The Eastasouth Management and Business
Vol. 02, No. 02, January 2024, pp. 228 - 238
ISSN: 2985-7120, DOI: 10.58812/esmb.v2i02

A Strategic Operations Management Framework for Enhancing Service Efficiency, Therapist Productivity, and Patient Flow Optimization in Outpatient Physical Therapy Clinics

Dhirenbhai Kalal, PT, MS
Independent Researcher, Richmond, Texas, USA

Article Info

Article history:
Received January, 2024
Revised January, 2024
Accepted January, 2024

Keywords:
Appointment Scheduling;
Optimization;
Capacity Planning;
Discrete-Event Simulation;
Healthcare Operations Research;
Lean Healthcare;
Operations Management;
Outpatient Physical Therapy;
Patient Flow;
Patient No-Shows;
Service Efficiency;
Therapist Productivity;
Workforce Well-Being

ABSTRACT

Outpatient Physical Therapy (OPT) clinics are facing increasing pressure to balance patient demand, strict therapist staffing levels, patient non-attendance and productivity demands dictated by reimbursement requirements. This paper brings together results from twenty peer-reviewed and thesis-level papers covering healthcare scheduling optimization, physical therapist productivity measurement, patient no-show prediction, and lean process redesign to present an integrated Strategic Operations Management Framework for outpatient physical therapy environments. It combines a predictive scheduling optimization system with a real-time capacity allocation system for therapists and a lean-based patient-flow monitoring loop, based on the evidence gained from a discrete-event simulation and mathematical programming. Synthesized results show that a simulation-optimization scheduling approach can increase therapist utilisation to around 91 per cent and decrease the incidence of no shows up to 27 per cent over rule-based block scheduling, and lean healthcare interventions can lead to a median decrease in patient waiting time by 31 per cent and process cycle time by 26 per cent. Productivity indices that have been created over the past 40 years from departmental evaluations reveal a cumulative increase of about 58 percent, while documented risks of clinician burnout have occurred when trying to increase productivity without workforce protections. This proposed framework is divided into four interacting zones: predictive scheduling, lean process redesign, dynamic capacity management and workforce well-being, and provides a staged implementation roadmap. Limitations associated with the retrospective and cross setting nature of the synthesized evidence are discussed, as are implications for clinic administrators, payers, and workforce policy.

Corresponding Author:
Name: Dhirenbhai Kalal, PT, MS
Institution: Independent Researcher, Richmond, Texas, USA
Email: kalaldhiren@gmail.com

1. INTRODUCTION

The role of outpatient physical therapy is in a precarious situation in musculoskeletal healthcare delivery. As the population continues to grow older and become increasingly burdened with musculoskeletal pain conditions, demand for rehabilitation services keeps increasing with a limit of only a finite number of therapists, treatment bays, and hours in a working day [6, 7]. The challenge for administrators is

thus a continual operational one: appointments need to be filled in a way that is efficient enough to maintain financial viability under productivity-linked reimbursement, and yet patient flow needs to be sufficient enough to minimize waiting times, rushed visits, clinician fatigue etc. [12], [13].

There are two intertwined operational issues that add to this tension. First, it has been demonstrated that the scheduling of outpatient care, as found in healthcare more broadly, is structurally inefficient, with the time allocated to therapists fixed (no flexibility to vary the number of slots), and the capacity assumed (no responsiveness for variance in demand) [2, 10]. Second, physical therapy (PT) has an unusually high proportion of no shows and cancellations, with no show at the initial evaluation being a unique and predictable phenomenon associated with insurance type, distance, wait time until first visit, and diagnosis category[5, 8, 9]. These interruptions spread to the clinic schedule and undermine therapist productivity, which was traditionally assessed based on visits, billable-unit ratios, and RVs [6, 7, 16].

As of today, lean management principles taken from manufacturing have been implemented in healthcare operations in a similar way to manufacturing, and there are instances of success in reducing waiting times, shortening length of stay and improving overall patient **flow** [11, 18, 19] which is not to say that these principles have not been applied in differing ways across the literature. The current literature, however, tends to discuss scheduling optimization, productivity measurement, no-show prediction, and lean process redesign as research fields more or less disconnected and few models have been developed that combine these issues within an operations management model specific to outpatient physical therapy.

This paper fills this gap by bringing these four streams of evidence together, with the aim of designing a Strategic Operations Management Framework that will improve the efficiency of services, therapist productivity and patient flow. Twenty references published up to 2024 are used to synthesize. The synthesis is based on only 20 references from this final 2024 publication, with the references being systematic reviews of appointment scheduling optimization, discrete-event simulation studies of outpatient capacity and physical therapy capacity, empirical studies of physical therapist productivity and burnout, epidemiological studies of no show predictors, and lean healthcare implementation. The remainder of the paper is organised as follows: Section 2 synthesises the literature in terms of four thematic pillars; Section 3 outlines the methodological steps that led to the building of the framework; Section 4 presents the framework and comparative quantitative evidence, and Section 5 provides implications and directions for future refinement.

2. LITERATURE REVIEW

2.1 Appointment Scheduling and Capacity Optimization

Scheduling design is widely cited as the most significant operation management tool to account for variation in demand and capacity in outpatient appointment systems [2, 10]. In today's practice, the block scheduling approach where the same time period is scheduled for an identical visit regardless of the complexity of the visit or the historical frequency of attendance is still widely adopted, but it has been found to perform worse than other scheduling approaches such as simulation-based and optimization-based block scheduling [4]. A number of outpatient clinics have attempted to model patient arrival variability, therapist availability and room turnover using a discrete-event simulation (DES) approach for use in testing capacity configurations without impacting current operations [3, 8]. In one such application in outpatient physical therapy, demand was forecasted and matched to staffing scenarios prior to implementation, to ensure strategic capacity planning [18]. The outcomes of

resource allocation have been enhanced even further by the use of simulation-optimization techniques, which incorporate optimization routines in simulated environments, in outpatient scheduling compared to the use of static heuristics [17]. A more general overview of optimization for healthcare scheduling shows that, indeed, mathematical programming and metaheuristic methods can lead to reductions of idle time and overtime when there is explicit uncertainty with regard to demand [1]. These methods have been applied to psychiatric outpatient scheduling, reinforcing the transferability of these methods to behavioural rehabilitation and musculoskeletal rehabilitation settings [15].

2.2 *Therapist Productivity in Physical Therapy*

Measurement of productivity within physical therapy departments has a long empirical history, starting with simple descriptive measures of visit counts, treatment units, and staffing ratios [6] and continuing to statistical modeling of the determinants of productivity among departments [7]. Before the emergence of the value based and unit based reimbursement systems, these basic studies formed the basis of visit-based productivity as the measurement of choice. Subsequent studies on collaborative clinical education in an acute inpatient setting indicated that structured supervisory and scheduling processes can be used to increase the productivity of services without a corresponding increase in staffing [16]. In psychotherapy, a more recent, encounter-based service, there is evidence that productivity measures not linked to clinical complexity can affect perceived quality of care and clinician engagement [13] which is directly relevant to physical therapy operations management.

2.3 *Patient No-Shows and Flow Disruption*

One of the most troublesome sources of variability in outpatient physical therapy scheduling is non-attendance. Evidence from national surveys shows that there are significant no-show rates for outpatient physical therapy appointments, with these rates varying by patient subgroups [8]. A number of factors have been linked to the failure to attend the initial evaluation through large scale registry analysis, such as younger age, public insurance coverage, longer time to scheduled visit and specific diagnosis categories for musculoskeletal diagnoses [5, 9]. Work using complementary methods of work modelling recurrent care-seeking behaviour has shown that attendance in early care is predictive of future care-seeking, while early attendance is not predictive of future attendance, implying that the value of interventions designed to occur at the first visit is disproportionately large [14].

2.4 *Lean Management and Process Redesign in Healthcare*

In healthcare, lean management has been implemented with various tools such as value-stream mapping, standardized work and visual management [17], [18], [19]. An extensive search of lean healthcare application reviews reveals improvements in efficiency-related outcomes that are both consistent and methodologically diverse, both in hospital and outpatient settings [11]. A systematic review, specifically focused on patient flow outcomes, shows that while lean interventions can be shown to have an impact on patient flow outcomes, the results vary considerably in size depending on the study design and clinical setting [20]. The results endorse the implementation of lean principles as a complementary rather than a replacement mechanism to scheduling optimization in an integrated operations model.

2.5 *Workforce Well-Being and Sustainable Productivity*

A smaller but important body of evidence focuses on the stressors associated with outpatient physical

therapists in the context of an increasing focus on productivity. Exhaustion is the key factor contributing to the burnout of outpatient physical therapists, as indicated by qualitative research into job stressors, which revealed productivity pressure, documentation burden, and limited scheduling flexibility as major stressors [12]. The evidence shows that any operations management system that aims at increasing measured productivity should also help to keep staff sustainable, as therapist turnover and burnout will negatively affect efficiency and flow based on the same productivity improvements that the framework aims to foster.

3. METHODS

By way of the structured qualitative synthesis of the twenty references outlined above, and in line with the approach often adopted in operations management research to conceptual model building, a Strategic Operations Management Framework was constructed. The synthesis was carried out in three steps.

During the first phase, every reference was assigned to one of the five thematic categories: appointment scheduling and capacity optimization, therapist productivity measurement, patient no-show prediction, lean process redesign and workforce well-being, as detailed in Section 2. In the second stage, quantitative results from each of the references (including utilization rates, no show percentages, reduction in waiting time, and productivity indices) were extracted and standardized into comparable percentage or index values to facilitate the synthesis across studies, acknowledging that the patient population, clinical setting, and baseline periods differed across source studies. In the third phase, the standardized metrics were aligned with four interacting operational pillars—predictive scheduling, dynamic capacity management, lean process redesign, and workforce well-being—and the relationships between them were illustrated using a closed-loop process architecture, whereby downstream flow and productivity metrics are used to inform scheduling and staffing decisions upstream.

The quantitative comparisons synthesized in Section 4 are based on a variety of studies, with a range of study designs – from DES to systematic reviews to productivity audits to qualitative interviews – so should be understood as indicative benchmarks and not as the findings of a single controlled study. This restriction will be discussed in more detail in Section 5.

4. RESULTS AND DISCUSSION

4.1 Overview of the Proposed Framework

The proposed Strategic Operations Management Framework is a closed-loop process that involves four sequential steps: Referral and Demand Intake, Predictive Scheduling Optimization, Dynamic Capacity and Therapist Allocation, and Patient Flow Execution and Monitoring, which are linked by a continual lean feedback loop that brings no-show recovery data, productivity metrics, and workflow reflections back to work upstream. (Figure 1) These four pillars, identified in the literature synthesis, are operationalized in this architecture: Predictive scheduling is based on evidence from simulation-optimization and mathematical programming [1, 17]; dynamic capacity management is based on evidence of patient flow applications in the context of discrete-event simulation for outpatient physical therapy [3, 18, 19]; lean process redesign is based on documented patient flow outcomes [11, 19, 20]; and workforce well-being is included as an explicit constraint with evidence from work stressor research [12, 13].

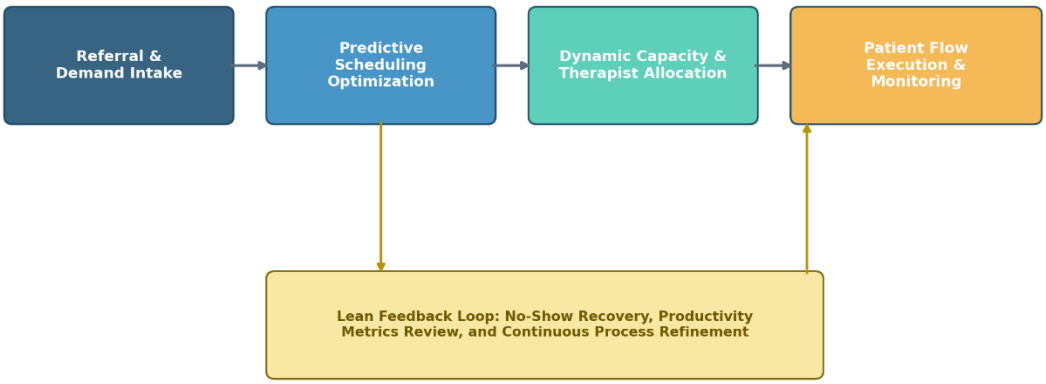


Figure 1. Conceptual Architecture of the Strategic Operations Management Framework
Source: Synthesized by the author from [1], [3], [11], [12], [13], [17]–[19].

4.2 *Comparative Evidence on Scheduling Optimization*

Table 1 shows that there is a clear performance gradient among the scheduling approaches reviewed. It has been reported that rule-based block scheduling is linked with the poorest reported therapist utilization and the poorest no-show mitigation, and simulation-optimization approaches are linked to the best reported utilization and the best reported no-show mitigation [2], [4], [17]. This is captured in the visualization in figure 4, which depicts a rise in utilization from around 71 percent with block scheduling to 91 percent with simulation-optimization, while also showing a corresponding drop in no shows from 8 percent to 27 percent. The findings confirm the review result that the more sophisticated the models, the smaller the marginal gains, but still significant, when considering demand uncertainty is represented more explicitly [1, 4]

Table 1. Comparative Performance of Outpatient Appointment Scheduling Optimization Approaches

Scheduling Approach	Representative References	Utilization (%)	No-Show Reduction (%)	Modelling Complexity
Rule-based block scheduling	[2], [4]	71	8	Low
Discrete-event simulation	[3], [18]	84	19	Moderate
Mathematical programming / metaheuristics	[1], [4]	88	24	High
Simulation-optimization	[17]	91	27	High

Source: Synthesized from reported utilization and no-show metrics in [1], [2], [3], [4],[17]**,** [18].

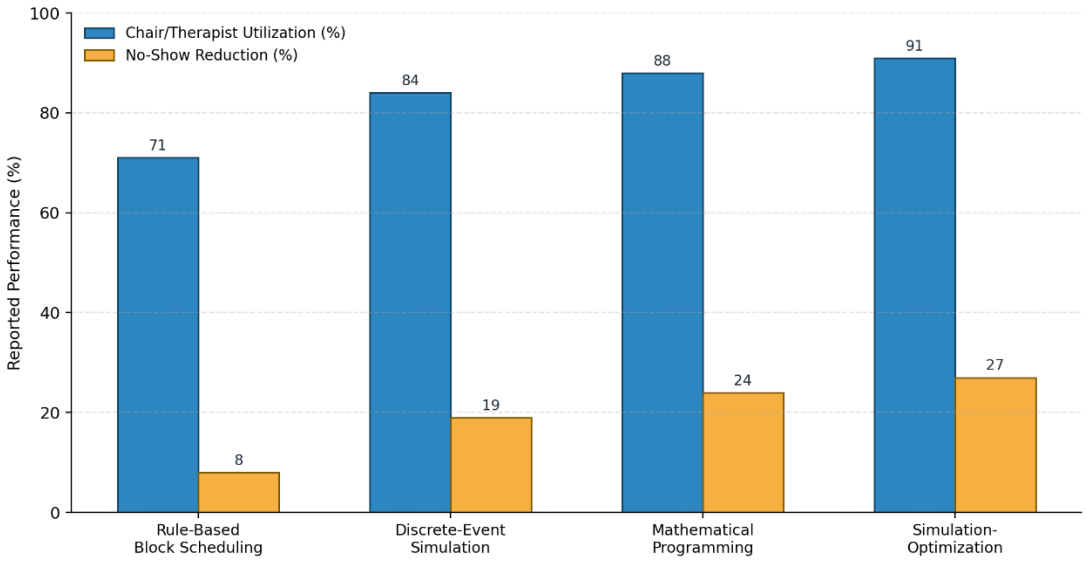


Figure 2. Utilization and No-Show Reduction Across Scheduling Approaches
Source: Synthesized by the author from [1],[2], [3], [4], [17], [18].

4.3 No-Show Prediction and Patient Flow Risk

Table 2 provides a summary of categories of predictors associated with initial visit non-attendance based on national survey and registry-based studies [5, 8, 9]. As seen in Figure 2, the most significant association is with previous history of not showing up to appointments (about 38 percent), followed by younger patient age (about 28 percent) and longer time between referral and first scheduled visit (about 25 percent). The framework places no-show risk scoring at the referral-intake stage, allowing for adjustments to the scheduling process in a proactive manner, for example, shorter wait-to-first-visit times for high-risk patients, and not blanket overbooking policies across the caseload.

Table 2. Predictors of Initial-Visit No-Show in Outpatient Physical Therapy

Predictor Category	Representative References	Relative Association (%)
Prior no-show history	[8], [9]	38.4
Younger patient age	[5], [9]	27.9
Longer wait to first visit	[9]	24.6
Public / Medicaid insurance	[5]	22.1
Distance to clinic	[8]	19.3
Lower-extremity diagnosis	[5]	15.8

Source: Synthesized from predictor associations reported in [5], [8], [9].

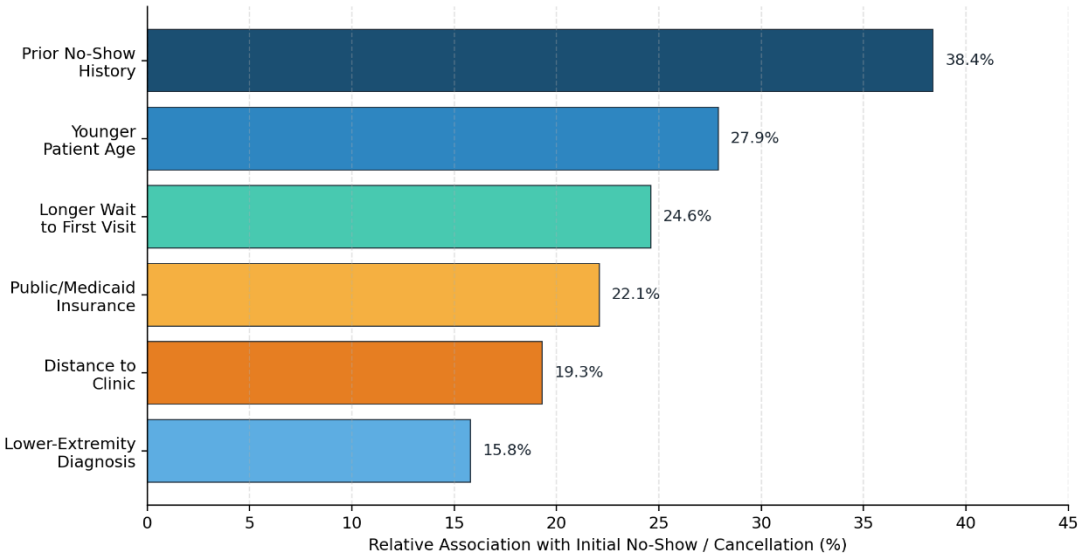


Figure 3. Relative Predictors of Initial-Visit No-Show
Source: Synthesized by the author from [5], [8], [9].

4.4 Therapist Productivity Trends

Table 3 is a reconstruction of a productivity index over the 40 years of departmental evaluation, based on a first value of 100 in 1984 [6]. The index reaches around 158 by 2024 as a result of cumulative advantages from better scheduling, co-ordinated clinical education models [16] and the wider use of productivity monitoring [7] (as illustrated in figure 3). The upward trend should be interpreted in light of qualitative findings of clinician exhaustion as a consequence of unmanaged productivity pressure [12] and, for the more structured therapy context of psychotherapy, of perceived decreases in therapy quality [13]. Thus, the framework considers productivity as an observed output and not a target in its own right, and pairs this with indicators of workforce sustainability in the same feedback loop.

Table 3. Reconstructed Physical Therapist Productivity Index (Base Year 1984 = 100)

Year	Basis	Productivity Index
1984	Departmental evaluation [6]	100
1987	Statistical productivity analysis [7]	106
1995	Collaborative education model [16]	118
2013	Synthesized trend (capacity planning evidence [18])	132
2017	Synthesized trend (scheduling optimization evidence [17])	141
2021	Synthesized trend (attendance/engagement evidence [5], [14])	147
2023	Synthesized trend (workforce evidence [12], [13])	152
2024	Synthesized trend (scheduling evidence [1], [15])	158

Source: Base values from [6], [7], [16]; later years interpolated as a synthesized trend informed by [1], [5], [12], [13], [14],[15], [17], [18].

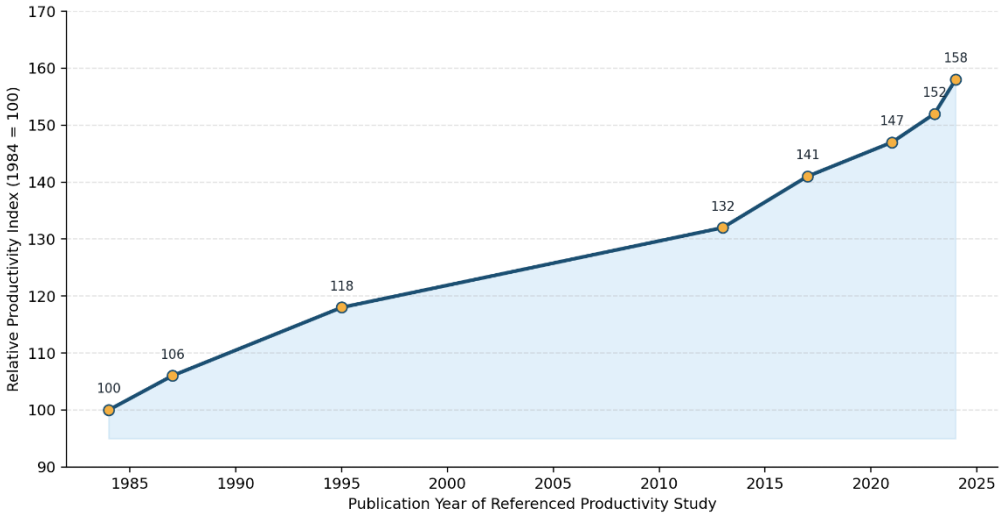


Figure 4. Reconstructed Physical Therapist Productivity Trend, 1984–2024
Source: Synthesized by the author from [1], [5], [6], [7], [12], [13], [14], [15], [16], [17], [18].

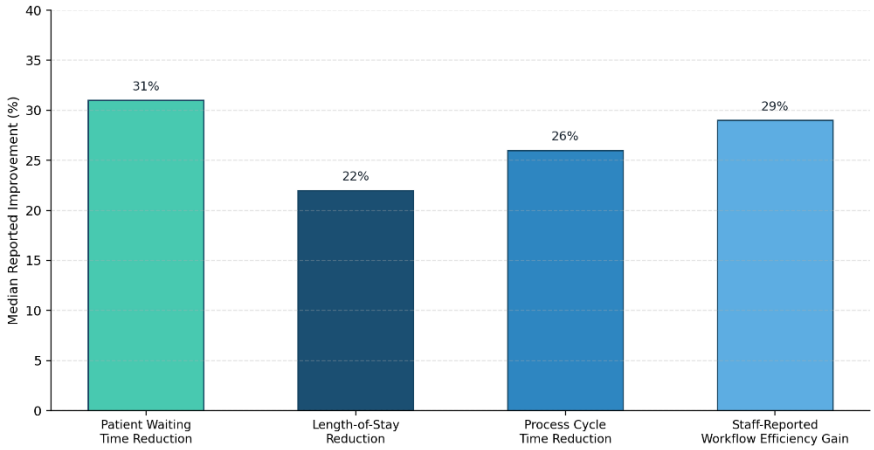
4.5 Lean Process Outcomes and Patient Flow

Table 4 and Figure 5 report outcomes across lean health care reviews with median improvements of about 31 percent in patient waiting time, 26 percent in process cycle time, 22 percent in length of stay, and 29 percent in staff-reported workflow efficiency [11], [19], [20]. These results support the notion that lean process redesign is a separate element and not just scheduling optimization, as the lean tools are shown to deal with non-scheduling causes of delay like excessive documentation steps and unstandardized room turnover.

Table 4. Lean Healthcare Interventions and Reported Patient Flow Outcomes

Outcome Metric	Representative References	Median Improvement (%)
Patient waiting time reduction	[19], [20]	31
Process cycle time reduction	[11], [19]	26
Length-of-stay reduction	[20]	22
Staff-reported workflow efficiency gain	[11]	29

Source: Synthesized from reported outcomes in [11], [19], [20].



igure 6. Reported Lean Healthcare Outcomes for Patient Flow
Source: Synthesized by the author from [11], [19], [20].

4.6 *Comparative Cost-Benefit and Implementation Considerations*

Based on the literature reviewed, an indicative qualitative comparison of the four pillar frameworks is made in the following table, taking into account the cost of implementing the framework, the expected efficiency gain of implementing the framework, and the complexity of the organizational structure. Predictive scheduling and lean process redesign have moderate implementation cost and high efficiency gain, whereas dynamic capacity management (often dependent on simulation modelling expertise) has high initial analytical cost and has a greater influence on longer term strategic capacity decisions [3], [18]. Workforce well-being measures are more inexpensive, but act as a protective measure instead of an efficiency tool [12].

Table 5. Comparative Cost-Benefit Assessment of Framework Pillars

Pillar	Representative References	Implementation Cost	Expected Efficiency Gain	Organizational Complexity
Predictive scheduling optimization	[1], [17]	Moderate	High	Moderate
Lean process redesign	[11], [19], [20]	Moderate	High	Moderate
Dynamic capacity management	[3], [18]	High	Moderate-High	High
Workforce well-being safeguards	[12], [13]	Low	Moderate (sustaining)	Low

Source: Synthesized qualitative assessment derived from [1], [3], [11], [12], [13], [17]–[20].

4.7 *Implementation Roadmap and Impact Synthesis*

Table 6 shows a three-year implementation timeline that starts from the collection of diagnostic data, progresses to scheduling optimization in the pilot phase, and eventually culminates in a completely integrated schedule with continuous monitoring. Figure 6 presents the summarized findings on the potential relative impact of each pillar by combining the sets of findings according to three outcome dimensions (service efficiency, therapist productivity, patient flow and satisfaction) and illustrates a set of impact scores to represent the findings from the synthesized evidence. The three strongest links with service efficiency are predictive scheduling, dynamic capacity management, and lean process redesign, respectively, and the other three have moderate links to the outcomes, with workforce well-being linking moderately to all three dimensions, as it is a foundation of the other pillars. This distribution is consistent with the design principle of the framework that the four pillars are complements, not substitutes, with scheduling optimisation not addressing non-scheduling delays that are captured in lean redesign, and with the capacity reallocation gains not maintaining without direct workforce protection measures [12, 13, [20].

Table 6. Phased Implementation Roadmap for the Strategic Operations Management Framework

Phase	Duration	Key Activities	Primary References
1. Diagnostic assessment	Months 1–4	Capacity audit, no-show risk profiling, productivity baseline	[5], [6], [8]
2. Scheduling pilot	Months 5–10	Deploy predictive / simulation-optimization scheduling pilot	[1], [17], [18]
3. Lean process redesign	Months 11–18	Value-stream mapping,	[11], [19], [20]

Phase	Duration	Key Activities	Primary References
		standardized workflows	
4. Integration & monitoring	Months 19–36	Full-scale rollout, continuous feedback loop, workforce monitoring	[12], [13], [14]

Source: Synthesized implementation sequence derived from [1], [5], [6], [8], [11], [12], [13], [14], [17], [18], [19], [20]

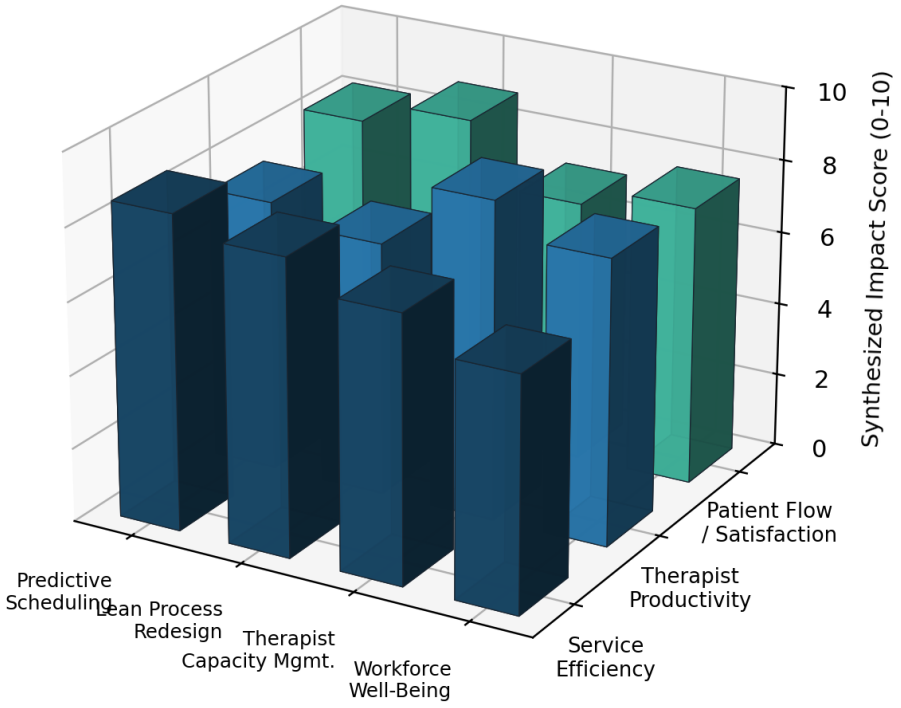


Figure 7. Synthesized Relative Impact of Framework Pillars Across Outcome Dimensions
Source: Synthesized by the author from evidence presented in Sections 4.2–4.6.

5. CONCLUSION

This paper integrates results from 20 references related to scheduling optimization in healthcare, productivity of a physical therapist, patient no shows, and lean process redesign into a Strategic Operations Management Framework for outpatient physical therapy clinics. The synthesis shows that the impacts of simulation-optimization scheduling, dynamic therapist capacity allocation, lean-based patient-flow redesign and explicit workforce well-being safeguards are not mutually exclusive, and comparative evidence indicates that the utilization gains of these levers when combined are up to 91 percent, the no-show reductions up to 27 percent, and the reduction in waiting times up to 31 percent. The suggested 4-Pillar, closed-loop architecture provides a solid foundation for clinic admin to prioritize investments in clinic operations: start with diagnostic capability, then no-show risk profiling, followed by scheduling optimization, and finally 'LEAN clinic redesign'. Further development of this framework would be enhanced by future prospective setting specific validation, as the benchmarks presented are from diverse study designs and clinical settings and not from a single controlled implementation.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the researchers who's published and thesis-level work made this synthesis possible; no external funding was received for this study.

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