

FULLY DIGITALIZED WORKFLOW IN DENTAL MEDICINE SERVICES: A MANAGERIAL PERSPECTIVE FOR MODERN ORAL HEALTH CARE

Dana Emanuela PITIC (COȚ)¹, Andreea Mihaela KIS^{1*}, Ramona Amina POPOVICI¹, Laria-Maria TRUȘCULESCU¹, Adina Feier (TIULEA)¹, Georgeta POPOVICI², Marius CIUTAN², Laura Diana POPOVICI³, Malina POPA⁴

¹Department I of Management and Communication in Dentistry, Faculty of Dentistry, "Victor Babeș" University of Medicine and Pharmacy Timișoara, Eftimie Murgu Square. 300041 Timișoara, Romania

dana.pitic@umft.ro, kis.andreea@umft.ro,

ramona.popovici@umft.ro, laria.trusculescu@umft.ro,

adina.feier@umft.ro

²National Institute of Health Services Management, Bucharest, Romania gpopovici@inmss.ro

³Student "Victor Babeș" University of Medicine and Pharmacy of Timișoara, Faculty of Medicine

⁴Department II, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy Timișoara, Eftimie Murgu Square. 300041 Timișoara, Romania

popa.malina@umft.ro

* Corresponding author Kis Andreea Mihaela - Department I of Management and Communication in Dental Medicine, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy Timișoara, Eftimie Murgu Square. 300041 Timișoara, Romania, kis.andreea@umft.ro

INTRODUCTION

Digital transformation in healthcare, accelerated by technological progress and post-pandemic pressure for efficiency, has become a strategic priority for modern medical systems. In dental medicine, digitalization is no longer a marginal process but an essential component of both clinical and economic management of practices [1]. The evolution from analog methods to fully digital workflows has redefined standards of precision, efficiency, and clinical communication [2,3]. The transition from analog techniques—based on physical impressions, gypsum models, and traditional laboratory collaboration—to fully digital workflows marks a paradigm shift. From a managerial standpoint, this transition involves reconfiguring internal processes, redefining professional roles, and making significant investments in equipment, training, and IT infrastructure. In the context of increased competition, rising patient expectations, and pressure to maintain quality and profitability, digitalization becomes a strategic differentiation tool.

The purpose of this article is to analyze the impact of a fully digital workflow on the managerial performance of dental practices and to identify directions for sustainable and efficient implementation.

The digitalization of dental medicine services represents one of the most significant transformations in oral health over the past decade. This article explores, from a managerial perspective, how the implementation of a fully digital workflow influences operational efficiency, the quality of medical services, and the economic sustainability of dental practices. The analysis is based on a comparative study between traditional and digital methods for single-unit prosthetic restorations, focusing on parameters such as treatment duration, accuracy, patient satisfaction, and implementation costs. The results show that the digital workflow significantly reduces working time and increases predictability but requires substantial initial investments and a well-grounded managerial strategy. The integration of digitalization in dental medicine is not only a technological change but also an organizational one, redefining the relationships between time, resources, and patient-perceived value.

CONTEXT AND OBJECTIVES

The digital transformation of medical services represents one of the key strategic directions of contemporary healthcare management. In dental medicine, the integration of fully digitalized workflows—from intraoral scanning to computer-aided restoration manufacturing—redefines clinical efficiency, patient experience, and organizational sustainability. The aim of this paper is to evaluate, from both clinical and managerial perspectives, the impact of implementing a fully digitalized workflow in dental practice compared with traditional methods.

MATERIALS AND METHODS

The study was conducted in an urban dental practice using a fully integrated CAD/CAM technology (intraoral scanner, design software, and CAM milling unit). Two groups of patients (n=20) were compared: 10 treated using a complete digital workflow and 10 using conventional methods. Indicators of clinical efficiency (treatment duration, occlusal adjustments), technical quality (marginal fit), and patient satisfaction (standardized questionnaire) were analyzed.

RESULTS

The complete digital workflow significantly reduced treatment time (1 visit vs. 2–3 conventional visits) and the number of occlusal adjustments. Patient satisfaction was higher in the digital group, due to procedural comfort and active participation in the treatment plan. From an organizational perspective, digitalization improved documentation, traceability, and interprofessional communication, contributing to operational efficiency and ecological sustainability.

CONCLUSIONS

The adoption of a fully digitalized workflow in dental medicine is not merely a technological innovation but a strategic transformation of dental services management. The benefits regarding efficiency, clinical quality, and patient satisfaction justify the expansion of this model, provided that implementation is sustainable and supported by continuous staff training.

Keywords: digitalization, dental medicine, healthcare management, CAD/CAM workflow, clinical efficiency, sustainability

OBJECTIVE

The main objective is to evaluate the managerial benefits and challenges associated with adopting a fully digitalized workflow in dental practice.

The research aims to:

- Optimize treatment duration and efficient use of human resources;
- Increase patient satisfaction and loyalty;
- Reduce operational errors through the standardization of digital processes;

- Identify the economic and organizational limitations of implementation.

From a healthcare management perspective, digitalization can be viewed as a form of disruptive innovation [4], capable of transforming service delivery and redefining the cost–benefit ratio in a modern dental practice.

THE CONTEXT OF DIGITALIZATION IN DENTAL MEDICINE

Digitalization gradually entered dental medicine starting in the 1980s with the introduction of CAD/CAM (Computer-Aided Design / Computer-Aided Manufacturing) technologies. These enabled the computer-aided design and fabrication of dental restorations, reducing dependence on manual processes and improving precision. Today, the complete digital workflow—including intraoral scanning, CAD design, CAM fabrication, and same-day cementation—is an emerging standard in modern clinics [5]. Beyond clinical advantages, digitalization provides managers with tools for cost control, productivity monitoring, and patient satisfaction analysis.

However, the adoption of digital technologies remains uneven. Large urban clinics and private chains invest more easily in equipment, while individual practices face financial and training barriers. This discrepancy highlights the need for strategic management of the digital transition.

MATERIAL AND METHOD

The study underlying this article compared two methods for creating single-unit prosthetic restorations: the traditional (analog) method and the fully digital method. The sample included 20 patients, divided equally into two groups:

- **Digital group:** complete in-office CAD/CAM workflow (scanning, designing, milling, and cementation during the same visit).

Traditional group: analog workflow based on conventional impressions, gypsum models, and collaboration with an external dental laboratory [6].

Patient selection was based on objective clinical criteria, without discrimination regarding gender, socioeconomic status, or age (within protocol limits). No participant was excluded for non-medical reasons. Patients were informed that participation would not affect their therapeutic relationship with the clinician, and refusal would not result in any negative consequences.

The research process was conducted in accordance with fundamental ethical principles: respect for persons, confidentiality, equity, and clinical safety. Transparency and accountability were maintained, ensuring that data collection protected the interests and dignity of participants.

For the digital group, the workflow included:

Intraoral scanning with a **Medit i700** scanner (Figure 1);

Figure 1 – Medit i700 Intraoral Scanner



- CAD design using **Exocad** software;
- CAM fabrication with the **CEREC Primemill** system (Figure 2);

Figure. 2 – CAM System – CEREC Primemill



- Definitive cementation during the same clinical session.

For the traditional group, conventional impressions and external lab collaboration were used. Participation in the study involved no additional costs for patients and did not negatively affect treatment quality. In both groups, restorations were performed according to good clinical practice standards. The choice of method depended on technological availability but did not affect therapeutic indication. In case of inconsistencies or technical errors in the digital process (e.g., incomplete scans or insufficient adaptation), corrective actions were taken immediately at no cost to the patient.

The following clinical and managerial performance indicators were analyzed: total treatment duration (measured by direct timing), number of occlusal adjustments (recorded at final placement), patient satisfaction (Likert-scale questionnaire, score 0–10), restoration accuracy, and data archiving potential.

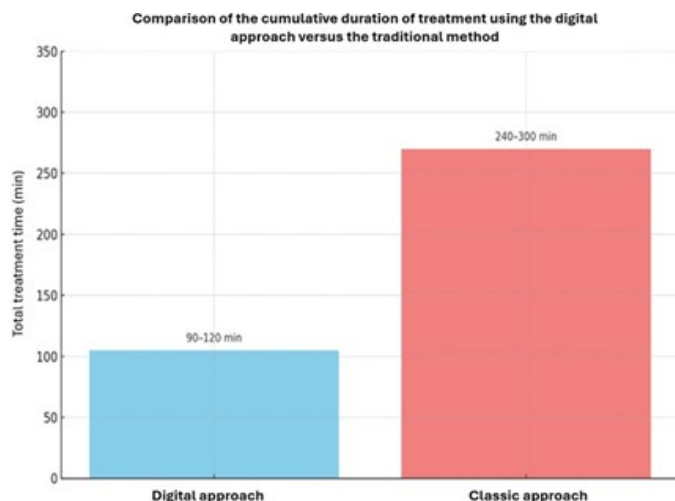
Data were analyzed descriptively and comparatively, evaluating their impact on working time, operational costs, and return on investment.

RESULTS

The results revealed clear advantages of the fully digital workflow:

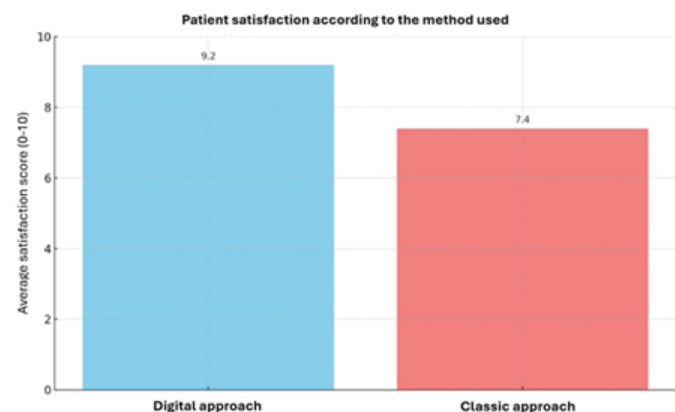
- **Treatment duration** was reduced from an average of 4–5 hours (traditional method) to 90–120 minutes (digital method), with a direct impact on patient scheduling and clinic productivity (Figure 3).

Figure 3 – Comparison of Total Treatment Duration: Digital vs. Traditional Method



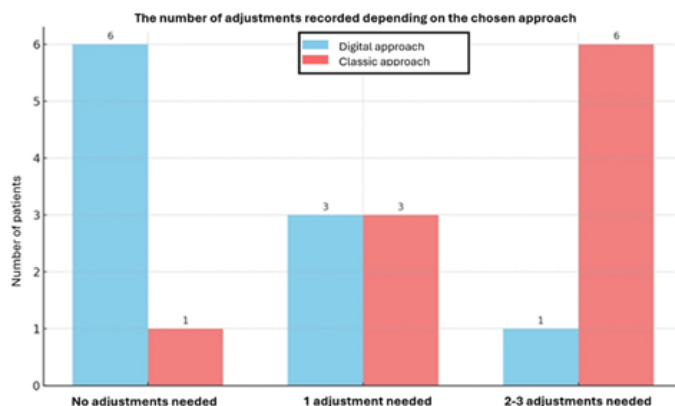
- **Patient satisfaction** was significantly higher in the digital group (average score 9.2 vs. 7.4). From a managerial standpoint, a satisfied patient becomes a service promoter and contributes to the organization's reputation (Figure 4).

Figure 4 – Comparison of Patient Satisfaction Levels in the Two Treatment Methods



- **Number of occlusal adjustments:** In the digital group, 90% of restorations required minimal or no adjustments (0–1 corrective interventions). This correlates with the high accuracy of scanning and computer-aided design. In contrast, the traditional group required 1–3 adjustments per case, particularly in functional contact areas (Figure 5). Digital accuracy and fewer adjustments resulted in time and material savings, as well as reduced process errors.

Figure 5 – Number of Adjustments Recorded in the Two Prosthetic Methods



Additionally, **digital archiving** enabled complete traceability, facilitating internal audits, performance analysis, and quality control. Each scan, design file, and final restoration was digitally stored, ensuring future access for adjustments, remakes, or post-treatment comparisons.

On the other hand, initial implementation costs were high (equipment, software licenses, staff training), requiring long-term financial planning. From a managerial perspective, the investment is justified by reduced recurring costs (impression materials, transport, gypsum models) and increased patient flow. Thus, the cost–efficiency ratio becomes positive within 12–24 months, depending on activity volume and full utilization of the digital system [7].

DISCUSSION

Clinically, digitalization ensures greater accuracy, error reduction, and treatment personalization [8,9]. From a managerial perspective, digitalization should not be seen solely as a technological acquisition but as an **organizational strategy**. Successful implementation requires four essential pillars:

1. **Strategic vision** – clearly defining digital objectives and expected benefits (efficiency, image, sustainability).
2. **Team training** – preparing dentists, assistants, and technicians to use the technology coherently; lack of skills is a major cause of implementation failure.
3. **Process integration** – aligning clinical, administrative, and logistical stages into a coherent digital system.
4. **Performance monitoring** – using clinical and economic efficiency indicators for periodic progress evaluation [10].

Digitalization also indirectly impacts human resource management by attracting younger professionals familiar with technology and enhances reputational management by positioning the clinic as innovative.

However, challenges must not be overlooked: maintenance costs, software updates, compatibility issues, and cybersecurity risks require responsible digital governance.

CONCLUSIONS AND RECOMMENDATIONS

Adopting a fully digitalized workflow in dental medicine is a strategic decision that redefines service efficiency and quality. Its benefits—shorter treatment duration, improved precision, patient comfort, and reduced errors—are evident. However, these advantages can only be achieved sustainably through proactive management based on planning, continuous training, and rigorous economic evaluation.

In the long term, the success of digitalization depends on continuous staff development, equipment interoperability, standardized clinical procedures, and data-driven management integration.

MAIN RECOMMENDATIONS FOR DENTAL CLINICS:

1. Conduct a cost–benefit analysis prior to investment and develop a realistic amortization plan.
2. Select compatible and scalable equipment to avoid dependency on a single supplier.
3. Implement an internal digital protocol to standardize clinical steps and ensure quality.
4. Monitor performance through indicators such as treatment duration, patient satisfaction, and error rate.
5. Adopt an ecological perspective by reducing waste and material consumption.
6. Invest in human capital through continuous training and organizational learning.

Digitalization represents, in essence, a form of **transformational leadership in healthcare**. It changes not only how work is performed but also how medical services are conceptualized—as integrated, sustainable, and patient-centered processes.

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