Project Number:

Quality Function Deployment: Healthcare Improvement

A Major Qualifying Project Report:

Submitted to the Faculty of

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Abstract

Using the QFD house of quality model, we were able to understand the fundamental customer quality and care requirements within the healthcare system. After creating a competitive analysis between five observed hospitals, we implemented a capstone design, which improved the original QFD house of quality model, specifically towards the hospital management. Furthermore, this design used the demanded quality and customer requirement relationship matrix to create a numerical understanding of the allocation of effort within specific areas of a hospital. This application can serve as a highly viable optimization tool within the healthcare system.

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Chapter 1: Introduction

In this chapter we will introduce the topic of our Major Qualifying Project as well as the eventual goals that we tend to meet by the end of our project and research. First we will introduce the goals and how they will be used throughout our project to amplify our research and observations. After introducing our goals and methods we will then introduce our MQP topic and the history of our MQP topic. This will help the readers get a background on the topic allowing them to have a better understanding of how and why Quality Function Deployment got started. Lastly we will look at the benefits that are associated with Quality Function Deployment so that the readers can understand how QFD would benefit their business relating to product and customer quality.

1.1 Goals

Our first goal that we wanted to attain from doing this project is a high understanding and knowledge of Quality Function Deployment. We want to learn what the methods of Quality Function Deployment and the applications that goes with Quality Function Deployment. By learning these methods and applications we will be able to apply our understanding of Quality Function Deployment to real world problems to help design quality products for customers. We will learn about the four phases that go along with QFD and how learning and applying these phases will give us the best understanding of QFD.

Our second goal is to be able to identify strategies and techniques associated with Quality Function Deployment. By researching and applying Quality Function Deployment to a real world problems will allow us to learn best strategies to attain the most accurate customer requirements, customer importance ratings, and other steps that are in product planning. As we

will find out through our applications of QFD customer requirements, customer importance ratings, and other steps within the product planning phase are very important to meet customer needs.

Our last goal we want to attain is the ability to prioritize customer needs and translate those needs into characteristics. By doing this we can get the most accurate QFD chart. A more accurate QFD chart means the more likely a product can be build to customer satisfaction. All these goals translate into one important goal. The knowledge and understanding to use Quality Function Deployment to highest of our abilities so when we apply QFD we can get the highest degree of customer satisfaction.

1.2 History of Quality Function Deployment

Quality Function Deployment was first developed in a by professors Shigeru Mizuno and Yoli Alao in Japan during the 1960s. Mizuno and Alao goals where to develop a method that would build a product that took customer satisfaction into consideration before being built as opposed to during or after the process. This first application used for Bridgestone Tire Company where it used the fishbone diagram to find customer requirements and the characteristics that they would need to control them[1]. (Creative Industries Research Institute).

In 1972 they used QFD in Japan at the Kobe Shipyard. This is where they took the fishbone diagram into a matrix. A study done in 1982 found that 54% of companies that were surveyed in Japan used QFD. The departments with the highest percentage that were using QFD were transportation, construction, and electronics to name a few. It would take a few years for QFD to makes its way over to the United States.

Don Clausing was one of the first to bring QFD over to the United States. It was first introduced at a GOAL/QPC conference in 1985. Don Clausing first learned of QFD while visiting Fuji-Xerox in Japan at the Tokyo Institute of Technology. Later that year QFD was taught to Larry Sullivan at a seminar for Ford Motor Company. Ford then starting using the QFD concept in everyday operations. May reason for this implantation at Ford of QFD was to counter that of its biggest competitor Toyota.

1.3 Benefits of Quality Function Deployment

The first benefit of using Quality Function Deployment is that it focused 100% on the customer. It looks at customer requirements and customer importance ratings which give a higher likelihood of success of customer satisfaction. Another benefit is improving communication throughout the team and also to the customer. The communication is horizontal within a company. More than one department will work on the QFD process. This will also result in understanding of the customer needs throughout the company which will lead to consensus decision making.

Other benefits associated with Quality Function Deployment are lowering costs and a greater chance that the product does well in the market. By applying QFD to a product you can reduce the number of design changes that you make to a product and you eliminate over designing a product. Lastly when you are focusing on the customer needs by looking at what they think is most important in a product there will be a higher likelihood that the product will do well in the market.

Chapter 2: Literature Review

As the introduction stated, the current process of QFD was created by the premise of transforming the demands of users into design quality in order to produce different methods for achieving a thorough manufacturing process. It is useful for in planning the characteristics of a new or existing product based on the marketing area of the company. Finally it turns the customer demand into a step-by-step process by prioritizing the several characteristics of the product in demand.

QFD began thirty years ago in Japan that was created based on giving products or services to simply make sure the customer was satisfied. It vehemently focuses the customer needs or desires to effectively use this process. Founders of the QFD model were Dr. Shigeru Mizuono, Dr. Yoji Akao, Dr. Tadashi Yoshizawa and other quality researchers. They developed further techniques in order to perfect QFD so that it could be applied to several different fields and maintain customer satisfaction.

Using the step-by-step process, we can correctly analyze the different characteristics that are implemented within each custom QFD analysis. This analysis is very beneficial because we can compare the importance of each characteristic with one another and also determine what qualities are necessary when competition is involved.

QFD became instantly popular due to its practicality but overall effectiveness in business in the 1960's when it was created. As time went on, this idea migrated to several countries from Japan as companies realized its usefulness in many facets of business. In 1983, many companies in North America discovered this approach and are currently using it with engineering to optimize their products and services and the design and development process of QFD itself.

Since then, QFD has not only improved quality within businesses but also the U.S healthcare industry and University level Education system.

2.1 University of Michigan curriculum improvement using QFD and AHP

QFD has been used in several different universities throughout North America, Europe, and parts of Asia. One of its earliest uses was in the mechanical engineering department of the University of Wisconsin – Madison in 1991. Its basic use was to assess and respond to the needs of his faculty. Many more application started to appear in the early 90's. In one high school guidance program, one reported the fantastic improvement of student involvement in college preparation. Moving further on in 1995, the curriculum of Wayne State University was observed by Hillman and Plonka. The curriculum was reviewed and changed if necessary based on the needs of the current industry and the employability of its engineering graduates.

Glenn H. Mazur, an adjunct lecturer at the University of Michigan College of Engineering, did further research. He was given the opportunity to teach a course in the University of Michigan, a course in total quality management. His goal was to understand the current needs that were required within the working industry and correlates that to what students should be learning within the classroom. He proposed a step-by-step process of understanding the customers within this set. At first he used Dr. Akao's internal/external evaluating scheme in order to organize that the customers were.

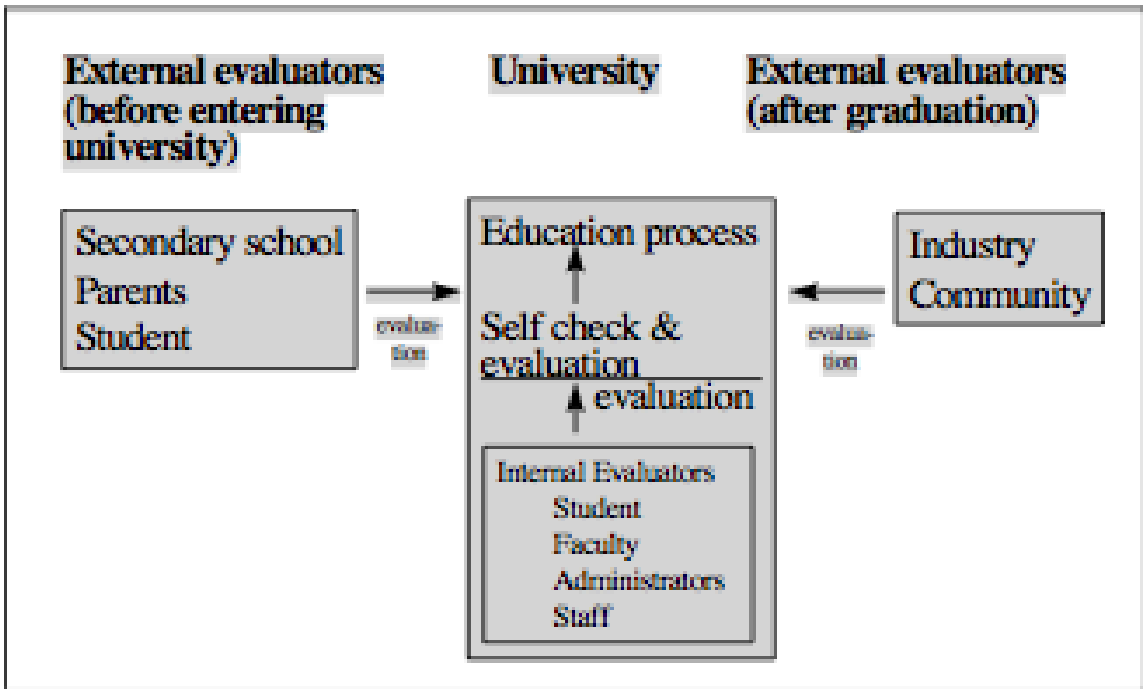


Figure 2.1 External Evaluators

In this Figure 2.1 External Evaluators we can see that there are two external evaluators and one set of internal evaluators. The latter is the one that is particularly important. As he was trying to improve upon the engineering courses within the university based on the growing industry of the outside World. The students in particular were the internal evaluators due to their choice of being taught the subject and the industry was the external evaluator because they essentially judged the students' performance when they graduate.

Just to make clear what the industry needed and wanted, Mazur spoke with several engineering managers in the automobile industry, as Michigan was one of the largest automobile manufacturing cities of the World. This was done to understand what traits were favored beyond the normal schooling of the students engineering field. In order to fully conceptualize the needs, Mazur asked the engineering managers to list based on importance what qualities were favored

over others. The Engineering managers used the analytic hierarchy process in order to accurately measure the importance of qualities within the graduating engineer.

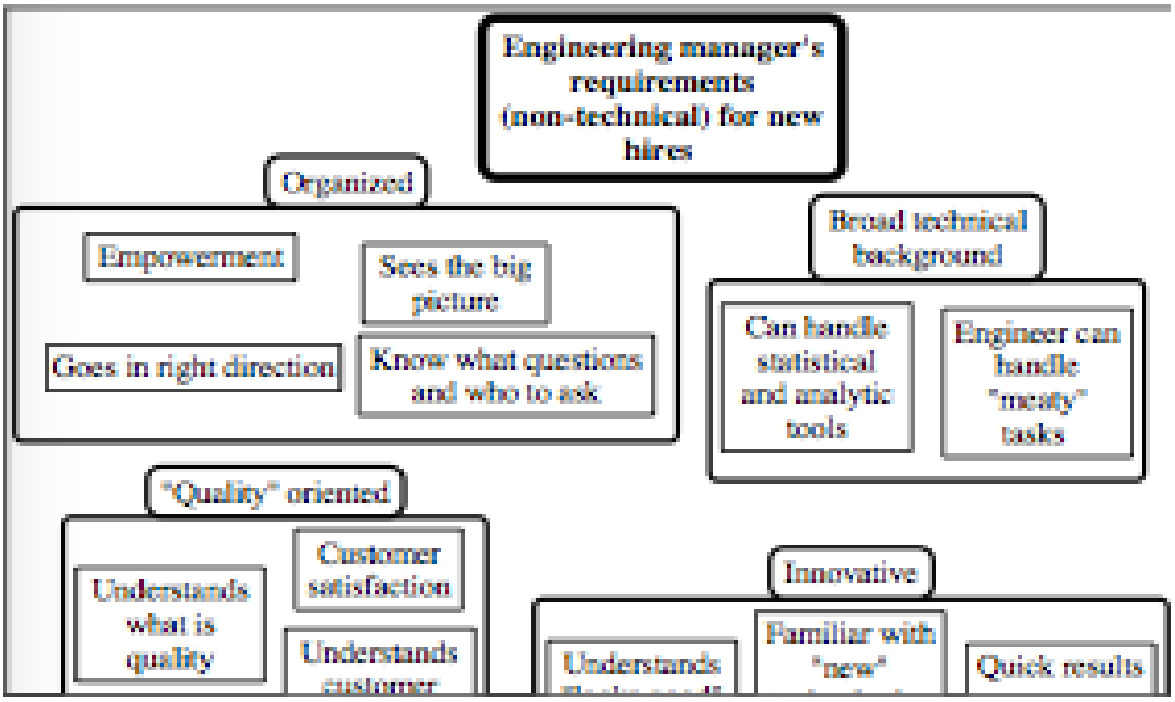


Figure 2.2 Engineer manager's Requirements

In this figure 2.2 Engineer Manager's Requirements, the qualities that were organized reached one sublevel. From this, the engineering managers used AHP to accurately rate their understanding of what is important in this automobile industry. The results are as shown in the next diagram:

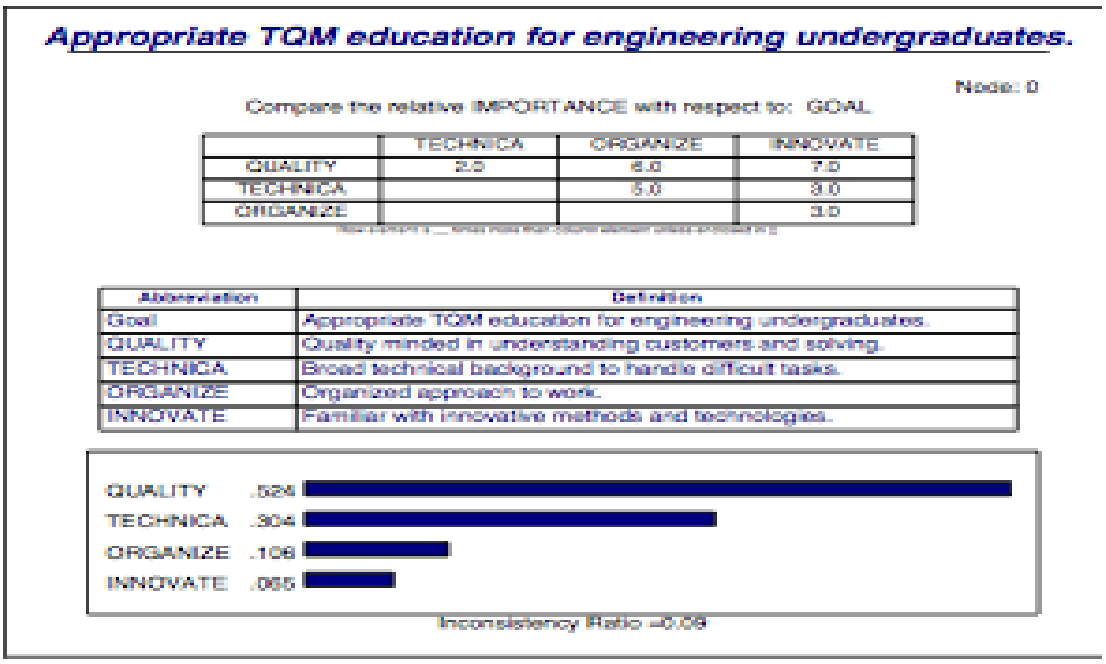


Figure 2.3 AHP Results

The details of understanding AHP are not necessarily important; however, a basic overview of this diagram will be explained. The AHP, which the engineering managers used, brought forth their personal opinions into a numerical weight decreasing by importance. As we can see, Quality was much more important than technical. Once this task was completed, the next major step was to translate this understanding to the requirements needed in the classroom. In order to complete this task, Mazur used a fishbone diagram with the head that held the "effect" and the skills/capabilities were listed through the bone. This information was then transformed into a quality table that contained the curriculum percentages; basically giving a minutely adjustable timeframe that should be spent on each attribute for the semester.

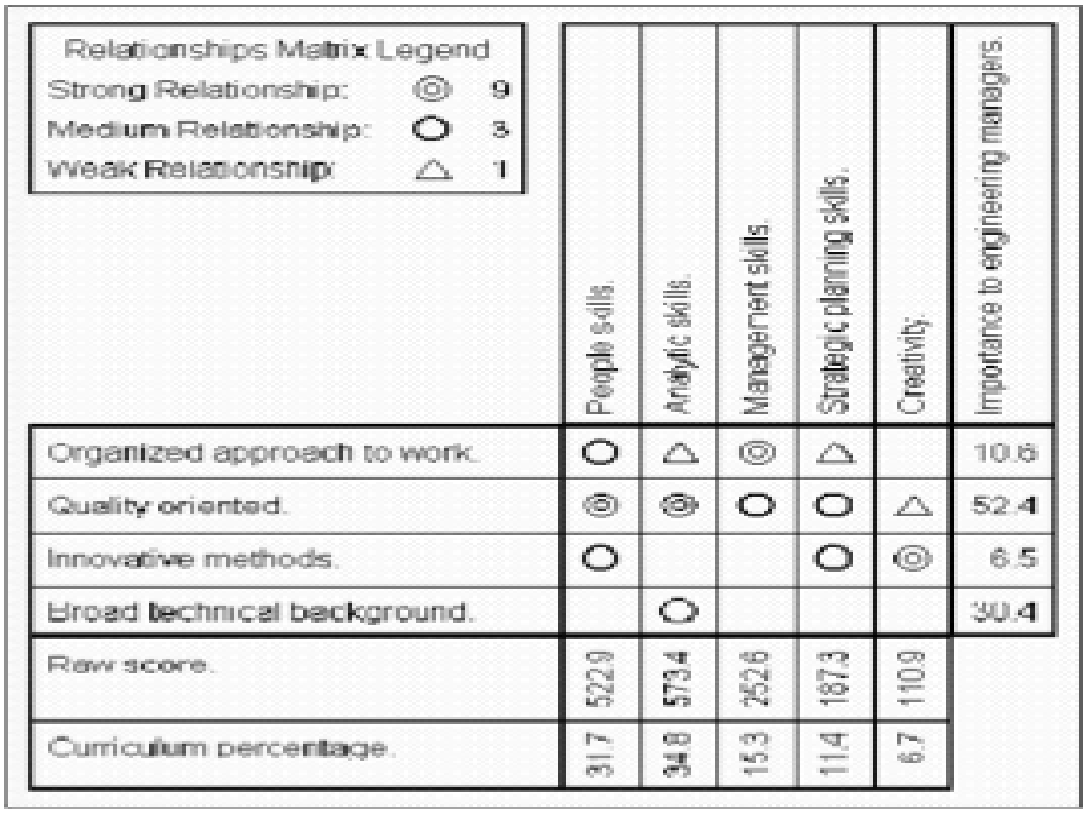


Figure 2.4 Quality Function Deployment Model

From this Figure 2.4 Quality Function Deployment Model we can see that the left side contains the different qualities that are desired, which creates a relationship matrix with the types of skills that are favored. The relationship matrix gives a visual representation of how each quality corresponds to each skill. Such as a quality oriented engineer should have great people skills; however, are not necessarily the most creative types. The right most columns show the importance to the engineering manager in terms of weight, just as was portrayed by the AHP model. Finally the raw score can be calculated once the relationship matrix has been taken into account. From the raw score, it is simple enough to calculate percentages and determine roughly how much time the curriculum should spend on each sub-subject.

Mazur was able to create an extremely well organized class schedule that fit the university requirements as well as making the students more appealing to the outside industry. This model and the steps used to create it made way for keeping up with current demands produced by the industry and keeping the university curriculum always up to date.

2.2 Greek Banking Sector Optimization using QFD and AHP

Although QFD is widely known in the manufacturing world, its methodology has also helped in the banking industry. It was utilized in the Greek banking sector in order to respond to customers' needs into attainable goals for expansion. Four people from the University of Macedonia, Greece, conducted this. Andreas C. Georgiou, Katarina Gotzamani, Andreas Andronikidis, George N. Paltayian all took part in administering this research. In general, their main goal was to understand the customers' wants from a bank in Greece. The team used a six selection criteria when analyzing the banks' customers. These were "Simple and effective service", "Innovation Products", "Pricing", "Working Hours", "Network Sufficiency", and "Location". The customers were however categorized into six different segments based on what bank product they used most frequently. These were housing loans, consumer loans, credit cards savings deposits, time deposits, and funds. The practical implications of their findings would greatly benefit in the decision making process regarding the correct initiatives to be taken with high plausibility of success.

In order to conduct this research, a questionnaire was given to the public to answer. It consisted of two parts; the first was demographic information discussing the six different marketable segments they belonged to. The second was a basic questionnaire that gave people

43 influencing factors of characteristics of a bank and they were to rate each factor from extremely important to not important at all.

Chapter 3: Quality Function Deployment

The QFD model that we will introduce in this chapter will be an application similar to what we have analyzed in the literature review. As we have stated, our project in detail is the use of QFD and house of quality model in order to understand the different aspects of a hospital, its efficiency from taking care of its patients to their response time when under pressure in dire situations.

The model itself consists of several different parts. We will use a step by step method to clearly explain and justify our procedure. As previously stated, the house of quality model has several parts from which it can be broken down into several numbers of steps. We however felt that it would be easiest to approach the model in a simple yet efficient process. Our intuition followed by careful planning brought us to dismantle the model into six important steps. Each step comprises the analysis of the quality demand and the quality characteristics; furthermore, each of these are basic elements to the house of quality model and will also be analyzed separately and how they affect one another in a positive or negative way. There is also a comparative analysis between five different hospitals we have used as examples. We used the demanded quality as a base for comparing the hospitals, from information we received from several sources. Finally, the quality characteristic was the final analysis. In this we focused on the importance of the quality characteristics and their "weight" when compared to each other. The model itself can be broken down into more than just six steps. However, we felt that each step was concise and explained the house of quality model effectively and in an organized fashion.

3.1 Customer Demands

This step closely observes just the demand quality aspect of the model. In other words, the customer requirements it holds and their importance in respect to one another. As listed in the model, the demand qualities are: Nurses Communicated well, Doctors Communicated well, Received help fast, Pain Always Controlled, Medicines always explained well, Rooms always clean, Quiet at Night, and At home recovery information. Customer requirements can be fairly vague but when it is displayed in the model as shown it is quite easy to comprehend what is expected in demand quality. When we think of a hospital, we believe it should be able to respond to patients quickly and keep other patients under constant care. This is the goal to comprehend and optimize.

The Customer requirements are without controversy the most important part of this model. Without it, there would be no available criteria to analyze or to improve upon. It is the grounds for us to build the house of quality model and the basis for optimization. In the four columns to the left of the demanded quality list, from right to left, shows the weight, relative weight, the max relationship value row, and the row number. The column on the right a weight ranging form 0 to 100 based on the research conducted and making an informed estimate as to what is most important and how all the other quality elements relate. The most important quality is how quickly patients received help. All other elements listed were given a weight based on its importance when compared to how quickly patients received help. For example, we saw fit that the doctor's communication was equally important to the staff controlling the patients' pain. Conversely, Patients receiving help quickly was scaled far more important than the quietness at night.

The simple comparison of importance carries over to the next column of relative weight. The numbers that were distributed in the previous column directly affect relative weight. Of the eight requirements, the relative weight is a sum, which adds up to a total of 100. The fundamentals of relative weight have large repercussions on how a hospital would conduct its business when dealing with patients. If we assume the relative weight is analogous to the attention which hospital management to focus on, then we can say that a fourth of the total attention should be focused on how quickly patients have been receiving help versus a tenth of the time on the communication ability of a nurse.

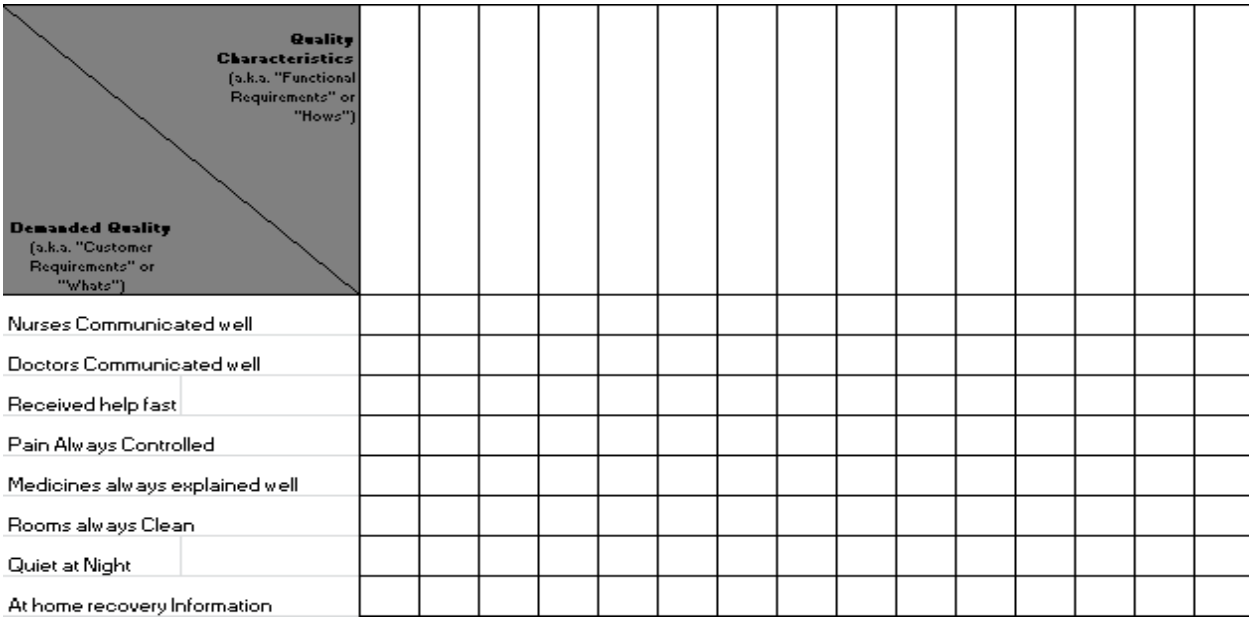


Figure 3.1 Voice of the Customer

3.2 Technical Requirements

Technical Requirements is our second step of Quality Function Deployment's House of Quality Diagram. This is also referred to as the voice of the engineer. This part of the house of quality diagram looks at what the customer wants from the demand quality and comes up with

the quality characteristics of how to achieve those demand qualities. Without those quality characteristics the hospitals will have no way to know what they have to do or what they need to have to meet the demands of the customers.

We choose our quality characteristics by looking at the demand quality and thinking of what would allow us to achieve those demands by the patients. As you can see in Figure 3.2 Technical Requirements our first and second quality characteristics that we came up with were staff explains information clearly and respectful towards patients. When we came up with both these characteristics we thought primarily of nurses and doctors communication. Our third customer quality characteristic was clean rooms daily. This was a quality characteristic of rooms always clean. The fourth characteristics were experienced staff. This was our most important characteristic because when thinking about our patient demand qualities, the characteristic that keep on coming up that would help us achieve the demands were experienced staff. The fifth quality characteristic was give written information for home recovery which we saw as a main characteristic for home recovery information and medicine always explained well. Give correct antibiotics and staff follows the correct procedures were are sixth and seventh quality characteristics. Both main characteristics helping achieve the patients pain always being controlled. Our last characteristics comes from patients having quiet overnight stays and the characteristic that we thought helped us achieve that was a regular nighttime visiting hours.

Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▲	▲	X	▲	X	X	X	X							
Quality Characteristics (a.k.a. "Functional Requirements" or "Hows") / **Demanded Quality** (a.k.a. "Customer Requirements" or "Whats")	Staff explains information clearly	Respectful towards patients	Clean Rooms Daily	Experienced Staff	Give written information for home recovery	Give correct antibiotics	Staff follow correct proceducere	Regular Nighttime visitor hours							
Nurses Communicated well															
Doctors Communicated well															
Received help fast															
Pain Always Controlled															
Medicines always explained well															
Rooms always Clean															
Quiet at Night															
At home recovery Information															

Figure 3.2 Technical Requirements

The second part of the Technical Requirements is to determine the direction of improvement. This is where the target value which will be talked about later and see if the company has to minimize the improvements, maximize the improvements, or stay at a target value. In our case we were looking to maximize our improvements for staff explains information clearly, respectful towards others, and experienced staff. For the rest of our quality characteristics we were looking to improve towards a certain target value for clean rooms daily, give written information for home recovery, give correct antibiotics, staff follows correct procedures, and regular nighttime hours.

3.3 Planning Matrix

The third step of our Quality Function Deployment was to determine the Planning Matrix within the House of Quality. As you can see in Figure 3.3 Planning Matrix, this step looks at the competitive Analysis of a certain company and its competitors. In our case we were not looking at one company and comparing them to others, but comparing all the companies to one another. The planning matrix uses a scale of 0 through 5 to analysis how each company is being rated. In this case 0 is the worst rating and 5 are the best.

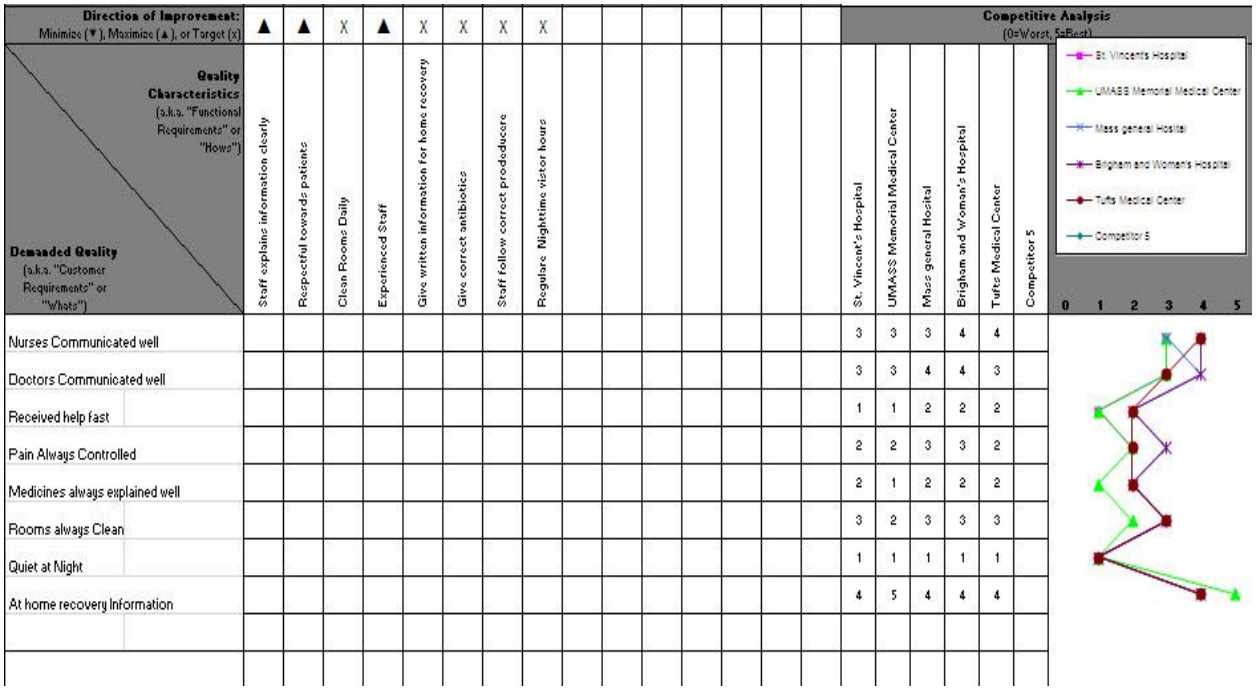


Figure 3.3 Planning Matrix

The companies that we decided to use to compare one another were St. Vincent's Hospital, UMass Memorial Medical Center, Mass General Hospital, Brigham and Woman's Hospital, and lastly Tufts Medical Center. All of which are highly recognized hospitals within the Worcester/Boston areas. We were able to gather our information on how to rate each of the

Demand Quality Customer Requirements by going to a hospital compare and looking up hospitals in Worcester, Ma and Boston, Ma. In that website we were given a few options of what data we could look at. For our data of customer ratings we needed to look at the Patient survey results. Our Customer Requirements were also determined from this patient survey so we used the customer feedback on this demand quality to determine the customer ratings.

As you can see for example of St. Vincent's Hospital in Figure 3.4 St. Vincent's Hospital Patient Survey we were given the hospital data on our customer demands. The customers who are patients in this case could answer always, sometimes, or never to the eight customer demand qualities. We were able to use the data and determine the customer ratings from that data. We based our ratings off of a grade like system using the 0%- 49%, 50%-59%, 60%-69%, 70%-79%, 80%-89%, 90%-100% to equal 0, 1, 2 ,3 ,4, and 5 respectfully.

View Graphs / View More Details	ST VINCENT HOSPITAL	MASSACHUSETTS AVERAGE	NATIONAL AVERAGE
Patients who reported that their nurses "Always" communicated well.	76%	78%	77%
Patients who reported that their doctors "Always" communicated well.	78%	79%	81%
Patients who reported that they "Always" received help as soon as they wanted.	59%	64%	65%
Patients who reported that their pain was "Always" well controlled.	65%	71%	70%
Patients who reported that staff "Always" explained about medicines before giving it to them.	63%	62%	62%
Patients who reported that their room and bathroom were "Always" clean.	74%	72%	72%
Patients who reported that the area around their room was "Always" quiet at night.	47%	51%	59%
Patients at each hospital who reported that YES, they were given information about what to do during their recovery at home.	86%	86%	83%

Figure 3.4 St. Vincent's Hospital Patient Survey

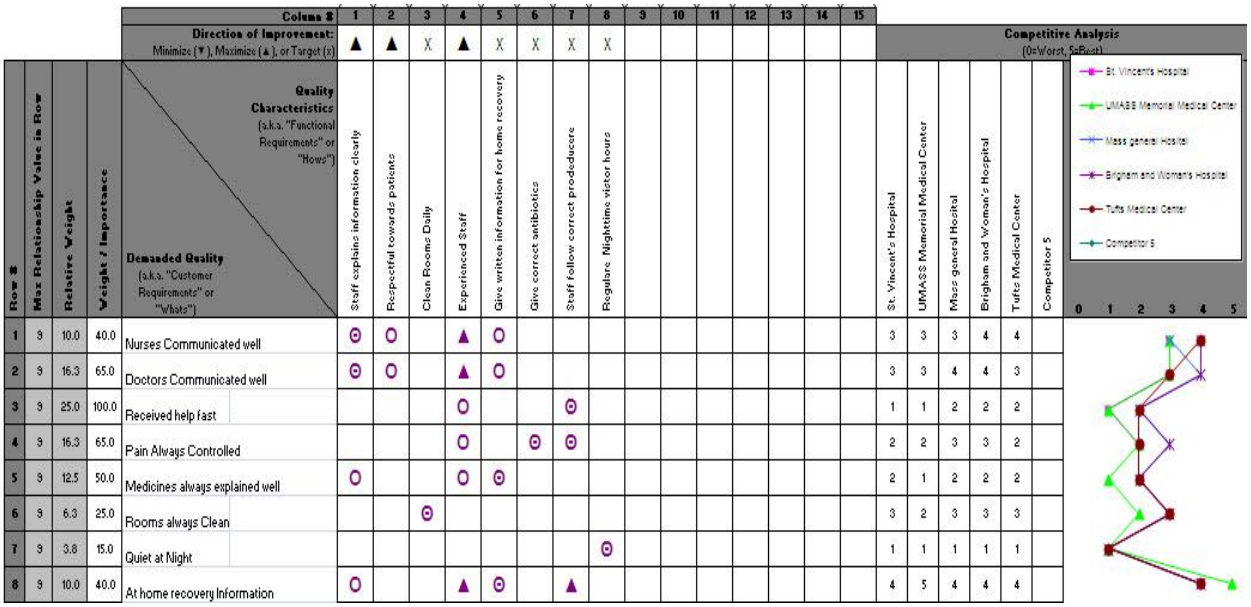
The planning matrix is the most important part of the House of Quality diagram to helping determine how a company is seen by its customers. When planning the product a company must first look at how to sell that product to its customers the best way that they can. They can do this by taking feedback from those customers that buy or use their product; in our example the customers are patients. Those five hospitals that we used as examples can look at the ratings of itself and its competitors and see what they need to improve upon to have the best service. They can look at how the patients rated other hospitals and implement some of what the other hospitals are doing that's helping them achieve a better product in the patient's eyes.

The second part of this panning matrix step is the Weighted Importance of the Customer Demand Quality. This part of planning matrix looks at the eight customer demand qualities that we have for our House of Quality diagram and shows a weighted importance two each one. There is no way two determine each weight using the House of Quality diagram it must be done by the individuals that are conducting the Quality Function Deployment research. By taking a look at Figure 3.5 Weighted Importance we can see the Weighted Importance that we were able to determine of each Demand Quality. We were able to do this by using our own experience with healthcare and patient care and what we as patients would see as the most important qualities for a hospital to have.

Out of the eight Customer Demand Quality Requirements our MQP group was able to determine that the most important Quality within a hospital would have to be Receive help fast. This could be from emergency room, to being prescribed medicine, to those on donor waitlists. All patients want to get help, medicine, and patient care as soon and quick as possible. We gave Receive help fast a weighted importance of 100 so that we could base the other customer demand qualities off of that. The next Weighted Importance that we determined was second most

important Customer Demand Quality was Pain always controlled and doctors communicated well. We thought that these two Demand Qualities were just as equally as important as the other. We gave those two Qualities 65 weight of importance which would give us about a relative weight of 16%. We choose the 65 because we were looking for a relative weight of around 15%. We knew that these two Demand Qualities were important but wouldn't be as important as the 25% that was for Receive help fast, but wouldn't be as low as some of the other ones.

Of the last five demand qualities we thought that nurses communicated well, medicine were always explained well, and at home recovery information were all basically just as important as one another. So there weight of importance were relatively close to one another. The last two customer demand quality both had to deal with overnight customer care. Rooms always being clean and the hospital being quiet at night we thought were the least important so our weight of importance were low giving us low relative weight.



Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	1 Staff explains information clearly	2 Respectful towards patients	3 Clean Rooms Daily	4 Experienced Staff	5 Give written information for home recovery	6 Give correct antibiotics	7 Staff follow correct proceducre	8 Regulare Nighttime visitor hours	St. Vincent's Hospital	UMASS Memorial Medical Center	Mass general Hospital	Brigham and Woman's Hospital	Tufts Medical Center	Competitor 5
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▲	▲	X	▲	X	X	X	X						
1	9	10.0	40.0	Nurses Communicated well	⊙	O		▲	O				3	3	3	4	4	
2	9	16.3	65.0	Doctors Communicated well	⊙	O		▲	O				3	3	4	4	3	
3	9	25.0	100.0	Received help fast				O			⊙		1	1	2	2	2	
4	9	16.3	65.0	Pain Always Controlled				O		⊙	⊙		2	2	3	3	2	
5	9	12.5	50.0	Medicines always explained well	O			O	⊙				2	1	2	2	2	
6	9	6.3	25.0	Rooms always Clean			⊙						3	2	3	3	3	
7	9	3.8	15.0	Quiet at Night								⊙	1	1	1	1	1	
8	9	10.0	40.0	At home recovery Information	O			▲	⊙		▲		4	5	4	4	4	

Figure 3.5 Weighted Importance

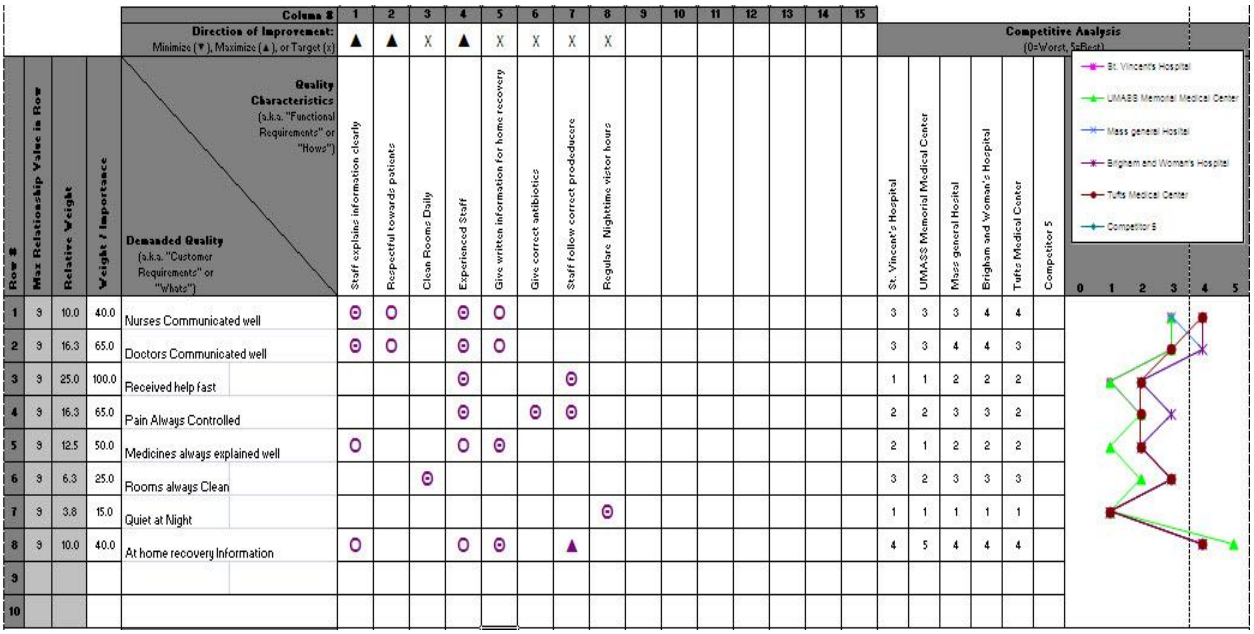
3.4 Relationship Matrix

The fourth step to our House of Quality Diagram within Quality Function Deployment is the set up a relationship matrix. The relationship matrix is designed to show a connection between the Customer Demand Qualities and the Quality Characteristics. The researchers are able to find this information/data by the opinions of the customers of the specific product. The relationship between the Demand Qualities and Quality Characteristics are shown by symbols representing a strong relationship, moderate relationship, and a weak relationship which are given a value of 9, 3, and 1.

With gathering this information and the planning matrix information this is a beginning step to makings a strategy that will improve the product that they are making or trying to sell to the customer. We are able to see the strengths and the weaknesses of the company which can be reviewed and determine what can be changed to equal the competition. The relationship matrix can be the voice of the customer and how they relate the demand quality with the characteristics or it can be how that company relates the two. The matrix should have at least one relationship measure for each of the voice of the customer and technical requirements.

The first customer demand quality that we looked at the relationship with our Quality Characteristics is the Nurse Communicate well. As you can see in Figure 3.6 Relationship Matrix we gave a strong relationship with staff explained information clearly and experienced staff. We thought that those were the most essential characteristics that a nurse should have so that they can communicate well to patients. Patients want their nurses to explain information as clearly as they can. They also want the nurses to have experience so when problems arise they know how to act. We gave a moderate relation between nurse communicated well with respectful towards patients and give information for home recovery. Both of which are not the most

essential characteristics but also add to a nurse that can communicated to the patients to the best of their abilities.



Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	Staff explains information clearly	Respectful towards patients	Clean Rooms Daily	Experienced Staff	Give written information for home recovery	Give correct antibiotics	Staff follow correct procedures	Regulare Nighttime visitor hours	St. Vincent's Hospital	UMASS Memorial Medical Center	Mass general Hospital	Brigham and Woman's Hospital	Tufts Medical Center	Competitor 5
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▲	▲	X	▲	X	X	X	X						
1	9	10.0	40.0	Nurses Communicated well	⊙	○		⊙	○				3	3	3	4	4	
2	9	16.3	65.0	Doctors Communicated well	⊙	○		⊙	○				3	3	4	4	3	
3	9	25.0	100.0	Received help fast				⊙			⊙		1	1	2	2	2	
4	9	16.3	65.0	Pain Always Controlled				⊙		⊙	⊙		2	2	3	3	2	
5	9	12.5	50.0	Medicines always explained well	○			○	⊙				2	1	2	2	2	
6	9	6.3	25.0	Rooms always Clean			⊙						3	2	3	3	3	
7	9	3.8	15.0	Quiet at Night								⊙	1	1	1	1	1	
8	9	10.0	40.0	At home recovery Information	○			○	⊙		▲		4	5	4	4	4	
9																		
10																		

Figure 3.6 Relationship Matrix

Our second customer demand quality was doctors communicated well. This was very similar to that of nurses communicated well. We thought that there was a strong relationship between the experience of the staff and staff explains information clearly too how well a doctor communicates. We gave a moderate relation with how doctors commutated with how respectful they toward towards patients and how well they gave information for home recovery for the same reasons as above.

Our third customer demand quality was receive help fast. As you can see we gave this demand quality the highest weight of importance which we talked about in the Customer Voice section of this chapter. Our receive help fast demand quality had strong relationships with both experienced staff and staff follows the correct procedures. For patients to receive help as soon as they walk through the door, the staff needs to know the right procedures for the patients to go

through. The staff also needs experience so that they know exactly how to treat each patient with making the least mistakes possible.

Our fourth demand quality was that pain was always controlled. Pain being always controlled had strong relationships with experienced staff, give correct antibiotics, and that the staff follows the correct procedures. Having a experienced staff like what was said in the previous demand quality will allow the hospital to treat the patient with the best knowledge that they have. Giving the correct antibiotics with allow the staff to control the pain the best way they can. Following the correct procedures will help control the pain for the same reason as receiving help fast. By the staff following the correct procedures this will lead to the pain of the patient being controlled.

Our fifth customer demand quality is medicine is always explained well. We had three relationships between this customer demand quality and quality characteristics. Those characteristics are staff explains information clearly, experienced staff, and give written information for home recovery. Staff explains information clearly had a moderate relationship. For medicine to be explained well the staff must explain it clearly and give the correct information to the patient. The patient needs to know how much of the medicine to take and when to take it. Experienced staff had a moderate relationship. An experienced staff will know exactly what information the patient needs for that medicine. Give written information for home recovery was given a strong relationship. For the same reasons as staff explains information clearly, the patient must know when to take medicine at home and how much to take.

Our sixth and seventh customer demand qualities both relate with overnight patient care. Those would be quiet at night and rooms are always cleaned. Quiet at night has a strong relationship with regulate nighttime visitors. There should a certain time when family members

and other visitors can come by the hospital to see the patient. A patient's stay should be as pleasant as possible and quality sleep is a big factor of that. Rooms are always clean has a strong relationship with clean rooms daily. Everyday a patient's room and the hospital should be clean. There are bacteria throughout the hospital from people being sick and there responsibilities on the hospitals part to lessen the patient and visitors contact with that bacteria.

Our last customer demand quality is at home recovery information which has a moderate relationship with staff explains information clearly and experienced staff, a strong relationship with give written information for home recovery, and a weak relationship with staff follows correct procedure.

3.5 Technical Correlation Matrix

The second to last step of our House of Quality diagram within Quality Function Deployment is the Technical Correlation Matrix. The technical correlation matrix looks at the customer requirements also known as the technical requirements as sees how each one affects the other. The goal is to see how each of the technical requirements, that we figured out in step 2, work together and change the requirements that have design conflicts. There are four symbols that represent strong positive correlation, positive correlation, negative correlation, and strong negative correlation. If there are strong correlations that are positive or any correlation between requirements there must be communication between engineers before making changes. A change in one requirement will affect that of another requirement. When it comes to negative or strong negative correlation changes would have to be made towards the requirements. An engineer doesn't want a requirement to negatively impact another.

The main reason for the technical correlation matrix is to find the negative correlation between requirements. When a House of Matrix has a negative correlation between customer

requirements, the engineer should try to make changes to eliminate that negative correlation. Sometimes improving a requirement can negatively affect another. This is because most of the technical requirements are closely related to one another. In some cases it is just best to not make improvements to some requirements.

As you can see in Figure 3.7 Technical Correlation Matrix we don't have any negative or strongly negative between any of our requirements. The strong positive correlation that we had for our Staff explains information clearly was with experienced staff and gives correct antibiotics. Staff explains information clearly also had two positive correlations with give written information for home recovery and staff follows correct procedures. We gave clean rooms daily a strong correlation with experienced staff. The experienced staff quality characteristic had a strong positive correlation with staff explains information clearly as mentioned previously. But also a positive correlation with give written information for home recovery, strong positive correlation with give correct antibiotics, and strong positive correlation with follow correct procedures. In addition to a positive correlation with staff explains information clearly and experienced staff, it also had a positive correlation with give correct antibiotics and staff follows correct procedures. Finally giving correct antibiotics had a strong positive correlation with staff following correct procedures in addition to the correlations previously mentioned for giving correct antibiotics.

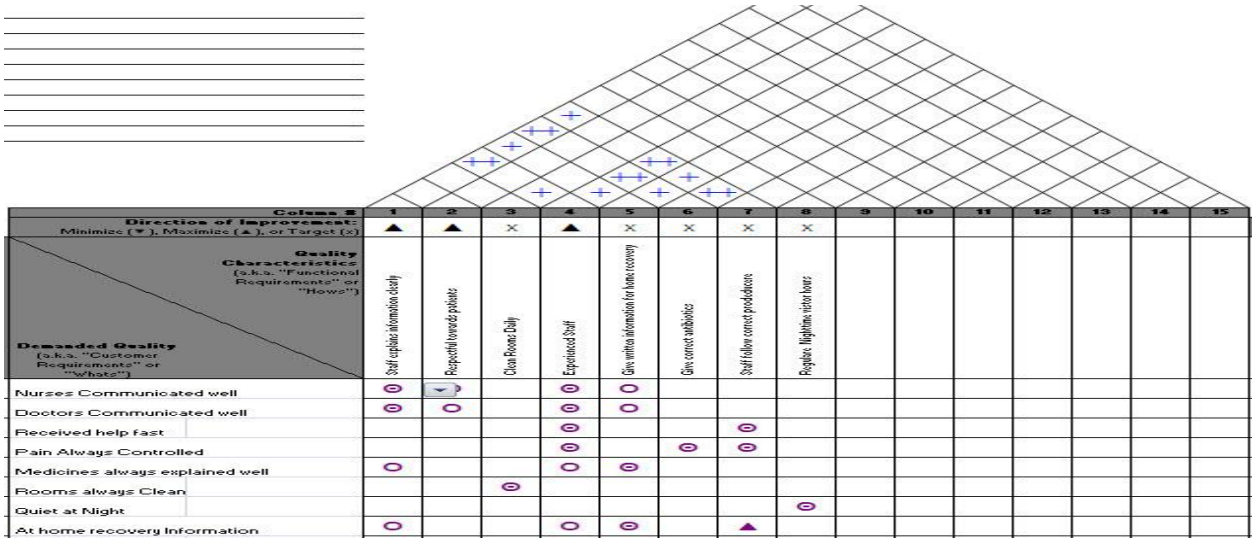


Figure 3.7 Technical Correlation Matrix

3.6 Technical Properties and Targets

The sixth and final step of Quality Function Deployment's House of Quality Diagram is the Technical Properties and Targets step. There are four important parts within this step. Those would be the target value, difficulty value, importance weight, and relative weight. The technical properties importance to the House of Quality Diagram is to give a weight of importance or priority weight for each of the customer characteristics. With having a high priority level for a characteristic, the engineer or company using this QFD, can then work quality characteristic issue to give the customer the best product. The goal of this step of Quality Function Deployment is to find the most important issues and work on those issues to give the highest level of customer satisfaction.

As can be seen in Figure 3.8 Technical Requirements, our first part of the Technical Properties and Targets was to set target values for each of the customer characteristics. This was done by taking what we thought the hospital should strive to achieve for each characteristic. For

most of our characteristics we wanted the hospitals staff to target 100% of the patients. We wanted 100% of the patients in the hospital to have staff explain information clearly, be treated respectfully, be given written home recovery information, given correct antibiotics. We wanted 100% of the staff to be experienced and to follow the correct procedures. The goals of the characteristics that dealt with overnight stay were that we wanted the rooms cleaned daily and that for their it to be quiet at night there had to be a visitor hour of 8 P.M. to 7 A.M. We gave difficulty rating for each of these character tics and their target values. These numbers represents how difficult it would be to achieve these target values.

The last two parts of the technical properties both relate to one another and those would be the weight of importance and relative weight. The weight of importance was calculate by taking the relative weight for the Customer demand qualities and taking the values of the relationships between those demand qualities and the quality characteristics. An example of this would be for their reposefully towards staff. A relative weight of 10 for the relationship with nurses communicates well and a relationship value of 3 give a value of 30. A relative weight of 16.3 for the relationship with doctors communicates well and a relationship value of 3 giving you 48.9. This gives you a weight of importance of 78.9. The weight of importance is then measured out of a value of 100% to give us the relative weight.

The relative weight tells us what which of the customer characteristics will have the highest priority. The highest relative weight is the characteristic that should have the highest priority. This means that the company, in our case hospital, should put that amount of relative weight to that characteristic to achieve the satisfaction that the customer wants. The hospital should do this for all the relative weights that were calculated for our QFD chart.

Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats") \ Quality Characteristics (a.k.a. "Functional Requirements" or "Hows")	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▲	▲	x	▲	x	x	x	x							
					Staff explains information clearly	Respectful towards patients	Clean Rooms Daily	Experienced Staff	Gives written information for home recovery	Gives correct antibiotics	Staff follow correct procedures	Regulate Nighttime visitor hours							
1	3	10.0	40.0	Nurses Communicated well	⊙	○		⊙	○										
2	3	16.3	65.0	Doctors Communicated well	⊙	○		⊙	○										
3	3	25.0	100.0	Received help fast				⊙			⊙								
4	3	16.3	65.0	Pain Always Controlled				⊙		⊙	⊙								
5	3	12.5	50.0	Medicines always explained well	○			○	⊙										
6	3	6.3	25.0	Rooms always Clean			⊙												
7	3	3.8	15.0	Quiet at Night								⊙							
8	3	10.0	40.0	At home recovery Information	○			○	⊙		▲								
9																			
10																			
				Target or Limit Value	To Every patient	To every Patient	Once a day	100% of Staff	To Every Patient	To Every Patient	All Staff	9PM-7AM							
				Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)	3	3	7	8	5	6	6	2							
				Max Relationship Value in Column	3	3	3	3	3	3	3	3							
				Weight / Importance	303.8	78.8	56.3	675.0	281.3	146.3	381.3	33.8							
				Relative Weight	15.5	4.0	2.9	34.5	14.4	7.5	19.5	1.7							

Figure 3.8 Technical Properties

Chapter 4: Capstone Design

For our capstone design we decided to improve upon the current house of quality model we have used for our research of the healthcare system. The application we have added on is fairly specific. The design uses the quality characteristics weight of importance to determine which is relatively the most important when the customer demand is also added to the weight. The relationship matrix was heavily used in determining our solution. The relationship between the technical requirements and the customer requirements brought forth a numerical result based on our analytical research. The final result of the application gave us a percentage of how much effort is being placed in the characteristic qualities. Using this percentage score, we correlate this to the average score of the different hospitals we have introduced for our research. This was accomplished by working in parallel with the importance for the technical requirements.

Our designing and solution was formed using excel. The percentage score, which we will show how we developed, forced us to understand the QFD diagram and its intricacies so that the numerical answer we formed had a purpose.

Our first step was to give a weight of importance to the technical requirements within the main house of quality diagram.

4.1 Step 1 to capstone design

Quality characteristics	weight/importance
Staff explains information clearly	40
respectful towards patients	20
clean rooms daily	10
experience staff	100
give written information for home recovery	50
give correct antibiotics	75
staff follow correct procedure	75
regular nighttime vistor hours	15
	385

Figure 4.1 Quality characteristics weight of importance

To determine the weight of importance in the quality characteristics, we used the sources information on what was most important to the hospitals and then added a numerical weight to each quality. The most important quality we determined was how experienced the staff was. Although other qualities are important to keep alert, an experienced staff will give the highest success rate. From that we calculated the weight of importance of each other quality by comparing it to an experienced staff. Once the weights of importance were created we used the total sum of the weights to create a relative weight that was out of 100.

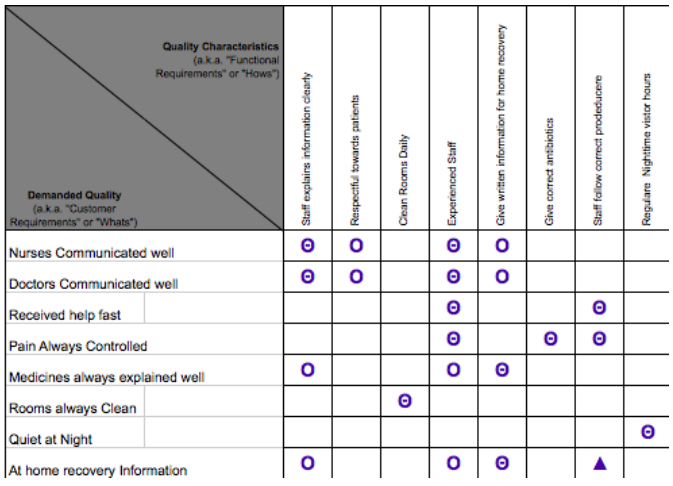
Quality characteristics	weight/importance	Relative weight
Staff explains information clearly	40	10.39
respectful towards patients	20	5.19
clean rooms daily	10	2.60
experience staff	100	25.97
give written information for home recovery	50	12.99
give correct antibiotics	75	19.48
staff follow correct procedure	75	19.48
regular nighttime vistor hours	15	3.90
	385	100.00

Figure 4.2 Quality characteristics weight of importance and relative weight

The Relative weight as shown in this table takes into account the weight of importance of each quality characteristic and then gives it a score out of a 100. The purpose of this is for the user to understand the fundamental meaning of these scores. Its simplicity creates a segue as a byproduct into using the relationship matrix. Once the relative weight has been calculated, we can use the combination of that and the scores of importance given in the relationship matrix to create the relative weight of importance with the customer requirements.

4.3 Step 2 to capstone design

Now that the quality characteristics relative weight has been calculated, we can use the numbers to calculate the relative weight of the customer requirements. The process is to use the relative weight of the quality characteristics and the weight given in the relationship matrix to develop the relative weight of the customer requirements.



X

Relative weight
10.39
5.19
2.60
25.97
12.99
19.48
19.48
3.90

Figures 4.3 and 4.4 Relationship matrix and relative weight

The weights in the relationship matrix are given by a rating of 1 for weak, 3 for moderate, or 9 for a strong relationship. By working horizontally and multiplying the relative weight with the relationship matrix, we were able to attain the relative weight of the customer requirements.

Customer requirements	Relative weight
Nurses Communicated well	381.82
Doctors Communicated well	381.82
Received help fast	409.09
Pain Always Controlled	584.42
Medicines always explained well	225.97
Rooms always Clean	23.38
Quiet at Night	35.06
At home recovery Information	245.45
	2287.012987

Figure 4.5 Customer requirement relative weight

Now that the relative weight of the customer requirements has been calculated, we can move on to calculated the percentage score. In order to do that, we will use the total sum of the relative weight and calculate the percentage of each relative weight.

Customer requirements	Relative weight	Percentage Score
Nurses Communicated well	381.82	16.70%
Doctors Communicated well	381.82	16.70%
Received help fast	409.09	17.89%
Pain Always Controlled	584.42	25.55%
Medicines always explained well	225.97	9.88%
Rooms always Clean	23.38	1.02%
Quiet at Night	35.06	1.53%
At home recovery Information	245.45	10.73%
	2287.012987	100.00%

Figure 4.6 Customer requirement relative weight and percentage score

The right most columns are the percentage scores. It's the final result of this design and its purpose is for a comparative analysis between the information gathered and real data we have

been provided. The percentage score gives the user a rough idea on the amount of focus that should be provided within the different customer requirements. For example, based on this percentage score, the amount of focus that should be provided to the pain always being controlled is 25.55%. This score is an arbitrary number until the fundamentals of each customer requirement is understood. When comparing this number to the percentage score of the rooms always being clean, of 1.02%, the user has to understand the complications of each customer requirement. In this matter, keeping the room clean, for the most part is fairly easy when compared to the patients pain always being controlled or limited. Consequently, these numbers not only provided the user with the understanding of where the focus should be but also where how much effort should be placed within each customer requirement. The percentage score takes all of that into account.

4.3 Step 3 to capstone design

Now that the percentage score has been attained, we compare this with the real data we have obtained.

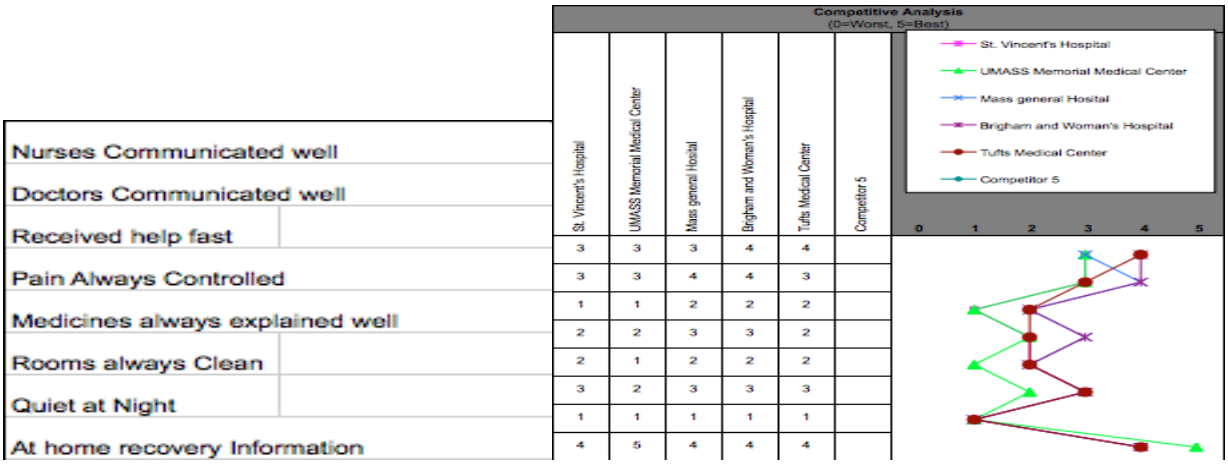


Figure 4.7 Customer requirement competitive analysis

This figure gives us the ratings of the customer requirements within the five different hospitals. The line graph to the right gives a visual to show exactly which customer requirements are doing well and which areas need to improve. One of the most important details within the line graph is that all the hospitals tend to follow a certain trend. The highest score available is a 5 and the lowest is a 1. We will also say, based on the data given, that the sufficient score is a 3 or anything above. The trend starts from the top of the graph where most of the rankings are 3 and some are 4. From there it dip in the 1's and 2's, fluctuates and then goes back up to a 4 or 5. We can call this a "W" curve. This trend will be extremely important in the comparative analysis.

In order to do a comparative analysis we will need to calculate the average score of the customer requirements. The scores are as follows:

Nurses Communicated well	3.40
Doctors Communicated well	3.40
Received help fast	1.60
Pain Always Controlled	2.40
Medicines always explained well	1.80
Rooms always Clean	2.80
Quiet at Night	1.00
At home recovery Information	4.20

Figure 4.8 Customer requirement average hospital score

Now that the average score of the customer requirements are calculated, we can compare the percentage score obtained with the average score recorded here.

Nurses Communicated well	3.40	16.70%
Doctors Communicated well	3.40	16.70%
Received help fast	1.60	17.89%
Pain Always Controlled	2.40	25.55%
Medicines always explained well	1.80	9.88%
Rooms always Clean	2.80	1.02%
Quiet at Night	1.00	1.53%
At home recovery Information	4.20	10.73%

Figure 4.9 Customer requirement average score and percentage score

Since a sufficient score is a 3 or above, we can clearly see that only 3 of the 8 customer requirements reach that sufficiency. Now that the two sets of numbers are next to each other, we can carefully extract the intricacies, which lie between the comparisons of the average score to the percentage score. The average score is a rating given by a customer survey at the five different hospitals used in this research. The percentage score is nothing but a measure of what should be done, or a guideline that should be followed. For example, in the first customer requirement, the nurses communicating well has little to do with the actual percentage score of 16.70%; however, once hospital management decides it needs to allocate its efforts in this area or relocate it to another we use the percentage score. Furthermore, the percentage score is similar to a set standard. If management puts 16.70% of its efforts into improving Nurses communicating well, they will reach a sufficient rating.

Using this specific example, we can compute a general formula for understanding the percentage score and its best use in terms of this field. The percentage score is an important numerical understanding of how the hospital should manage its efforts to produce a patient friendly environment. We can see that if the average score needs to be improved, hospital management needs to keep its efforts up to the standard set by the percentage score. On the contrary, if the score is relatively high, it would be efficient to reduce the efforts in one specific

area and improve it within another. For example, the average score in at home recovery information is a 4.20 but the average score for quiet at night is only 1.00. The percentage score for each is 10.73% and 1.53%. Following this procedure, it would make sense to reduce the amount of efforts being put into at home recovery and perhaps increase the patients' time to sleep. Although it is important to excel in all customer requirements, it is more important to reach a sufficient standing before trying to attempt to improve everything to a very high rating.

Chapter 5: Improvement on the Healthcare System

In this chapter we will discuss how our application is an improvement on the healthcare system. We took the example that we developed in chapters 4 and 5 and more specifically looked at the UMASS Memorial Medical Center as our real example. We did this to explain how our example within our new application is an improvement on the healthcare system. We decided to compare UMASS Medical Center with the national average instead of to the other hospitals that we used during chapter 4. We decided that the value of 0-5 that we would give the national average would be a 4. As we can see in Figure 5.1 UMASS Memorial Medical Center QFD the values that we had for our Demand Qualities were 3,3,2,3,3,2,5,3. These values were based off of the surveys submitted by patients of UMASS. The survey like we stated before was based off an always, sometimes, and never questionnaire. You may notice that these values of different of that of the ones we talked about in the previous chapters. To make the example easier to understand we changed the values to compare them to the national average instead of the averages of the 5 hospitals we used in previously.

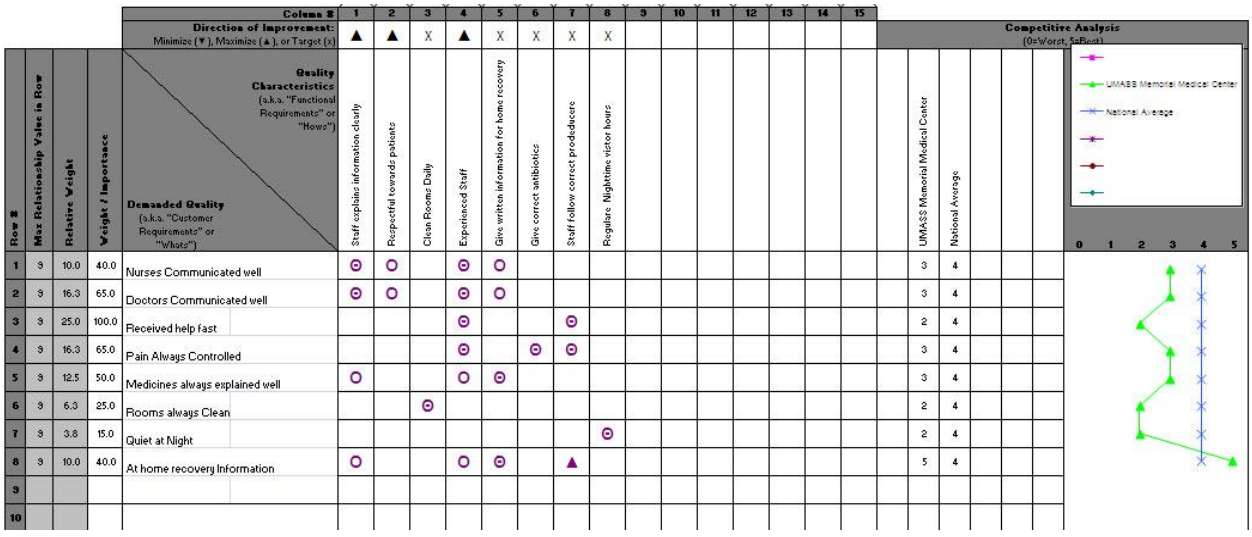


Figure 5.1 UMASS Memorial Medical Center QFD

Nurses communicated well had a national average of 77% and a UMASS average of 72% which can be seen in Figure 5.2 Data of UMASS Medical Center. The decided with this information that we should give Competitive Analysis value of 3. This is because the UMASS average is very close to that of the national average. Doctor's communicated well had a national average of 81% and a UMASS average of 76%. For the same reasons as above a value of 3 was given to this demand quality for the competitive analysis. Our third demand quality of received help fast had a national average of 65% and a UMASS average of 53%. A value of 2 was given for the competitive analysis because of the UMASS average being so much lower than the national average. The demand quality of pain always being controlled had a national average of 70% and a UMASS average of 64%. Pain always controlled was given a value of 3 because of UMASS average being so closed to that of the national average. The fifth demand quality of medicines always explained well had a national average of 62% and a UMASS average of 57%. Again this demand quality was given a competitive analysis value of 3 because of it being so close to the national average. The demand quality of rooms always being clean had a national average of 72% and a UMASS average of 61%. Since the UMASS average wasn't that close the national average. We gave a competitive analysis value of 2. Our seventh demand quality was Quiet at Night. With a national average of 59% and a UMASS average of 42% the competitive analysis for Quiet at night was given a value of 2. The UMASS average was a significant percentage way from the national average. Lastly at home recovery information had a national average of 83% and a UMASS average of 88%. Since the UMASS average succeeded that of the national we were able to give a competitive analysis value of 5.

View Graphs View More Details	UMASS MEMORIAL MEDICAL CENTER INC	MASSACHUSETTS AVERAGE	NATIONAL AVERAGE
Patients who reported that their nurses "Always" communicated well.	72%	78%	77%
Patients who reported that their doctors "Always" communicated well.	76%	79%	81%
Patients who reported that they "Always" received help as soon as they wanted.	53%	64%	65%
Patients who reported that their pain was "Always" well controlled.	64%	71%	70%
Patients who reported that staff "Always" explained about medicines before giving it to them.	57%	62%	62%
Patients who reported that their room and bathroom were "Always" clean.	61%	72%	72%
Patients who reported that the area around their room was "Always" quiet at night.	42%	51%	59%
Patients at each hospital who reported that YES, they were given information about what to do during their recovery at home.	88%	86%	83%

Figure 5.2 Data of UMASS Medical Center

Now that the percentages are present, we can compute the percentage score in order to determine not only where the hospital is lacking but by how much, and what the management team can do to improve it.

As we explained in the chapter 4, how to determine the percentage score, we will apply the same steps and then further analyze exactly how these numbers we compute can possibly help UMASS. For reference, we will be using the percentage score that was determined using the house of quality model in Chapter 4.

Customer requirements	Relative weight	Percentage Score
Nurses Communicated well	381.82	16.70%
Doctors Communicated well	381.82	16.70%
Received help fast	409.09	17.89%
Pain Always Controlled	584.42	25.55%
Medicines always explained well	225.97	9.88%
Rooms always Clean	23.38	1.02%
Quiet at Night	35.06	1.53%
At home recovery Information	245.45	10.73%
	2287.012987	100.00%

Figure 5.3 Percentage score

Now, since we are applying our custom improvement of the house of quality model, we will compare competitive values of UMASS versus the national average as our first step.

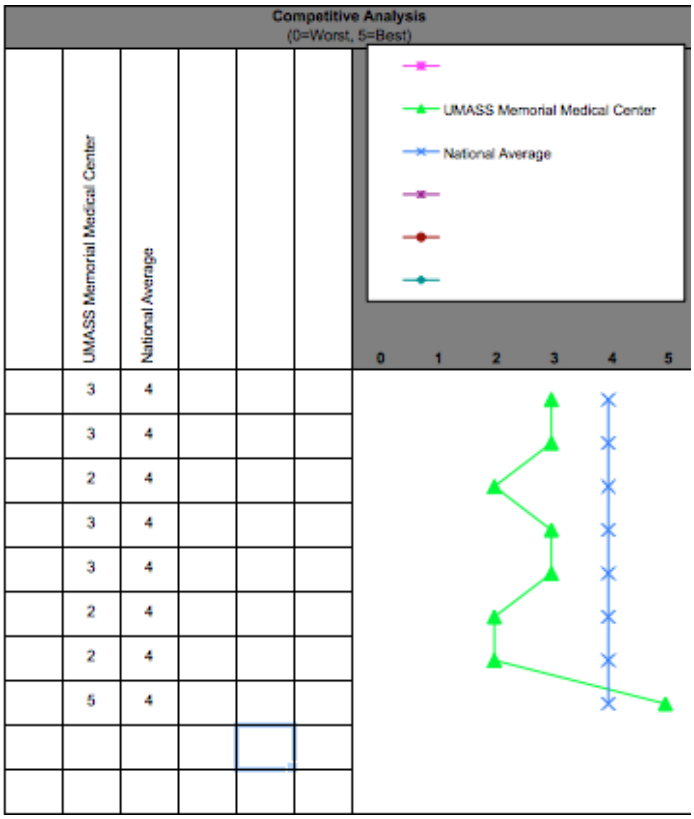


Figure 5.4 Competitive analysis between UMASS and National Average

As we can see from the competitive analysis, the national average is the line in blue and the UMASS memorial center is in green. It was explained earlier that the national average would be a set standard that could be used to compare any hospital with. Following this, we observe that UMASS is lacking in several categories compared to the national average. Firstly, there is only one area where the UMASS exceeds the national average, which is the hospital is at home recovery information. However, in reference to the percentage score, it only gets a value of 10.73%. That is the fourth lowest percentage score, just a little higher from the other categories. Due to that, we can let these two go for the moment and focus on the more important customer requirements.

The first four carry the highest percentage scores and make up a good amount of the total. How well nurses and doctors communicated both received a score of 16.70%, patients received help fast received a percentage score of 17.89%, and pain was always controlled received a score of 25.55%. To put this in perspective, the total sum of these scores is 76.84%, which means that most of the effort and time within the hospital should be used within these four categories. There were two other scores that were fairly important: medicine was always explained well and at home recovery information. They received a score of 9.88% and 10.73% respectively; however, since the at home recovery information was already exceeding the national average, we felt it was okay to leave this out of the calculation, and since the medication explanation was not as important compared to the other four explained, we decided to leave it out of the analysis for now.

If hospital management could utilize this information, their hiring of new staff and allocation of assets and staff would heavily improve. With this, we can be sure that the customer review of the hospitals will surely increase. To understand this further, we can observe the

scores given by the customer of UMASS within each of the four categories. The percent given by the data collected in a survey shows that there is a deficiency of 6%, 3%, 9%, and 7%, respectively within each of the four categories. In reality, that is not much of a difference and it can be improved. In order to do this, understanding the percentage is crucial.

The hospital management may argue that these four areas are the hardest to improve, but that is why the percentage score gave a total sum of 76.84%. This number represents roughly the amount of effort and time that should be placed in order to improve these four categories. This number can also be used to allocate the staff accordingly where and when it is appropriate. Specifically, there are some categories, which may be easier to accomplish than others. The way doctors and nurses communicated with patients can be improved if there is an internal review of procedure the staff should follow. The details of this improvement can be left with the departments. The area that needs to be focused on the most is definitely how fast the patients received help. In terms of the survey, it had the second lowest customer satisfaction out of any category. Now, based on the percentage score 17.89%, it is the second most important requirement where staff and management should be focusing on.

The other portion of this data is the four categories that we have not discussed. Although every aspect of a hospital is important and vital so that it as a whole is running efficiently, we have to determine the categories that are more important. Regarding the latter four, they have a total sum percentage score of 23.16%. While these are important, the amount of effort required to improve these four is not even close to the former four. Specifically, there are only three categories that we need to focus on because the at home recovery information already exceeds the national average. This brings the percentage score down to 12.43% with three categories: medicine always explained well, room always clean, and quietness at night. Two of these

categories do not require very much effort into improving. The rooms always being clean, and quietness at night are requirements that can easily improved within a few days if dealt with correctly. The medication being explained clearly is heavily dependent on the communication of doctors and nurses.

Chapter 6: Conclusion

Our original Quality Function Deployment Diagram was the main idea to this project. The capstone design part was built from this method of design quality. The restate from Chapter 3: Quality Function Deployment, we have six main steps: Customer Requirements, Technical Requirements, Planning Matrix, Interrelationship Matrix, Technical Correlation Matrix, and Technical Properties. The whole goal of this diagram is for a company to look at the needs of the customer. They use the information that they gain to see how they can have the highest degree of customer satisfaction. The main goal of Quality Function Deployment is to prioritize the customer quality characteristics. As you can see in Figure 5.1 QFD Original Diagram, the quality characteristic with the highest priority would be experienced staff.

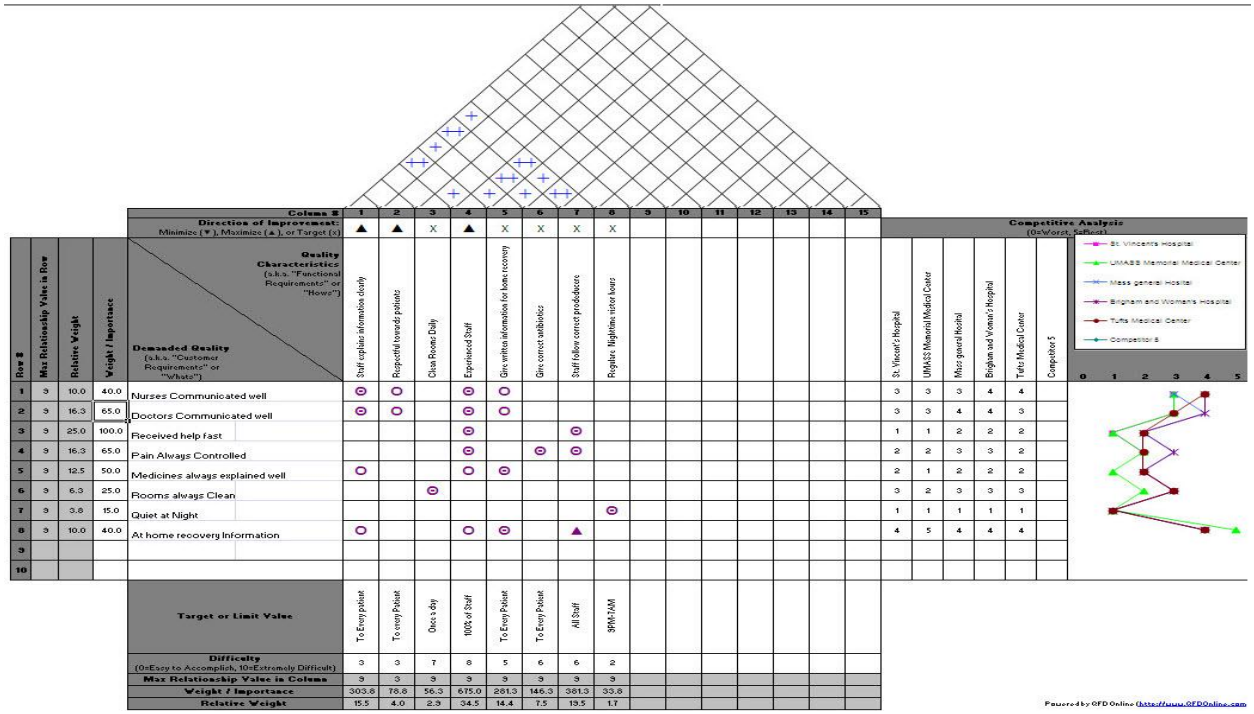


Figure 6.1 QFD Original Diagram

As we have stated in Chapter 4 Capstone design we made a few changes to the Quality Function Deployment's House of Quality Diagram. As you can see in Figure 5.2 QFD Capstone Design Diagram, we added a few more Weight of Importance and Relative weights. We also added a customer rating average which would be used in analyzing the following diagram. The weight of importance above the Quality Characteristics represents the importance that we give each characteristic. The weight of importance and relative weight next to our competitive analysis represents that same as that of the Relative Weight below the target value, but in our case relative weight of the quality characteristics that we came up with for the customer and the relationship values of that specific Demand Quality. The final numbers, as stated previously, represent the priority the company should have for each Customer Demand Quality. These numbers should then be compared with the companies rating and the average company ratings.

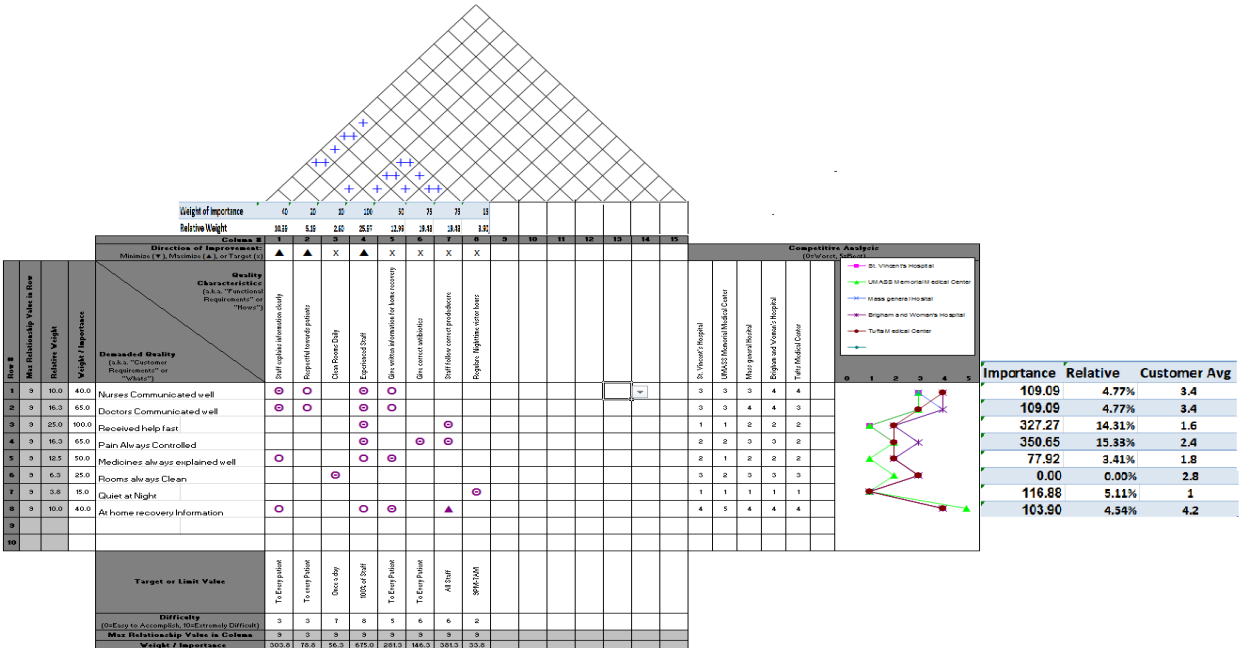


Figure 6.2 QFD Capstone Design Diagram

The house of quality model helps explain the relationships between different aspects of a hospital and has a direct relationship with how well it responds to the patient requirements. To help explain this relationship, we brought created a percentage score, which gauged the effort and importance within a specific requirement. The percentage score helped analyze specifically the importance of each quality and how much effort would take in order to improve upon it. The customer survey of each hospital gave us real data to compare and work off of. After conducting our research and gathering data, we felt that this application can be of real use to hospitals around the country. It can be used to allocate assets and staff accordingly where and when it is needed.

There were some drawbacks with our conclusion of this research. Even though the percentage score gives a good estimate on the amount of effort and focus there should be when the hospital is trying to maintain or improve its customer requirements, it does not take into account some of the other aspects when it comes to running a hospital. One of the major factors is the amount of money there is coming in, where it can be used, and how much can be used to hire. If we were able to harness this information, we could use linear programming to greatly improve our research and in turn effectively help hospitals in optimizing their departments and staff. As of now, our research and conclusion help understand where hospital management should focus their attention; however, to bring our research one step further we need to bring the financial side of this as well. For now though, we leave that to the hospital management, as we feel that our work can be used to greatly improve customer satisfaction at any hospital.

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