

Designing A Patient-Centered Healthcare Information System to Achieve the Quadruple Aim: A Process-Centric Approach

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Abstract

Background: The healthcare sector has long focused on the Triple Aim framework improving patient experience, improving population health, and reducing costs. However, rising levels of physician burnout and dissatisfaction have been shown to threaten these goals, leading to the necessary evolution towards a Quadruple Aim, which adds the crucial goal of improving the work life of healthcare providers.

Methods: This study proposes that a process-centric approach is essential to achieving the Quadruple Aim by steadily balancing patient and provider needs. A mixed methodology was employed, initiating with a quantitative and qualitative survey distributed via digital ways and in person to evaluate patient experiences and expectations of healthcare services. Successively, a prototype of a process-centric Health Information System (HIS) was designed and developed using the YII PHP framework to explain the core principles of transparency and structured communication.

Results: Survey results implied that while patients commonly find healthcare information useful, a significant percentage report only moderate satisfaction with services, emphasizing opportunities for process improvement. The developed HIS prototype presents a functional platform for complaint management, allowing transparent communication between patients, doctors, and hospital administration, with distinct interfaces and workflows for each stakeholder.

Conclusion: A shift from purely patient-centric to a process-centric model in health informatics offers a tangible path to addressing the four goals of the Quadruple Aim. By improving the transparency of clinical and non-clinical processes, such systems can improve the patient experience while granting structured, manageable feedback channels to alleviate provider burnout.

Keywords: Quadruple Aim; Process-Centric Healthcare; Patient-Centric Healthcare; Physician Burnout; Health Information Systems, Service Science.

1. INTRODUCTION

The global healthcare industry is under persistent pressure to provide higher quality care more efficiently. For years, the guiding framework for this effort has been the Triple Aim, a model focused on three interdependent goals: enhancing the patients' experience of care (Better Care), improving the health of populations (Better Health), and reducing the per capita cost of healthcare (Lower Costs) [1]. While this framework has provided significant positive change, its implementation has exposed a perilous flaw: the framework's intense focus on system outcomes has often come at the cost of the well-being of healthcare providers themselves [2].

A growing body of research indicates that physician burnout, a syndrome of emotional exhaustion, depersonalization, and low personal accomplishment, is a prevalent crisis [3]. Provider burnout directly threatens the success of the Triple Aim; it is linked to lower patient satisfaction, an increase in medical errors, and higher operational costs due to physician turnover. The realization that care for the patient necessitates care for the provider has led to the introduction of the Quadruple Aim, which integrates a fourth objective: improving the work life and satisfaction of the healthcare team [4].

Accomplishing this new, more holistic set of goals necessitates a shift in the way healthcare information systems (HIS) are designed. The traditional clinic-centric model, where processes are fragmented across different facilities, is insufficient. While the move towards patient-centric systems, which place the patient's needs and values at the core of all clinical decisions, was a substantial step forward, it does not inherently solve the provider burnout crisis [5].

Our research claims that the next necessary evolution is towards a process-centric healthcare system. This approach builds upon patient-centric principles but extends the focus to include the transparency, quality, and efficiency of the underlying processes for all key stakeholders, including providers. It speculates that by making healthcare processes transparent, you can simultaneously improve patient satisfaction

(fulfilling the Triple Aim) and create a more structured, predictable, and less burdensome environment for physicians (fulfilling the Fourth Aim).

2. LITERATURE REVIEW

2.1. The Evolution from Triple to Quadruple Aim

The Institute for Health Improvement (IHI) developed the Triple Aim framework to enhance the performance of the health system. The three foundations, Better Health, Better Care, and Lower Costs, are codependent, meaning that the efforts aimed at achieving one of the objectives can affect the others. As an example, the overuse of diagnostic tests can be eliminated to save money and at the same time enhance patient outcomes by preventing unnecessary tests. Nonetheless, the framework's focus is mainly external, centered on the patient and the population [6].

This focus omits the operational stress assigned on the clinical workforce. High levels of administrative burden, combined with the burden to meet performance metrics, have led to prevalent physician burnout. This burnout is not simply a concern of personnel management; it is a serious hazard to the entire system's quality and safety. In response, Bodenheimer and Sinsky proposed expanding the framework to the Quadruple Aim, including "improving the work life of health care providers" as the fourth essential goal. This addition properly recognizes that a satisfied, engaged, and resilient workforce is a requirement for achieving the original three aims [7].

2.2. Healthcare System Models

Historically, healthcare delivery has been clinic-centric, where the hospital or clinic is the center of the whole system. In this model, patient records and care histories become dispersed across numerous specialist locations, forming an inefficient and often frustrating experience for the patient [8].

The patient-centric model developed as a direct response to these shortcomings. It is outlined as care that is respectful of and responsive to individual patient preferences, needs, and values, guaranteeing that these values guide all clinical decisions [9]. This model supports shared decision-making, care coordination, and transparency, which ally well with accomplishing the Triple Aim. Key features of a patient centered HIS include care coordination, patient involvement in care decisions, and system transparency regarding practices and fees [10].

2.3. The Process-Centric Approach

While patient-centricity is vital, a process-centric approach provides a more comprehensive framework for accomplishing the Quadruple Aim. Process-centric healthcare focuses on making the entire service delivery process transparent and efficient for all stakeholders. A healthcare process, in this framework, is constructed to build a transparent system that reaches two primary outcomes which are a high-quality service for the patient and a high satisfaction for the care provider [11].

Thus, a well-designed process-centric system is the implementation method for the Quadruple Aim. It accomplishes the Triple Aim by inspiring patients with clear information about their care path, treatment options, and costs, leading to higher satisfaction. Concurrently, it accomplishes the Fourth Aim by structuring workflows, clarifying expectations, and providing formal channels for communication and feedback, which can reduce the administrative chaos and uncertainty that contribute to physician burnout. In essence, process-centric healthcare achieves the Quadruple Aim by clearly designing for the satisfaction of both the service consumer, the patient, and the healthcare provider [11, 12].

3. METHODOLOGY

3.1. Research Design

To investigate the requirements for and the application of a process-centric HIS, mixed-methodology was adopted. This approach involved two main phases: a survey to gather quantitative and qualitative data on patient perspectives regarding healthcare services, and the development of a prototype web-based system to serve as a proof-of-concept for the process-centric model.

3.2. Survey and Data Collection

A self-administered questionnaire was designed to gain a deeper understanding of patient requirements and current experiences within the healthcare system. The questionnaire was structured around four primary questions designed to cover the entire arc of a healthcare visit:

1. Previous experience seeking healthcare services and the reasons for it.
2. Information-seeking behavior before a visit and the helpfulness of that information.
3. The outcome of the healthcare visitation.
4. Satisfaction with the service received and any challenges encountered.

The survey was sent out through a variety of means, such as sending a SurveyMonkey link through WhatsApp and email, and sending out printed copies in person at hospitals to reach a wider demographic. All the data was gathered in a highly ethical manner with informed consent, confidentiality, and anonymity of all the participants being observed.

3.3. System Architecture and Development

A web-based HIS was designed to illustrate the principles of a process-centric system with complaint management as one of the key processes. This process was selected due to its direct involvement of patients, providers, and administration and its vitality as a patient and provider satisfaction driver.

The system was built on the Yii framework, which is a component-based PHP framework with high performance and is appropriate in large-scale applications. The hardware design was a typical personal computer to develop and a dedicated server to deploy online. The database of the system was developed with three main tables: a user_tab to maintain accounts of patients, doctors and administrators; a message_tab to keep the initial complaints of patients; a reply_tab to keep the responses of the administration or healthcare providers, which would form a clear and trackable chain of communication.

4. RESULTS AND DISCUSSION

The mixed-methodology approach generated two separate sets of results: an analysis of user perspectives from the survey and a functional system prototype representing the core beliefs of the process-centric model.

4.1. Survey Analysis

The survey provided quantitative and qualitative intuitions into how patients interact with and perceive healthcare services. The data indicates a high level of engagement and a clear need for process improvements.

Regarding healthcare service utilization, most of the surveyed population is actively engaged with the healthcare system. Almost 38% of respondents reported receiving healthcare services in the past, while another 43% had not but indicated they might seek healthcare services in the future. Only 19% stated they had no past or future intention of seeking services (Error! Reference source not found.).

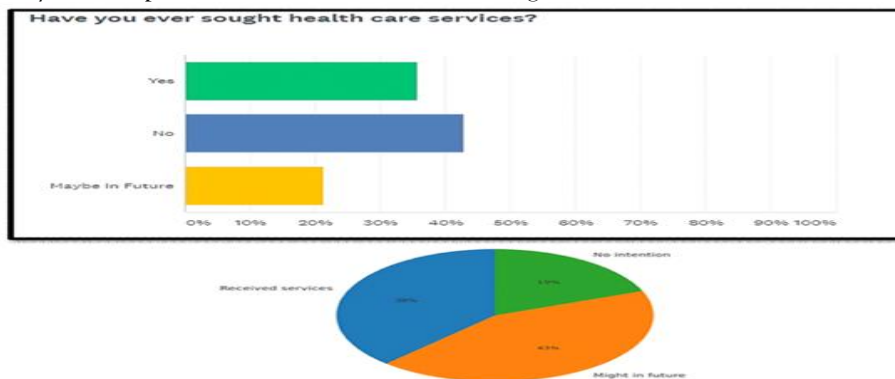


Figure 1. Previous experience with health care service.

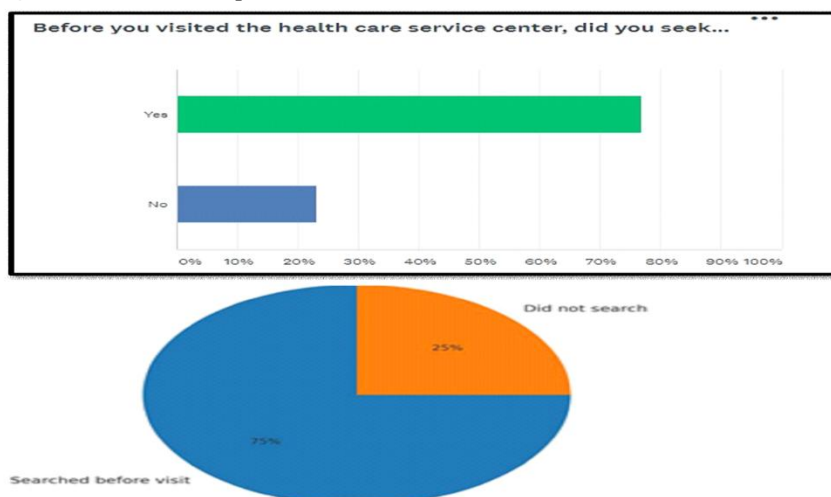


Figure 2. Searching for information about health care services.

Regarding information-seeking behavior, there is a strong tendency for patients to seek information proactively before engaging with a provider. Over 75% of respondents confirmed they looked for information elsewhere before visiting a healthcare service center (**Error! Reference source not found.**). The data tremendously shows this effort is worthwhile, as 100% of those who sought information found it to be helpful (**Error! Reference source not found.**). This highlights the value and necessity of accessible, transparent information for patients.

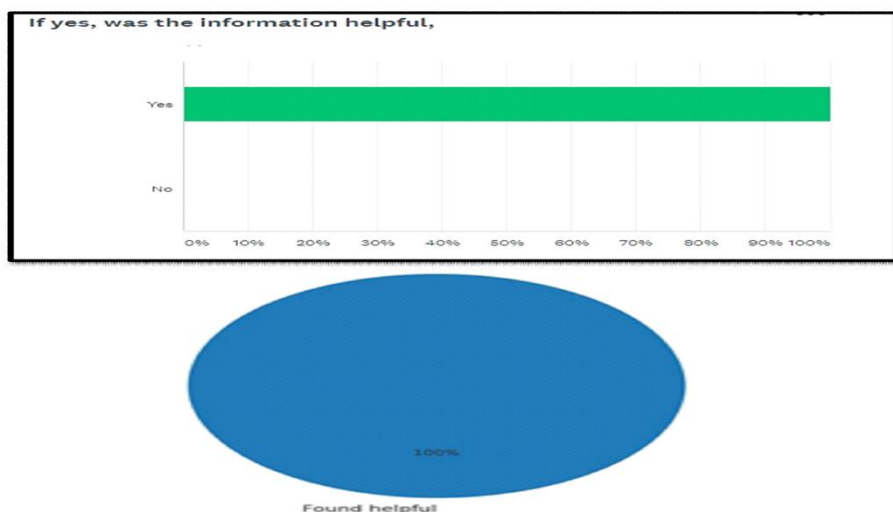


Figure 3. Helpfulness of the available information.

Regarding service outcomes and satisfaction, the survey showed a subtle picture of patient satisfaction. When asked about the outcome of their visit, 60% of respondents acknowledged that they received the service they were looking for. Nevertheless, a significant portion (30%) felt the outcome was only "Some How" successful, and 10% informed a negative outcome (

Figure 5). This is manifested in the satisfaction ratings, where a substantial one-third (33%) of respondents were only "Somewhat satisfied". While a collective of 67% reported being "Satisfied" or "Very satisfied," the large number in the middle category suggests that core process-related frictions are skeptical from an otherwise acceptable clinical experience (

Figure 5).

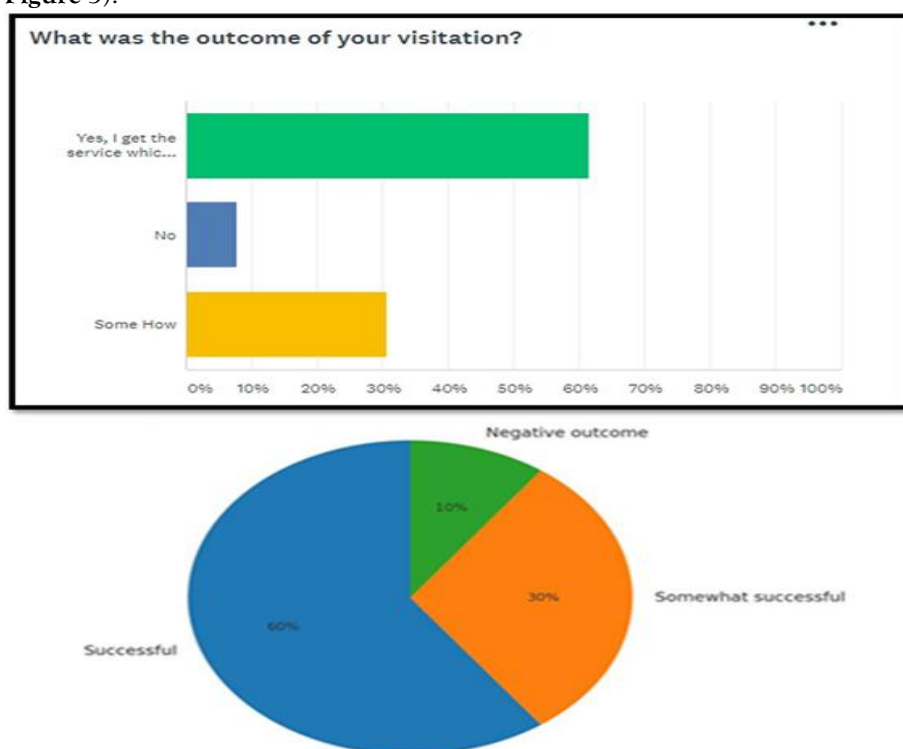


Figure 4. Outcome of using health care services.

Regarding qualitative insights, a key observation from the data analysis was that most users (75%) engaging with healthcare services were not the direct patient but were instead pursuing care on behalf of family members. This implies that healthcare systems must be designed to adapt communication and information sharing with designated family caregivers.

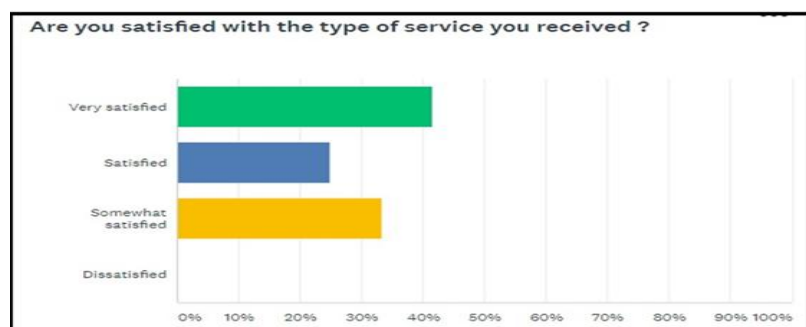


Figure 5: Satisfaction of services

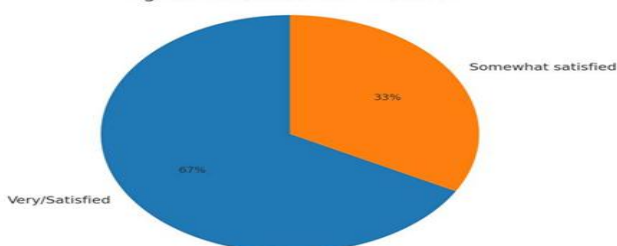
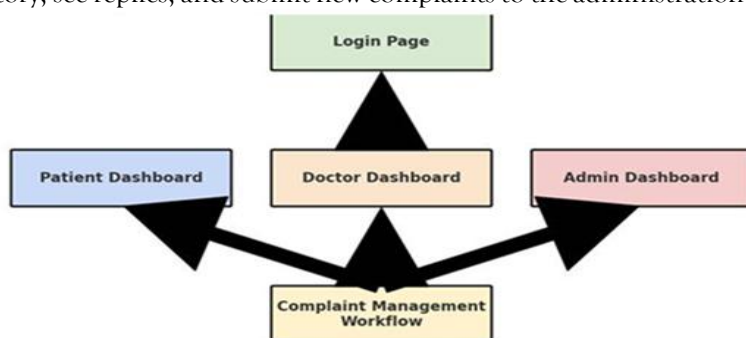


Figure 5. Satisfaction of services.

4.2. System Prototype

A functional prototype of a process-centric HIS was developed as a tangible outcome of this research. The system was designed to address the need for transparency and structured communication through a committed complaint management workflow.

Regarding user-specific interfaces, the system provides separate login portals and dashboards for three key user roles: the patient, the doctor, and the hospital administration. This guarantees that each stakeholder has access to relevant information and functionalities. A patient, after logging in, can view their complaint history, see replies, and submit new complaints to the administration (Error! Reference source not found.).



ID	To	From	Complaints Subject	Complaints Content	Attachment	Complaints Date
9	Ohalla	atuf	test	this for test		11/18/2019
10	Ohalla	Ohoud Fahad	test	test		11/18/2019
11	Ohalla	Ohoud Fahad	test	test		11/18/2019
12	Ohalla	Ohoud Fahad	test3	test3		11/18/2019
13	Ohalla	atuf	test	test		11/25/2019
14	Ohalla	Ohoud Fahad	test2	test		11/25/2019
15	Ohalla	atuf	تقرير	تقرير		11/26/2019
16	Ohalla	Ohoud Fahad	تقرير	تقرير عن الخدمة المقدمة		11/26/2019
17	Ohalla	atuf	service	improve service		11/27/2019

Figure 6. Patient Complaint Data Page

The core of the system is a transparent, closed-loop process for managing feedback. A patient starts the workflow by sending a complaint with a subject and detailed content. This complaint then appears in the hospital manager's dashboard, where it can be reviewed. The manager can then formulate and send a reply directly through the system, detailing the actions taken. Healthcare providers can also be involved in viewing and replying to relevant complaints. Following this, the patient receives the reply and can update the status of the complaint to indicate whether they are satisfied with the resolution, which effectively closes the feedback loop. All of these interactions are stored and linked via IDs in the database, including the initial message in the message_tab, the response in the reply_tab, and the users involved in the user_tab. This method of centralized record keeping establishes a documented and trackable record of the entire process, preventing feedback from being lost and providing the administration with valuable data for quality improvement.

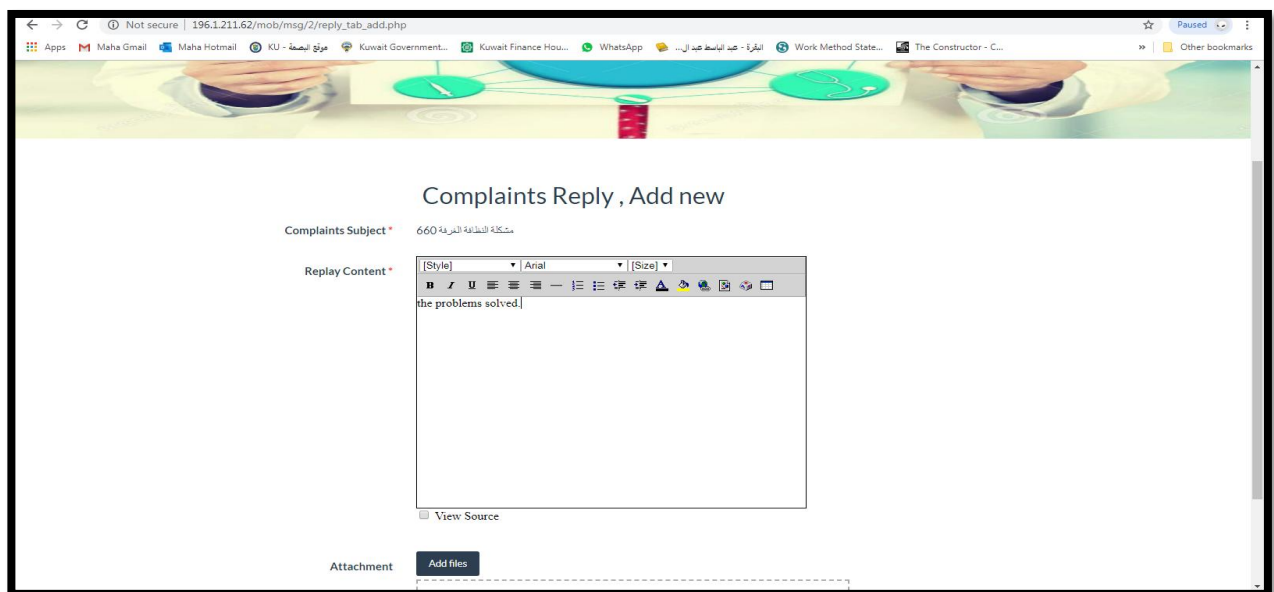


Figure 7. Hospital Manager Reply Form

5. DISCUSSION

5.1. Interpretation of Findings

The survey findings quantitatively confirm the challenges that the process-centric model seeks to address. The high percentage of users who are only "somewhat satisfied" despite receiving their required service allies with broader academic reviews which have found that the relationship between patient expectation and satisfaction is complex and often unclear [13]. The fact that satisfaction is not secured even with a positive clinical outcome advocates the argument that satisfaction is strongly influenced by the quality of the surrounding processes, a key assumption of this study. The need for a system to improve these processes is further emphasized by a study by [14], who identified 'communication' as one of the most frequent subjects of patient complaints. Our developed HIS prototype, with its focus on creating a transparent communication channel, is therefore a direct response to this well-documented problem area. The system serves as a practical employment of the strategies called for by [15], who concluded that effective complaint management requires easy-to-use, incorporated channels that raise patient awareness and create space for analysis and learning.

5.2. Implications for the Quadruple Aim and Provider Well-being

The process-centric model, as demonstrated by the prototype, offers a tangible pathway to fulfilling all four objectives of the Quadruple Aim, a framework introduced by Bodenheimer and Sinsky to address the shortcomings of the Triple Aim [7]. This study's central argument, that system design must equally consider patient and provider needs, is a direct operationalization of Bodenheimer and Sinsky's foundational principle: Care of the Patient Requires Care of the Provider. Our approach has significant implications for the crisis of physician burnout, which was found to deeply negative impacts on providers and patients alike [16]. The HIS prototype alleviates some drivers of this burnout by professionalizing the feedback process. It passes complaints to management in a structured way rather than through disturbing, face-to-face arguments, thereby focusing on the fourth aim of Better Care-Team Satisfaction. This

organized method also enhances the patients' experience "Better Care" by ensuring their voice is formally tracked. While not directly measured, the model has clear implications for Lower Costs, as fixing systemic issues identified through complaint data can reduce medical errors and improve efficiency. Finally, a system that fosters trust encourages proactive patient engagement, contributing to the goal of Better Health for the population.

5.3. Limitations and Future Research

This study has several limitations that can be averted in future research. The sample size and geographical area covered by the survey were small and the results need to be confirmed by a larger and more representative population. Although the HIS prototype is functional, it covers a single healthcare process. Future efforts must be directed to the further expansion of the system to cover other important processes like appointment scheduling, referral management, and a clear fee payment system. Furthermore, research should be undertaken to formally measure the impact of such a system on provider well-being using established metrics like the Employer Satisfaction Index (ESI), which was noted in the initial research. A longitudinal study tracking changes in patient satisfaction scores and provider burnout rates before and after the implementation of a comprehensive process-centric HIS would provide definitive evidence of the model's efficacy in achieving the Quadruple Aim.

6. CONCLUSION

The shift of the Triple Aim to the Quadruple Aim is an inevitable recognition that a sustainable, high-quality healthcare system needs to take care of its providers in addition to its patients. This paper suggests that process-centric health informatics is a feasible and viable means of realizing this holistic vision. By surveying the users of healthcare and creating a prototype HIS, this study has shown that the needs of both patients and clinicians can be directly met by focusing on the transparency and efficiency of the underlying processes. We can enhance the patient experience and make the environment more manageable and satisfying to the providers who are the heart of the healthcare system by developing systems that are clear, reliable, and responsive. The process-centric model provides a bright way forward in the challenging yet essential task of creating a better healthcare future for everyone.

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