Hospital Facility Layout

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Abstract
Many hospitals in the United States are designed using old techniques which have proven to be inefficient; there is a high cost of maintenance, and poor patient services are usually present. The implementation of a standard set of engineering facilities planning and design techniques can help minimize this waste. To aid in the creation of a set of standards to be used when designing an area of a hospital, research has focused on patient-centered care and the Patient Centered Medical Home (PCMH). Patient-centered care addresses many concerns in hospital facilities including lack of financial counseling, long wait times, overcrowding during peak hours, excessive personnel, and many other things. In order to move in the direction of this idealized state of healthcare, this research has combined patient-centered care with facility layout in order to provide a resource to increase the throughput of patients while addressing their concerns. Implementing this approach will require improving information systems, addressing logistical issues, and more extensive record keeping. Using this research along with Systematic Layout Planning (SLP), a “real-life” and an “ideal” patient-centered layout has been created. These layouts have been mirrored in a simulation model to prove the efficiency of a patient-centered system. The results have shown a significant decrease in patient waiting times, travel distance, and the required number of employees.

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The Need for Project

Hospitals are complex and require verified techniques to address increasing patient volumes and complex logistical systems. Hospital operations require diverse functions and complex logistical systems that link different departments. The planning and implementation of a facility design becomes increasingly difficult when factoring in required sterile rooms while keeping sick patients away from them. From an Industrial Engineering perspective, if the wrong technique is implemented, an incredible amount of waste can be created inside the hospital. Long distances that patients, medicine, and information have to travel contribute to inefficient practices. The 2012 healthcare system is doctor-centered and is not ideal in addressing all patient needs and requirements.

The Design Project Objectives and Requirements

The project objectives are to create a set of recommendations to be referenced by healthcare professionals that take into account patient-centered care. These recommendations must be supported and/or proved by industrial engineering techniques.

Design Objectives

The objective of this project is to create a set of recommendations to be referenced by healthcare professionals. The recommendations address work-flow, quality of service, logistics, and safety issues. To verify these recommendations, Industrial Engineering techniques have been used to test both a “real-life” and an “ideal” system. These techniques include Arena simulation and Systematic Layout Planning (SLP) (Rep. 4).

Design Requirements

All recommendations must be built on findings uncovered using Industrial Engineering techniques. All recommendations must take into account patient satisfaction and comfort, not just on systems efficiency. Patient-centered care should play an integral role and be present in all recommendations. Patient-centered care should also be present and rationalized in the simulation and the “ideal” facility layout which will be the foundation for all of the recommendations.

Design Concepts Considered

Several industrial engineering techniques have been used extensively in healthcare facility design, which will affect the patient-centered model created by the capstone design team.

Operations Research Techniques

Linear programming is a common mathematical modeling tool that is used to minimize cost and maximize revenue. It can also be used in staffing, scheduling, resource allocation, and inventory ordering and management. More complex mathematical models such as integer programming and genetic algorithms have also been applied to healthcare facilities.
**Systematic Layout Planning (SLP)**

The designer develops a relationship chart that shows the importance of each department with respect to each other. From here an activity relationship diagram is developed. This diagram is adjusted according to trial and error. This has been used extensively in layouts fields including healthcare to plan and implement new or to modify existing structures (Rep. 2.3.1).

**Controlled Movement Method**

Given the need for sterility in a hospital, certain areas must be allocated only for “clean traffic” to pass through. Traffic entails hospital staff, patients, visitors, food, linens, and other materials that move through the hospital facility. In order to respond to the need of segregating “soiled traffic” from “clean traffic”, hospitals have parking for staff and visitors separate from patients and ambulatory parking. This also translates to different examination, operating, and storage rooms where entry is only allowed to “clean” personnel. This facility design technique also keeps movement of outpatients and inpatients separate because they do not want a patient who was just discharged to encounter a contagious disease on his or her way out of the hospital (Rep. 2.3.2).

**Discrete-Event Simulation**

Simulation has been used extensively in the past when it comes to healthcare, often along with other methods. Research shows that simulation has been used in facilities planning and design in many fields. In a field such as healthcare where there is very little room for error, simulation has proved to be ideal. Simulation can be a great tool when it comes to the initial planning, reevaluation, or future expansion and it can help any project. One must use simulation in order to test the more complex areas of healthcare: scheduling, facilities planning and design, resource allocation, staffing, queuing analysis and many others. It is imperative to use such tools, if available, where any real world changes could be costly financially, to the quality of service, or to the safety of the consumer (Rep. 2.3.3).

**Recommended Design Concepts**

SLP was used to create relationship charts between different areas of a hospital. It was used to create a floor plan, which will be tested using simulation and compared to a realistic non-patient-centered design.
patient satisfaction. The relationship diagram will be used in order to create an optimized floor plan for the ideal patient-centered care facility (Rep. 4).

**Discrete-Event Simulation**

Simulation was used to create two separate systems: a patient-centered model and a realistic non-patient-centered model based on data acquired from MEEI and the VA clinic in Vermont. The realistic model was created initially and the patient-centered model was created by modifying the original model based on researched patient-centered care principles. There were 7 principles found such as coordinated and integrated care and enhanced access (Ref. 20). These were implemented in the simulation for example to reduce doctor service times and reducing the amount of patients that require further tests after leaving the doctor’s office. All of these modifications were further verified by data collected from MEEI and the VA clinic as well as previous patient-centered implementations researched, including those created by UC Davis, Health Partner Medical Group, and others (Rep. 4).

**Analysis of Figures**

Performing SLP and applying patient-centered principles on a real layout to create an “ideal” layout resulted in a 48% decrease in patient travel distance through the system (as shown in the image on the cover page). This decrease may significantly contribute to patient satisfaction.

After applying patient-centered care principles in the new simulation model, wait times and employee numbers were reduced. Some of the numbers are shown below (Rep. 4).

<table>
<thead>
<tr>
<th>Measure Of Performance</th>
<th>From Realistic Scenario</th>
<th>From Patient-Centered Care</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Time in System</td>
<td>78.83 minutes</td>
<td>51.89 minutes</td>
<td>Total Time reduced by 34.17%</td>
</tr>
<tr>
<td>Waiting Time in System</td>
<td>8.41 minutes</td>
<td>1.68 minutes</td>
<td></td>
</tr>
<tr>
<td>Patient Travel in System</td>
<td>From 7 to 9 stages</td>
<td>From 5 to 7 stages</td>
<td>Total travel reduced by 25%</td>
</tr>
<tr>
<td>Number of Receptionists</td>
<td>5 Receptionists</td>
<td>2 Receptionists</td>
<td># Of Receptionists reduced by 60%</td>
</tr>
<tr>
<td>Number of Pharmacists</td>
<td>2 Pharmacists</td>
<td>1 Pharmacist</td>
<td># Of Pharmacists reduced by 50%</td>
</tr>
</tbody>
</table>

**Key Advantages of Patient-Centered Care**

Patient-centered care reduces current healthcare frustration by increasing responsiveness, having better scheduling system, and having electronic records to provide a better access to patient information and to increase the organization within the system. The main goal of PCMH is to provide personalized treatment and facilities layouts that are based around the patient. This may involve the reduction of noise in order for the patient to heal faster, bringing machines to the patient room so that the patient does not need to be moved, and encouraging the nurses to have more interactions with the patient in order to provide the patient with peace of mind and a
comfortable stay. All of these procedures will ensure a more efficient treatment due to customized care that the patient is receiving. It also focuses on having more flexible schedules and provides help with medications costs and insurance in order to meet patients’ needs (Rep. 3).

**Financial Issues**

Patient-centered facilities have proven to be financially sound investments all over the healthcare industry. When comparing the two models that were created by the capstone team significant savings have been achieved in staffing and queuing costs. With the improved flow cutting the amount of receptionists and pharmacists working has reduced staffing costs by $94,000 a year.

**Recommended Improvements**

Since the project’s scope was to create an ideal system, there are many assumptions that have been used in the simulation that helped create the ideal world for the simulation to run in. The world is far from ideal, so in order to create system that can run in a realistic world, much further research will need to be conducted. Also, each of the simulations will have to be significantly more complex and contain real-life numbers in order to verify what would happen in the real world.