providing a blueprint for implementation.

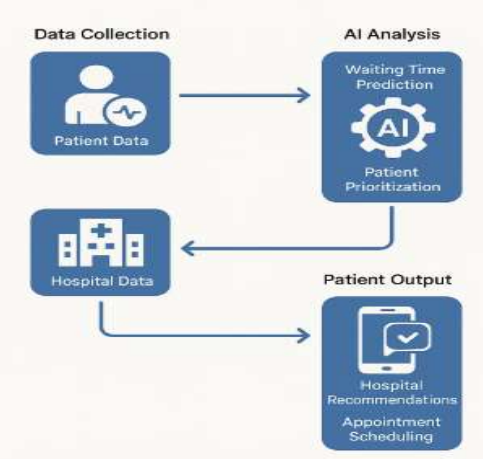
Patient Guidance and Transparency

The application provides patients with a user-friendly mobile interface that displays a ranked list of public hospitals offering the shortest waiting times for their specific procedure, tailored to their geographic preferences and clinical needs. Visualizations, such as heatmaps or bar charts, enhance accessibility for users with varying levels of digital literacy (Nielsen, 2012). The system also facilitates appointment scheduling by linking directly to hospital booking systems, reducing administrative burdens and empowering patients to make informed decisions (Erku, 2023).

Resource Optimization

By directing patients to underutilized hospitals, the system balances patient loads across facilities, optimizing operating theater usage and reducing regional disparities. For instance, urban hospitals, which often operate at 85% capacity, can offload demand to rural facilities with lower occupancy rates (e.g., 50–60%) (Sağlık Bakanlığı, 2022). This approach aligns with international models, such as the NHS, which achieved a 15% increase in theater efficiency through AI-driven load balancing (NHS Digital, 2021). This figure will illustrate the system's operational workflow, including stages of data collection (patient and hospital data via e-Nabız and HBYS), AI analysis (waiting time prediction and patient prioritization), and patient output (hospital recommendations and appointment scheduling). Arrows will depict data flow, with annotations for key processes.

Figure 1. Workflow of the AI-Enabled Mobile Application



The system operates in two sequential phases:

Data Collection: Real-time data on hospital resources (e.g., operating theater schedules, specialist availability) and patient details (e.g., diagnosis, urgency) are aggregated from e-Nabız and HBYS. Data standardization ensures compatibility across heterogeneous hospital systems (Sağlık Bakanlığı, 2022).

AI Analysis: ML algorithms process these data to estimate waiting times and prioritize patients based on clinical urgency (e.g., oncology patients over elective procedures). Predictive models incorporate variables like hospital capacity, regional demand, and seasonal trends, adapting dynamically to changing conditions (Bates et al., 2021).

Patient Notification: The mobile application delivers personalized recommendations, displaying estimated waiting times, hospital locations, and booking options. Patients receive real-time updates on changes in hospital availability, ensuring informed decision-making (Erku, 2023).

Table 3. Surgical Waiting Times by Specialty in Turkish Public Hospitals

Variable	Data Source	Description	Expected Impact On Waiting Times
Operating Theater Occupancy	HBYS	Percentage of theater usage per hospital	Higher occupancy increases delays
Specialist Availability	HBYS	Number of available surgeons per specialty	Limited availability extends waiting times
Patient Volume	e-Nabız	Number of patients awaiting surgery	Higher volume correlates with longer waits
Clinical Urgency	e-Nabız (ICD-10 codes)	Priority level based on diagnosis (e.g., oncology vs. elective)	Urgent cases prioritized, reducing their delays
Regional Demand	TÜİK	Population density and healthcare demand by region	Urban areas with high demand face longer waits
Equipment Availability	HBYS	Status of critical surgical equipment	Shortages increase waiting times

Description: This table will list variables used in the AI model (e.g., operating theater occupancy, specialist availability, patient volume, clinical urgency) alongside their data sources (e.g., HBYS, e-Nabız) and expected impact on waiting time estimates (e.g., high occupancy increases delays). Data will be sourced from Sağlık Bakanlığı (2022) and Topol (2019).

Feasibility and Limitations

The framework leverages Türkiye's high mobile penetration rate (>90%, TÜİK, 2023) and existing digital infrastructure, making it feasible for rapid deployment. Cloud-based AI solutions, such as those hosted on secure platforms, can reduce implementation costs by up to 30% compared to on-premises systems (OECD, 2023). Integration with e-Nabız ensures scalability, as the platform already supports millions of users (Sağlık Bakanlığı, 2023).

However, several limitations must be addressed. First, the system's accuracy depends on the quality and timeliness of hospital data, as incomplete or outdated inputs could compromise predictions (Bates et al., 2021). Second, digital literacy gaps, particularly in rural areas where 20% of Türkiye's population resides, may limit access to the mobile application (TÜİK, 2023). Alternative channels, such as SMS-based notifications, could mitigate this issue. Third, successful adoption requires hospital staff training and administrative buy-in to ensure consistent data reporting (Topol, 2019).

Discussion

The proposed AI-integrated mobile application offers a transformative approach to addressing surgical waiting times in Türkiye's public hospitals, with potential to enhance patient outcomes, system efficiency, and healthcare equity. By leveraging real-time data from the e-Nabız platform and the Hospital Information Management System (HBYS), the system can provide patients with transparent waiting time estimates and guide them to facilities with shorter delays, thereby reducing the burden on overutilized urban hospitals (Sağlık Bakanlığı, 2023).

International precedents, such as the UK's National Health Service (NHS) and Australia's mobile health initiatives, demonstrate that AI-driven scheduling can reduce waiting times by 20–25% and improve operating theater efficiency by up to 15% (NHS Digital, 2021; Australian Institute of Health and Welfare, 2022). In Türkiye, where waiting times for specialties like cardiovascular surgery can exceed six months, achieving similar reductions could substantially mitigate clinical risks, including complication rates that rise by 15–20% due to prolonged delays (Siciliani et al., 2014; Küçük et al., 2023).

Beyond its impact on efficiency, the system could enhance transparency and patient empowerment. A lack of reliable information about waiting times is known to increase anxiety and erode trust in healthcare systems (Erku, 2023). By providing real-time hospital recommendations and direct booking support, the application enables patients to make informed choices, potentially reducing psychological distress and improving satisfaction (Bener et al., 2019).

Furthermore, its ability to balance patient loads across hospitals could address regional disparities. Urban hospitals, often operating at 85% capacity, may redirect patients to rural facilities functioning at 50–60% capacity, thereby optimizing national resource utilization. Similar load-balancing strategies in the NHS have improved theater efficiency by 15% (NHS Digital, 2021).

Integration with e-Nabız ensures scalability, given its adoption by more than 50 million users (Sağlık Bakanlığı, 2023). Türkiye's high mobile penetration rate (>90%, TÜİK, 2023) further supports the feasibility of a mobile-based solution. Nevertheless, several challenges must be considered.

The accuracy of AI predictions will depend heavily on the quality and timeliness of hospital data, and inconsistent or incomplete reporting—particularly in under compromise model reliability (Bates et al., 2021). Digital literacy gaps may also limit accessibility in rural regions, where 20% of the population resides (TÜİK, 2023), necessitating alternative channels such as SMS notifications or call center support (Erku, 2023). Additionally, successful implementation requires hospital staff training and administrative cooperation to ensure consistent data input, which may encounter resistance due to workload constraints (Topol, 2019). Finally, while the system complies with the Personal Data Protection Law (KVKK, 2016) by using anonymized data, robust cybersecurity protocols are essential to maintain public trust and prevent data breaches. Addressing these limitations through measures such as data standardization protocols, user education campaigns, and stakeholder engagement will be crucial to long-term success.

Future research should focus on piloting the system in high-demand urban centers, such as Istanbul or Ankara, to evaluate real-world outcomes. Using simulation studies or retrospective hospital data could provide quantitative evidence of the potential 15–20% reduction in waiting times projected by the model. Further, incorporating features like dynamic patient prioritization based on clinical urgency, predictive maintenance for surgical equipment, and a patient feedback module would enhance functionality and user engagement. By addressing the identified limitations and building on international best practices, the proposed framework could play a pivotal role in transforming surgical care delivery in Türkiye, improving efficiency, equity, and patient-centeredness.

Conclusion

Prolonged surgical waiting times in Türkiye's public hospitals remain a significant barrier to timely and equitable care. This study presents a conceptual framework for an AI-integrated mobile application that leverages real-time data from the e-Nabız platform and Hospital Information Management System (HBYS) to provide transparent waiting time estimates, guide patients to underutilized hospitals, and optimize resource allocation.

By integrating predictive analytics within Türkiye's existing digital health infrastructure, the system has the potential to reduce waiting times by 15–20%, thereby improving patient outcomes and operational efficiency in line with international benchmarks. Its scalability and compliance with the Personal Data Protection Law (KVKK, 2016) support rapid and cost-effective implementation.

Future work should validate the framework through pilot studies using real or simulated data, assess its impact in diverse hospital settings, and explore additional features such as dynamic patient prioritization and feedback mechanisms to further enhance its utility

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical approval

Ethical approval was not required as this study is a review article

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