

# **A Survey of Systems and Improvement Approaches for Psychological Healthcare**

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## **Abstract**

This paper reviews the literature to date that uses industrial and systems engineering and operations management methods to improve psychological healthcare in the military setting as well as in the civilian sector. The study findings are categorized using an Enterprise Architecture framework; the categorization highlights the enterprise architecting views that have been more thoroughly studied and those areas that have not been addressed as extensively by the present research. The review also found that methods based in industrial and systems engineering and operations management concepts related to improvements in policy may be developed more holistically in the both the military and civilian sectors. In conclusion, methods used to improve psychological healthcare in both sectors may be transferable across sectors and should be considered for to the improvement of psychological health at large.

## **Keywords**

Industrial and systems engineering, enterprise systems, U.S. military, psychological health

## **1. Introduction and Background**

In recent years, the U.S. health care system has seen escalating costs in delivering patient care that has been attributed to the relative fragmentation of the system; unfortunately, limited technical and intellectual capital has been employed to improve or optimize the operations of the U.S. health care systems or in assessing its performance to date [1]. Further complicating efforts to improve the delivery of health care in the United States has been the complexity of the issues surrounding the health care system, such as the effects of rapid advances in medical technology; the incentive structure of the U.S. health care and insurance markets; and the role of information technologies. An approach that considers the health care system holistically and analyzes all system entities and their effects may aid in the examination of complex issues surrounding health care delivery in order to develop robust recommendations for optimal system quality and performance.

Some of the challenges that affect the overall U.S. health care system influence certain health care systems more intensely. In particular, the military is facing psychological health challenges such as post-traumatic stress disorder (PTSD) and major depression due to the enduring nature of the recent conflicts in Iraq and Afghanistan, including extended deployments and prolonged exposure to combat stress [2]. Furthermore, from 2000 to 2005, health care spending in the Department of Defense (DoD) has seen a hundred percent increase, while the total DoD discretionary budget in comparison increased by seventy percent, indicating that as costs escalate and budgets remain constrained, the current system may be rendered unsustainable [3].

Challenges faced by the military regarding PTSD and service member psychological health is not contained within the military sector; as psychological health patients in the military sector may eventually require treatment and care in the civilian sector, the psychological health systems in the civilian sector can be said to be facing these same challenges. For example, patients treated for traumatic brain injury (TBI) resulting from military combat operations may eventually require transition from a military medical center to specialized civilian psychological health centers, presenting a complex logistical challenge, in addition to the lack of performance measures assessing best treatment practices and overall system effectiveness [4].

Stakeholders in both the military and civilian sectors are working and adopting recommendations to improve psychological health care delivery. The military's efforts are supported by Congress, which has directed a task force within the DoD to examine all matters related to psychological health in the military and to provide Congress with

recommendations to improve mental health care delivery in the military [3]. While some psychological health care programs implemented within the military have been found to be successful [5], it is unclear whether the full continuum of psychological health care is complete for meeting the current and future needs of service members and their families [3]. A systems perspective is advised for improvements to the full continuum of care [9], but limited research has considered such an approach. The civilian sector has seen similar challenges with creating a systematic approach to care for psychological.

One notable shift towards using systems thinking to improve the U.S. health care system occurred in 2001, when the Institute of Medicine put forth the following quality characteristics that would describe a high performing, transformed, patient-centered health care system (Figure 1):

- *Safe*—avoiding injuries to patients from the care that is intended to help them
- *Effective*—providing services based on scientific knowledge to all who could benefit and retraining from providing services to those not likely to benefit (avoiding underuse and overuse, respectively)
- *Patient-centered*—providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions
- *Timely*—reducing waiting times and sometimes harmful delays for those who receive and those who give care
- *Efficient*—avoiding waste, including waste of equipment, supplies, ideas and energy
- *Equitable*—providing care that does not vary in quality because of personal characteristics, such as gender, ethnicity, geographic location, and socioeconomic status” [1, p. 14-15].

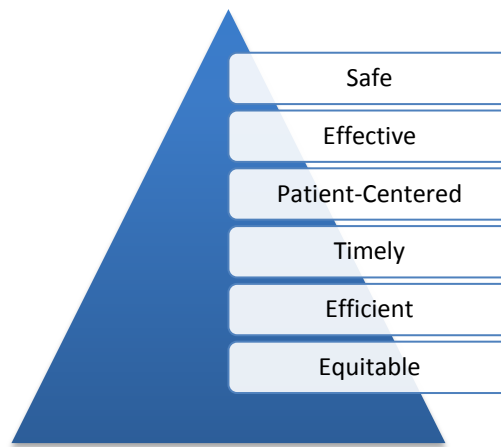


Figure 1. Six Interrelated Dimensions of Quality for a Transformed Health Care System [1]

This vision set forth by the IOM provided outcomes for which quality improvement efforts within health care systems should aim, and indirectly underscored the importance of systems thinking in improving the delivery of health care in the United States. In 2005, the IOM and the National Academies of Engineering (NAE) further this effort by partnering to specifically emphasize the contribution that industrial and systems engineering could make in efforts to improve health care systems [1].

We posit that both health care systems can leverage knowledge from each other in examining these methods and strategies to improve psychological health care delivery. We review literature to date that uses industrial and systems engineering and operations management to implement system improvements devoted to the system of care for psychological health care in the U.S. military and civilian health care systems. This review is a part of a larger initiative to examine the full continuum of care for psychological health care, and presents areas for future research.

## 2. Methods

The present research summarizes the key findings to date from the industrial and systems engineering and operations management literature that examines psychological health in the military and civilian sectors. To the authors' knowledge, a review of this body of knowledge did not exist prior to the present research. The literature was identified through a literature search. The key word "Mental health" paired with the keywords "operations management" "operations research" and "engineering" separately were used to search the Google Scholar, ProQuest, and INFORMS databases. References were retained and additional references that were not identified via the search were considered for review based on the experience of the researchers. In total, twelve references were reviewed. Future research should consider a more in-depth, systematic review of the literature on this topic.

Findings from the relevant literature in both military and civilian spheres were categorized using the architectural views introduced in Nightingale and Rhodes's Enterprise Architecture framework and its eight views: Strategy, Organization, Processes, Knowledge, Information, Policy, and Products/Services (Figure 2). This framework was chosen because of the breadth of the topics covered within the literature that addressed psychological health issues using industrial and systems engineering and operations management approaches. An enterprise can be defined as a complex, integrated, and interdependent system of people, processes, and technology that creates value as determined by its key stakeholders [10]. Nightingale and Rhodes [11] found that enterprises are often insufficiently architected from a single point of view, such as a strategy view or a process view, and posit that enterprises must be architected from all architectural views collectively, as alignment across all views is critical to achieving performance [11]. The military and civilian systems for delivering psychological health care are highly complex, large enterprises that consist of multiple organizations, processes and stakeholders. Mapping the current literature to the Enterprise Architecture framework allows the observation of the views within the military and civilian enterprises that have been examined and not addressed by the current body of knowledge.



Figure 2. Enterprise Architecting – Eight Views [11]

## 4. Findings

Models utilizing a systems paradigm for the improvement of psychological health has been seen as early as 1966, when Hunter and Schnee [12] agreed to analyze problems related to the location of new Outpatient Psychiatric Clinics with regards to Pennsylvania's Comprehensive Mental Health Plan, and the importance of the examination of future health requirements and human resources required to meet these needs was identified. Similar models to those developed to combat the incidence of PTSD and related conditions in the military sector have since been used

to improve psychological health system performance, with various focal points such as process improvement, human resource allocation, and performance measurement. This section presents those models for both the military and civilian sectors, and categorizes them by architectural views as presented in the Enterprise Architecture framework [11]. A summary of findings mapped to the appropriate architectural view can be found in Table 1.

#### 4.1 Strategy, Services

As described in the Enterprise Architecting framework [11], the Strategy view encompasses all factors relevant to creating an enterprise reflective of its strategy: strategic goals, the enterprise vision and direction, including its business model, and its objectives and metrics, while the Services view describes the primary and supporting services the enterprise delivers to its customers. An enterprise's strategic goals influence decision-making regarding various resources (e.g., human and technical) and how they are used, as resource assessment and allocation should be aligned with the enterprise's strategy and services if the enterprise is to be effective and successful. The majority of the literature identified in this category related to resource decision-making.

##### *Military Literature*

The Center for Naval Analyses (CNA) developed the Psychological Health Risk-Adjusted Model for Staffing (PHRAMS) that identifies the proper level of staffing at the local level for psychological healthcare providers [13]. PHRAMS is based on current demand and helps to determine what levels of human resources are needed in the future as opposed to just allocating resources currently in possession more efficiently.

Atkinson et al. [14] developed a dynamic model to forecast future demand, i.e., the number of OIF Army and Marine service members that will develop PTSD, accounting for an additional time lag from the time of exposure to combat stress to the development of PTSD symptoms [14]. Their model estimated based on current conditions that the amount new PTSD cases would increase by approximately 20,000 cases each year the war is prolonged. It should be noted that there was considerable uncertainty to the model ( $\pm 30\%$ ), but this is a useful effort that can greatly contribute to the care of PTSD in the future, as the model is refined.

The Workshop Steering Committee on Systems Engineering Health Care supported by the IOM presented areas for future research for traumatic brain injury (TBI) [4]. Areas for research included the development of enterprise-level performance metrics for TBI; the examination of the alignment of relevant organizations, processes and human resources; and the study of resource allocation in a period of scarcity. The impact of various co-morbidities of TBI patients, including PTSD, was also considered. Two challenges contributing to the difficulty of this future research include the number of organizations and facilities involved in the system, as well as limited capabilities for patient tracking and case management [4].

##### *Civilian Literature*

Researchers have also modeled civilian mental health programs, which tend to use human resource availability and program efficiency and effectiveness to assist in decision-making regarding resource allocation at the program level [15, 16]. For example, Leff et al. [16] developed a linear programming model that allowed system managers to allocate human resources via the aggregation of patients according to their functional level and service needs, and defining "service package options" for each aggregate patient group while maximizing a measure of system welfare within the available resources. In the State of New York, a simulation model for psychological health care was developed for the Ways and Means Committee of the New York State Assembly for fiscal and legislative planning, further demonstrating the value of a systems approach in resource allocation in the civilian sector [17].

#### 4.2 Organization, Process

The Organization view in the Enterprise Architecture framework [11] is described as representative of an enterprise's organizational structure, including relationships, culture, behaviors and boundaries across entities in the enterprise, while the Process view represents the enterprise processes that are designed to create value for the enterprise [11]. The dynamics of an organization affect the implementation of system changes, as the relationships between individuals and the overall culture of the enterprise will largely determine the outcome of those changes and the extent to which they are successful. The literature identified in this category related to organizational and quality improvement efforts and organizational and personnel behaviors.

*Military Literature*

Burnam et al. [18] reviews several academic and practitioner sources of quality improvement (QI) techniques including improvements to patient self-management support and clinician education and decision support. The summary also notes that the consideration of providers’ attitudes, beliefs, and motivations in the design of QI interventions may be critical to long term success. In particular, strong support from leadership was found to be a critical factor in implementing successful QI for psychological health care [18].

*Civilian Literature*

Currently, an effort is underway to map clinical, financial and organizational factors driving the usage of state psychiatric hospital services in the Central region of North Carolina [21]. These factors will later be used in modeling the dynamics of psychological health care delivery in this region and support implementation and planning efforts in the Eastern and Western regions of the state in an effort to alleviate the severe shortage in services for psychological health in North Carolina.

**4.3 Policy**

The Policy view describes the political, regulatory and societal factors indicative of the environment in which the enterprise operates [11]. The literature identified in this category related to policy decisions based on process redesign efforts.

*Civilian Literature*

Smits [22] developed a systems dynamics model to examine the impact of policy and process design on the management of intake and treatment processes in psychological health care. This model simulated the impact of changes in the design of intake and treatment processes to the existing care unit, demonstrating that process redesign and stepped care had the most impact in increasing client intake rate and revenues per day. Similarly, a stochastic model was used to examine changes in patient numbers as general hospital psychiatric units were increasingly used as alternatives to public psychiatric hospitals; this model was eventually used in local and state planning [23].

Table 1. Summary of Findings Mapped to Applicable Enterprise Architecting Views

Applicable Views of Enterprise Architecting	References of Existing Frameworks and Models	
	Military	Civilian
<b>Strategy</b>	[4, 13, 14]	[15-17]
<b>Process</b>	[18]	[21]
<b>Policy</b>	--	[22, 23]
<b>Services</b>	[4, 13, 14]	[15-17]
<b>Organization</b>	[18]	[21]

**5. Discussion**

This literature review demonstrates there is ample opportunity for future industrial and systems engineering and operations management research in psychological health across all aspects or views of the enterprise: Strategy, Policy, Process, Services, Organization, Knowledge, and Information. Initial target areas for future research could be the enterprise architecting views that appear to have no existing frameworks and models: Knowledge and Information. The greatest potential for impact may lie in applying frameworks and models developed for the civilian sector into the military’s efforts for psychological health care, including for PTSD and related conditions. Additionally, some research conducted in the military psychological health care context could be used to further improve models and planning for civilian psychological health care efforts as well.

Modeling efforts have been made towards understanding the strategies of psychological health enterprises, particularly regarding resource allocation, demand forecasts, and even prevalence of psychological conditions. One difference between the military and civilian models is that the military models of resource allocation tend to forecast the demand for psychological care services and use that demand to help determine future resource level needs [e.g., 13]. Civilian psychological health care models tend to examine the most efficient allocation of resources, including measures of patient functionality, service needs, and overall system welfare [e.g., 16]. Combinations of models from

the military and civilian sectors would provide even more robust models that consider both general patient demand and resource allocation as well as more detail regarding patient needs to take a more holistic approach.

Regarding organizational factors of the enterprise, strong support from military leadership was shown to be a critical factor in implementing successful improvements for psychological health care [18], and should be taken into consideration when adopting QI for the military psychological health care sector. Future work could apply these findings to focus on how leadership may affect troop morale and combat spirit, and its overall effect on overall combat effectiveness [19, 20]. Policy and process-related factors, including performance measurement systems and evaluation of program effectiveness [7, 8] may benefit from the use of system dynamics modeling [e.g., 22]. Furthermore, information gained as a result of process-redesign could be used to inform future policymaking and initiative planning [21].

## 6. Conclusion

The findings underscore the benefits of using a systems framework, such as the Enterprise Architecture framework [11], to examine multiple aspects or views of an enterprise in order to understand how a body of knowledge currently addresses those views. It is evident that the military and civilian sectors have both made significant efforts using industrial and systems engineering and operations management to improve psychological health care delivery; however, none of this work to date appears to focus on the knowledge or information views, which consider the knowledge and abilities inherent to the enterprise and how information flows throughout the system. Understanding tradeoffs and flows of information within the psychological health care delivery enterprise will be critical as information technologies advance, and future work to assess how best to incorporate new information technologies in an effort to improve psychological health care delivery in both military and civilian sectors should provide valuable insight in future planning. Finally, it appears as though both sectors have not yet considered how best to architect future psychological health care enterprises with consideration to treatment type (e.g. cognitive-based therapies compared to pharmaceutical therapies). Future work may also focus on a comparison between models for treatment types, as that knowledge may help decision-making and resource allocation regarding patient and treatment types. As industrial and systems engineering and operations management is used to assess the current states of health care systems and leveraged for transformation and performance assessment, a holistic view of health care enterprises will be critical for researchers and healthcare practitioners alike in order to study and improve the system-at-large.

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