Health Information Exchange System in Saudi Arabia

SELP 695 - Systems Engineering Integrative Project
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Spring 2015
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1.1 Overview

- The medical world is greatly advancing, yet it is not being updated in all parts of the world.

- Approximately 89,000 deaths are caused annually by medical errors, and this is ranked as the sixth leading cause of mortality in Saudi Arabia.

- Saudi Arabia spends most of its income on two things: education and medical care. Regardless of this fact they have not been able to improve their health information exchange system.

- Implementing an HIE system will save the country a tremendous amount of money and most importantly save many lives.
1.2 Current System in Saudi Arabia

There are four main hospitals in Saudi Arabia that serve approximately seventy percent of the country’s population:

1. Shomasy Hospital
2. King Saud University Hospital (KSUH)
3. Ministry of Defense Hospital (MDH)
4. Ministry of Interior Hospital (MIH)

There is no specific health information exchange system between these hospitals. In order to obtain patient health records it requires many authorizations. This process takes on average three to four weeks.
1.2 Current System in Saudi Arabia

**KSUH**
- Paper based Medical records
- All patients will be accepted
- Very long waiting time
- Takes up to one month to exchange health information

**Privet Hospitals**
- Electronic Medical records
- Very expensive medical cost
- No health information exchange

**Shomasy Hospital**
- Paper based Medical records
- All patients will be accepted
- Very long waiting time
- Takes up to one month to exchange health information

**MIH**
- Electronic Medical records
- Only patient with files will be accepted
- In emergency case Only Red and Orange tags will be accepted
- Takes up to one month to exchange health information

**MDH**
- Electronic Medical records
- Only patient with files will be accepted
- In emergency case Only Red and Orange tags will be accepted
- Takes up to one month to exchange health information

*Figure 1.0: Current Health Information Exchange*
1.3 Problem Statement: Emergency Room

Figure 2.0: Current Emergency Room Patient Flow
1.4 Project Objectives

- Demonstrate how System Engineering methodology and management solutions could handle such a complex project.

- Compare health information exchange approaches of other countries and suggest measures that can assist the medical sector of Saudi Arabia in applying the HIE system among its hospitals.

- Examine the ethical issues related to the shared health information.

- Emphasize public awareness, since this is a new concept to the culture as a whole.

- To use modern technologies and stakeholders’ participation as a key for effective transformation.
1.5 Interrogatives

**Who:** (Stakeholders)
- Ministry of Health
- Physicians, Nurses and Staff
- Main Four Hospitals
- Patients
- IT companies
- Private Hospitals

**Where:**

**What:**
Patients face difficulties while transferring from one hospital to another, and in case of an emergency, the work for the doctors and staff is more complex because they cannot have access to previous health records of the patients from different hospitals.

**Why:**
HIE needs to be installed in Saudi Arabia for the following reasons:
- Reduction of medical errors
- Improve healthcare quality
- Clear communication between hospitals
- Time of physicians, nurses and staff used more efficiently
- Reduce patient waiting time

**How:**
2.0 Literature Review

2.2 Health Information Exchange in Other Countries

- Research of countries who have had success with the implementation of the HIE system will be used as the background of the project solution

- The focus of the literature review will be on these three countries:

1. USA  
2. Germany  
3. New Zealand.
2.2.1 The United States

- In 2013 alone 58% of American hospitals shared health information with other health care providers. This figure translated to roughly a 167% increase since 2007.

- More than 57% of hospitals electronically exchanged laboratory results, radiology reports and ambulatory with outside providers in 2013.

- The HIE system used in Indiana has made the claim that it is the biggest statewide exchange system, which was launched in 2004 assisted in lowering of the health care costs of the state by up to 34%.
2.2.2 New Zealand

New Zealand is ranked by the Commonwealth Fund survey in 2012 as number one out of all leading countries for their great use of a Health Information Exchange

- 50% of the patients referred or transitioned to different hospitals are through an HIE system

- Health information such as test results can be requested and obtained easily within three business days. About 50% of patients use this requesting system monthly

- 40% of clinical laboratory test results are used as statistical data about a hospital as well as the country overall

- 80% of prescriptions are written electronically.
2.2.3 Germany

Germany are currently in the process of giving out electronic health insurance cards to patients

- Based on this, at least 50 million patients in Germany are expected to receive access to the electronic information exchange by the end of 2015

- The new system will allow complete access to records by hospitals in the country

- HIE system has reduced medical errors in the country by approximately 17%

- The hospitals with the HIE systems have witnessed an increase of patients case load by up to 11% since 2010.
3.0 System Requirements Analysis

3.1 Top Level Requirements

3.2 Second level Requirements

- 3.2.1 Emergency Room Requirements
- 3.2.2 System Use Requirements
- 3.2.3 Education Requirements
3.1 Top Level Requirements

- The HIE systems shall reduce medical errors by 15%.
- HIE shall provide better coordination and information flow between the main four hospitals through the new organized electronic system.
- The new HIE system shall be made mandatory by the Ministry of Health.
- The HIE system shall maintain accurate health records to help with medical research by the Ministry of Health.
- The HIE system shall reduce health care cost by eliminating redundant and unnecessary testing.
- The HIE system shall improve health care quality and process by reducing time wasted in unnecessary movements and allow patient to be treated everywhere.
3.2 Second level Requirements

3.2.1 Emergency Room Requirements
- All Emergency rooms in all four hospitals shall be connected to the HIE system
- Each emergency room shall have at least three HIE employees in charge of the data input
- Each emergency room shall have computers approved by the IT Company to guarantee HIE performance

3.2.2 System Use Requirements
- The system shall be easily accessible
- The system shall be available 24 hours a day, 7 days a week
- The system shall be coordinated with the Ministry of Health

3.2.3 Education Requirements
- Training shall be provided for all users of the system
- The HIE system shall have an informative brochure for all patients provided by the Ministry of Health.
4.0 Cost and Benefit analysis

- Conducting a CBA is a necessary step in executing a large-scale project, such as the new HIE system in Saudi Arabia.

- Saudi Arabian medical system is mostly being funded by the Saudi government, the CBA will be conducted on the basis of reducing health care costs and improve healthcare quality.

- Applying an HIE system can streamline the ER operations, reduce administrative costs and reduce medical errors.

- Cost savings will also come from eliminating redundant or unnecessary testing as well as lowering working hours and reducing patient visit time in an emergency rooms.
4.0 Cost and Benefit analysis

- cost related to the system such as:
  - Hardware
  - Software
  - Computerizing paper based records
  - Standardizing medical terminologies and health information structure

- cost related to the implementation of the system such as:
  - Provide training for the use of the new system
  - Hiring an HIE employees for data entry and update
  - Support and maintenance.
<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Implementing cost</th>
<th>Annual cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIE system hardware (Including: PCs, routers, switches and other related HW)</td>
<td>HIE department requires a specific computer which connects to the system directly which cost approximately $15,000</td>
<td>15,000 * 4 = $60,000</td>
<td>2,000 * 4 = $8,000</td>
</tr>
<tr>
<td>Standardizing Medical terminology and database structure</td>
<td>According to Epic Averona several studies estimate the cost of standardizing an electronic health record (HER) is $70,000 per provider</td>
<td>70,000 * 4 = $280,000</td>
<td></td>
</tr>
<tr>
<td>Database management system + HIE software</td>
<td>According to Oracle company website: License fee + maintenance fee for such complex project is = $ 300,000 /year</td>
<td>$300,000</td>
<td>$300,000</td>
</tr>
<tr>
<td>Temporary productivity loss</td>
<td>An estimation of temporary (3-month) loss of productivity (for physicians and nurses overtime) $30,000 per Hospital</td>
<td>30,000 * 4 = $120,000</td>
<td></td>
</tr>
<tr>
<td>Support and maintenance</td>
<td>In most cases, clinical decision support features will decrease utilization by suggesting more appropriate testing</td>
<td></td>
<td>6,000 * 12 = $72,000</td>
</tr>
<tr>
<td>Training</td>
<td>Estimated training cost of $500 for nine HIE employees per hospital (three employees per shifts, three shifts per day)</td>
<td>9 * 500 * 4 = $18,000</td>
<td></td>
</tr>
<tr>
<td>HIE employees</td>
<td>Each ER in the four hospitals shall have three employees for data entry and provide nurses with new patent health records</td>
<td></td>
<td>9 * 2,000 * 4 * 12 = $860,000</td>
</tr>
</tbody>
</table>

Total implementation cost = $778,000  
Total annual cost = $1,240,000

Total cost = $1,240,000 + 778,000 = $2,018,000
4.0 Cost and Benefit analysis

- The cost savings were broken into:
  - hospital readmissions
  - physical examinations
  - physician consultations

As well as time saving for physicians, nurses and emergency room which is a huge waste in the current system.
4.0 Cost and Benefit analysis

The average number for the ER patient in the main four hospitals is 60,200 patient per year
KSUH – 35, MDH – 50, MIH – 50 , Shomasy – 30 Patient per day

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Annual savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory/microbiology, Radiology, Consultations</td>
<td>According to the American College of Emergency Physicians. HIE saved more than $2,000 per patient. (The average number for ER patients for the four main hospitals is 60,200 patient per year)</td>
<td>2000 * 0.20 * 60,200 = $24,080,000</td>
</tr>
<tr>
<td>Time saving in Hospital admissions</td>
<td>Each new patient needs to open a file in order to be treated this admission takes time and effort each time a new patient comes</td>
<td>50 * 0.2 * 60,200 = $602,000</td>
</tr>
</tbody>
</table>

Total cost = $1,240,000 + 778,000 = $2,018,000
Total saving = $24,682,000
SPP = $2,018,000 / $24,682,000 = 0.0817 = 8.17% year
5.0 Implementation Methodology

- 5.1 Concept of Operation
- 5.2 System Architecture
- 5.3 Risk Analysis
- 5.4 Testing, Verification and Validation
5.1 Concept of Operation

- The HIE system is going to be managed by the Ministry of Health and directed by the emergency department of the main four hospitals.

- A computerized electronic network system will be used to serve users’ needs.

- It will eventually be implemented in all hospitals in Saudi Arabia.
5.2 System Architecture

High-Level Operational Concept Graph (OV-1) AS-IS Current:

Figure 5.0: Current Health Information Exchange
5.2 System Architecture

High-Level Operational Concept Graph (OV-1) TO BE:

**Priveet Hospitals**
- Electronic Medical records
- All patient will be accepted
- Less medical cost
- Instant health information update

**MIH**
- Electronic Medical records
- All patient will be accepted
- Less medical cost
- Instant health information update

**HIE System**
- Electronic Medical records
- All patient will be accepted
- Less medical cost
- Instant health information update

**Shomasy Hospital**
- Electronic Medical records
- All patient will be accepted
- Less medical cost
- Instant health information update

**MDH**
- Electronic Medical records
- All patient will be accepted
- Less medical cost
- Instant health information update

**Ministry of Health**
- Physicians

**KSUH**
- Electronic Medical records
- All patient will be accepted
- Less medical cost
- Instant health information update

**FIGURE 6.0: Health Information Exchange after Implementing HIE**
5.2 System Architecture

Operational Node Connectivity Description (OV-2):

FIGURE 7.0: Node Connectivity Diagram
### 5.2 System Architecture

#### Operational Information Exchange Matrix (OV-3)

<table>
<thead>
<tr>
<th>No.</th>
<th>Source</th>
<th>Destination</th>
<th>Exchange Information</th>
<th>Exchange Type</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Four main hospitals</td>
<td>HIE</td>
<td>Update health information</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>2</td>
<td>HIE</td>
<td>Four main hospitals</td>
<td>Electronic health information</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>3</td>
<td>Private Hospitals</td>
<td>HIE</td>
<td>Update health information</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>4</td>
<td>HIE</td>
<td>Private Hospitals</td>
<td>Electronic health information</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>5</td>
<td>HIE</td>
<td>IT</td>
<td>Maintenance request</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>6</td>
<td>IT</td>
<td>HIE</td>
<td>Update maintenance request</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>7</td>
<td>Physicians, Nurses and Staff</td>
<td>HIE</td>
<td>Patients visit information</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>8</td>
<td>HIE</td>
<td>Physicians, Nurses and Staff</td>
<td>Patients health information</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>9</td>
<td>Physicians, Nurses and Staff</td>
<td>Patient</td>
<td>Treatment</td>
<td>In person</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>10</td>
<td>Ministry of Health</td>
<td>HIE</td>
<td>Regulations and policies</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>11</td>
<td>HIE</td>
<td>Ministry of Health</td>
<td>Statistics and reports</td>
<td>Electronically</td>
<td>Just-In-Time</td>
</tr>
</tbody>
</table>
5.2 System Architecture

Block Definition Diagram (BDD):

![Block Definition Diagram (BDD)](image)
## 5.3 Risk Analysis

### Risk Mitigation Table and Risk Matrix

<table>
<thead>
<tr>
<th>Risks</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- HIE System failure, IT system does not perform in accordance with the agreed specifications.</td>
<td>Insure that the requirements for remedying any failures are clear, including appropriate allowances made for timeframes and the consequences of the remedy not being executed within those timeframes</td>
</tr>
<tr>
<td>2- fails to properly specify the requirements and, as a result of this, the supplier's solution fails to meet actual requirements</td>
<td>The Ministry of Heath conducts an internal or external peer review of its technical requirements, to ensure that these are appropriate.</td>
</tr>
<tr>
<td>3- Schedule Risk, Delays</td>
<td>A detailed project plan is included in the contract, setting out a clear timetable and project milestones</td>
</tr>
<tr>
<td>4- Stakeholders fail to contribute as expected</td>
<td>Clearly assign responsibilities to each stakeholder</td>
</tr>
<tr>
<td>5- System use risk</td>
<td>Provide a training for all systems users</td>
</tr>
<tr>
<td>6- Over budget risks</td>
<td>The Ministry of Heath determines its key requirements in advance and does not change them unless this is absolutely necessary</td>
</tr>
</tbody>
</table>

### Likelihood vs Impact Matrix

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Insignificant</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td>Moderate</td>
<td>High</td>
<td>Extreme</td>
<td>Extreme</td>
<td></td>
</tr>
<tr>
<td>Likely</td>
<td>Moderate</td>
<td>High</td>
<td>Extreme</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possible</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>Extreme</td>
<td></td>
</tr>
<tr>
<td>Unlikely</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Rare</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td></td>
</tr>
</tbody>
</table>
5.4 Testing, Verification and Validation

The following features will be verified on a continues bases throughout the development of the project:

- The system features
- The system accessibility
- Integration and sharing features
- The system storage capacity
- Coordination features
- Network security
- Overall efficiency

Validation will be achieved by governments acceptance of this systems:

- Government acceptance.
6.0 Lean Methods and Quality Tools

- Lean technique involves reducing the time taken to produce an item by eliminating processes that do not impact or add value.

- The entire health system in Saudi Arabia is based on traditional thinking and rigid ways that do not want to be changed or updated, which leads to “do not fix it, if it isn’t broke” type of mentality.
6.0 Lean Methods and Quality Tools

Medical errors, long waiting time and inconvenience

- Why?

• Takes up to four weeks to exchange health information and patient load vary between hospitals

• Poor coordination between the four main hospitals

• Non standardized methods of health information exchange and medical terminologies

• Each hospital have their own management system

• There is no Health Information Exchange System mandated by the Ministry of Health
6.0 Lean Methods and Quality Tools

- Lean for HIE must adhere to these concepts: “It has to give speed, lower costs and connect processes into flow and remove waste” (Oppenheim, 2008)

By applying Lean Thinking in new HIE system, it will eliminate Six out of Ohno’s Seven Types of Waste which are:

- **Inventory** – organized electronic records
- **Transportation** – easy access to the HIE
- **Unnecessary Movement** – by excepting all patients
- **Defective Outputs** – reduce medical errors
- **Waiting** – instant access to the HIE
- **Over-processing** – eliminate unnecessary testing and redundancy
7.0 Ethical Issues

Privacy and Security

Three primary security goals

- Confidentiality
- Integrity
- Availability

Saudi Arabia Health Care Standards

- Must be authorized to gain access to it
- Health information must be protected and auditable.
- Useable and accessible upon authorized demand.
8.0 Lessons Learned

- Integrate **Systems Engineering** processes into a possible solution in order to better the health care sector in Saudi Arabia.

- Importance of **Lean and Quality**, which strives for the success of the system while considering how every move is going to affect, benefit, or harm the people.

- Importance of considering any **Ethical Issues** that might be caused.

- Learning who is involved as a **Stakeholders** in order to successfully implement the HIE system.
9.0 Conclusion

- An HIE System in Saudi Arabia has to be implemented to improve the healthcare in the country by reducing cost and medical errors.

- Saudi Arabian healthcare system must let go of their old traditional ways and evolve following countries such as the U.S, Germany and New Zealand who show great success with HIE.

- People are the most valuable asset. It is important to respect their opinions and experience, and provide them with the appropriate tools and working environment in order to help them to become a problem solvers.
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Thank You

Questions?