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Decision Making On Laboratory Technicians, Biomedical Engineers, Chemical Engineers and Radiology Technicians Execution Valuation Through Implementation Of Quality Function Deployment; A Case Study in Jordan

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Abstract
Quality Function Deployment (QFD) is a departmental implement that offers apparent connective operation to aid teams converging on the requirements of the chaps throughout the overall improvement cycle of a manufacture. It offers the means for translating chap necessities into suitable technical requirements for every stage of a manufacture development life-cycle. It aids enhancing more chaps-oriented manufactures. Despite the QFD benefits, it is not a simple implement to use. This article outlines how a method such as QFD is exploited to enhance the execution of lab technocrats in a hospital. A model representing the variables dealing with chemical engineers and lab technocrats was constructed and a lot of proposals for execution enhancement were proposed.

Key words: lab technocrats' execution, House Of Quality (HOQ), execution, Quality Function Deployment (QFD).

Introduction

Chats have expectancies about the manufactures goodness. If their actually examination was more than their anticipations, then they will feel pleased. If not, then they will sense not content. As a consequence, goodwill is a tool to measure people's feelings of manufactures goodness, and it is widely utilized as approval measure indicator.

The severe changes in the environment have made noticeable pressures on healthcare providers to reevaluate their strategies. So, a managerial model is constructed utilized QFD where strategies are improved through a partnership between managers and clinicians for the thrift of overall goodness of healthcare in the accelerated changes in the healthcare sector.

In regarding duty quality studies, most literature on service quality is relied upon the traditional one proportion quality model. That is, the outcome is confined that if a duty provider delivers what consumers anticipated well, the chaps are gratified. If not, the chaps are not gratified [1].

In 2010, Hamidullah researched the utilization of QFD as an implement for expansion the car dashboard of Toyota and Honda motor cars. He exploited a questionnaire to obtain the VOC representing to chaps' requirements which were then transformed into technical specifications.

The output from House Of Quality (HOQ) was utilized in concept production. Pugh chart was exploited for concept choosing. Computer Aid Drawing (CAD) models of the selected concepts were shown [2].

There were a few articles investigating the application of QFD as measurement. For example; Pochampally et al, used quality QFD and Linear Physical programming (LPP) in a mathematical model to measure the gratification level of the supply chain with respect to each of the metrics [4].

Most of the researches conducted on applications of QFD in medical sector were primarily conducted from the viewpoint of medical devices. In 2014, Saleh et al, conducted a research on application of QFD and genetic algorithm for replacement of medical equipment. In his research; he presented a new approach to solve medical devices replacements problems.

He applied a framework combining QFD and genetic algorithm to prioritize the medical equipment for replacement process taking into account a set of criteria. He also prioritized list is optimized based on the available

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budget of the hospital to maximize the quantity of replaced devices.

The validation of the supposed model was executed on 60 different types of medical devices. Results show that the proposed model can efficiently classify the priority into four subcategories, and simultaneously maximize the number of medical devices to be replaced based on the budget constraint [5]

In 2014,Salehet al, developed a new model for preventive maintenance priority of medical devices through applying QFD. They improved a 3 domain framework including requirements, function, and concepts. The requirements domain is the HOQ matrix or planning matrix. The second domain is the design matrix. Eventually, the concept domain contains the critical criteria for preventive maintenance prioritization with its weights. Based on the eventual scores of the criteria, the prioritization of medical devices is performed. The model included 5 levels of priority for preventive maintenance. The results showed a high correlation between risk - based criteria and prioritization[6].

In 2015, Yeh et al, evaluated the efficiency of implementing quality management practices in the medical industry. They agitated the efficiency of 30 Quality Management Practices (QMP) including Strategic Management, Balanced Score Card, Knowledge Management, and Total Quality Management in the medical industry. They applied A V-shaped performance evaluation matrix to determine the top ten practices that are crucial but not easy to utilize or applied. QFD is then utilized to find key factors to enhance the application of the top ten tools.

Key factors for QMP application were sequenced in order of importance as top management involvement, inter-department communication and coordination, teamwork, hospital-wide participation, education and training, consultant professionalism, continuous internal auditing, computerized process, and incentive compensation[7].

Methodology

Case study methodology was utilized in this study by a group of lab technocrats and biomedical engineers in two infirmaries: Prince Hamza Hospital(PHH) and Jordan University Infirmary (JHI). It started from identifying the chaps (specific set of medical turfs dealers)needs (Voice Of Chap) (VOC) to get their finding on the QFD matrix which called also HOQ case study pattern as illustrated in figure 1.

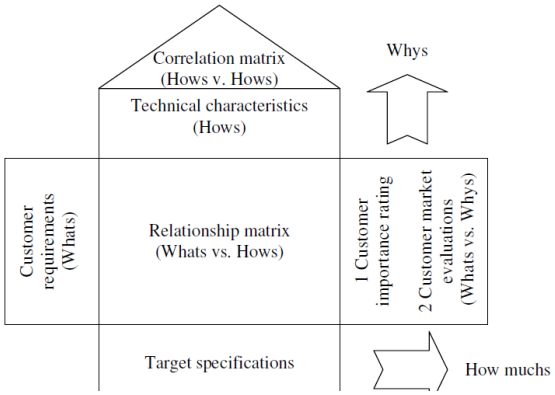

Figure 1. House Of Quality (HOQ) [3]

The HOQ is the primary planning tool in the QFD approach. It is a conceptual map that provides the means for inter functional planning and communication of chap needs and technical responses. In the HOQ, The steps to build the HOQ are:

- List chap needs (whats),
- List technical features (hows),
- Develop a relationship matrix between whats and hows,
- Develop an interrelationship matrix between hows,
- Develop prioritized chap needs,
- Develop prioritized technical features

Constructing chap needs is the most crucial stage in QFD operation. In this study, the main chap needs (WHATs) have been prospered from thresher written by the biomedical engineers and lab technocrats group and interviews. In these two situations, infirmaries were visited physically to get direct annotations of the different types of duty quality features problems they were encounter. Second, it is crucial to construct technical specifications in QFD operation.

In order to achieve chaps' needs, the infirmaries personnel had determined the technical specifications (HOWs). Other parameters for QFD pattern had also been determined. These parameters included the importance weight of chaps' needs and competitive evaluation. They were evaluated using the case study model; the relative and absolute weights of the chap needs and technical specifications were enumerated from QFD equations.

In this study, duty execution features and deliberates that need to be developed were determined by the biomedical engineer during data dissection and assessment. The data gathered from case study model has been integrated and analyzed to the QFD pattern. Then, the technical specifications were determined. These shall have the highest relative and absolute weights that the infirmary personnel should concentrate on it and enhance it in order

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to achieve or overtake chap anticipations and enhance the duty execution supplied by the infirmary. The last stir was measuring the duty execution of the case study infirmary. Finally, the quantitative amount in % of the infirmary's quality execution was deliberated by dividing the actual execution grade to the maximum execution grade.

Results and Discussions

As stated earlier, the two main aims of this research are to deliberate mission execution and to differentiateonus features that need to be developed in order to ameliorate the studied infirmaries chap's temperance . This can be accomplished by establishing QFD model.

In building our QFD pattern, we refaced the foremost phase which was pinpointing the chap (laboratory technocrats, biomedical engineers, chemical engineers and radiology technocrats) needs as shown in table 1:

Table1. Chaps ((laboratory technocrats, biomedical engineers, chemical engineers and radiology technocrats) needs Voice Of Chap (VOC)

			Importance weight
	Laborer's related factors	Hard duty devices	10
		Lab technocrats dealing with patients	7
		Radiology technocrats dealing with patients	7
		presence of devices with ability to perform all medical tests	7
		presence of safe radiology Devices	9
	Availability factor	presence of lab technocrats personnel	9
		presence of radiology technocrats personnel	9
		presence of back up devices	5
	Reliability factor	Presence of exercised crew.	9

In this phase the datum amassed from PHH and five experienced persons representing the major sectors of hospitals in Jordan were exploited to pinpoint the proportion of significance weighting for every execution directory. This proportion was put on the Chaps' necessities on the left side of HOQ as shown in table 1.

It was annotated that hard duty devices was the most serious execution part in the laborer's related factors and lab technocrats' treatment of patients was the least important execution part in the laborer's related factors.

It was also noticed that presence of back up devices was the least important execution part in all significance weights.

It was also annotated that the presence of lab technocrats' personnel and the presence of radiology technocrats' personnel were the most important execution parts in the availability factor and the presence of back up devices was the least important execution part in the availability factor. It was also remarked that Presence of exercised crew in the reliability part had high important weight.

The following step was constructing the duty features as displayed in table2; this datum was inspired by knowing all the commensurable features of the PHH crew which they were perceive they were related to achieve the specified chaps' needs.

Affinity diagrams were employed to explicate the PHH features; a further row was inserted to display the direction of divergence in every one of these fickle which was considered to be as a consequence of a development in PHH execution as demonstrated in figure 2.

Quality is the Medical instrumentations purchasing criteria	Training on communication skills	Existence of adequate Budget	Medical instrumentations purchasing process	Hiring More crew	Training and instruction

Figure 2. Technical needs and its direction of changes

The roof matrix then found, it was employed to pinpoint where the technical necessities that characterized technical needs enhanced or encumbered each other. It has been constructed through the cells of the roof asking the question: Does enhancing one necessity lead to decaying or development in the other technical need? [1].

The roof avouched where a focused lab technocrats execution improvement could yield a range of benefits to

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technical needs. It focused attention on the negative relationships in the technocrats' execution. This represented occasions for innovative dismissals to be applied.

To establish the roof, the roofs for PHH, JHI and six experienced persons' matrices were constructed and then brainstorming was conducted to predicate the average roof that represents all of them as shown in figure 3:

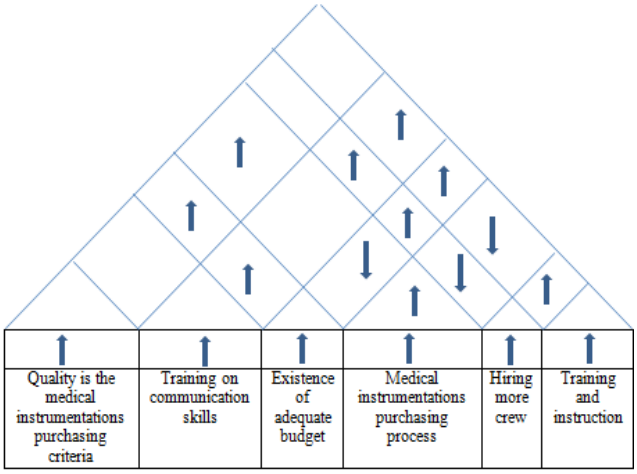

Figure 3. The roof

The planning matrix placed to the right side of HOQ was then predicated. It quantified the chaps' needs priorities and the execution of PHH crew. The measures used here were inspired by questionnaires disbursed in the hospital.

The planning matrix was predicated through quantifying the execution of PHH and JHI which acquired by knowing the execution importance in each category. The interpolation procedure was utilized to acquire the weighting breed for each variable. The outcomes were shown in table 2:

After the mean value for each execution indicator was gained, the execution indicators (presence of lab technocrats' personnel and presence of radiology technocrats' personnel) were assigned a magnitude of 5 because it had the highest arithmetic average value; the execution indicator (Lab technocrats dealing with patients) was assigned a value of 1 because it had the lowest arithmetic average value magnitude. The interpolation method was used to find the weight of each execution indicator.

Table 2.Executionimportance for PHH

			Execution deliberate
	Laborer's related factors	Hard duty devices	4.6
		Lab technocrats dealing with patients	1.8
		Radiology technocrats dealing with patients	1.9
		presence of devices with ability to perform all medical tests	4.3
		presence of safe radiology Devices	3.7
	Availability factor	presence of lab technocrats personnel	3.0
		presence of radiology technocrats personnel	3.0
		presence of back up devices	2.4
	Reliability factor	Presence of exercised crew.	4.6

The following deliberates of HOQ was interrelation matrix, the interrelations matrix combining the technical needs and VOC should be constructed. The level of interrelation was weighted on a four point scale (High, Medium, Low and None which represent with space) and a symbol expounding this level of interrelation was registered in the matrix cell. To form it, the matrices for PHH, JHI and five experienced people's matrices were found and then brainstorming was made to construct the average matrix that represented all of them as shown in table3:

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Table 3. Interrelation matrix

	Training and instruction	Hiring more crew	Duration of medical instrumentations purchasing process	Existence of adequate budget	Training on communication skills	Quality is the medical instrumentations purchasing criteria
Hard duty devices			H	H	H	H
Lab technocrats dealing with patients	M	M		L	H	
Radiology technocrats dealing with patients	M	M		L	H	
presence of devices with ability to perform all medical tests	L		M	H		H
presence of safe radiology Devices			H	H		H
presence of lab technocrats personnel	L	H		H	L	
presence of radiology technocrats personnel	L	H		H	L	
presence of back up devices		L	H	H		M
Presence of exercised crew.	H	M		H	L	M

Every grade of interrelation weighting was assigned a value, e.g. -High=9, Medium=3, Low =1 and none =0. It was twigged from the table that the relationship between "quality is the medical instrumentations purchasing criteria criterion and hard duty devices criterion" is high because the quality adoption enhances the existence of hard duty devices.

The relationship between "Medical instrumentations purchasing process criterion and presence of devices with ability to perform all medical tests criterion" is moderate. The purchasing process increases the probability of existing of devices with ability to perform all medical tests.

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The relationship between "training and instruction criterion and presence of lab technocrats personnel criterion" is low because training and instruction not necessary means presence of lab technocrats personnel.

- Planned temperance rating

The planned temperance rating quantified the level that PHH crew plan to arrive it to achieve the grade of laborers' temperance. They were taken from its crew. The results of planned temperance rating were illustrated in table 4:

Table 4. Planned temperance rating, amelioration factor and the overall weighting of the execution indicators.

	planned temperance rating	amelioration factor	overall weighting
Hard duty devices	5.0	0.08	0.8
Lab technocrats dealing with patients	3.0	0.24	1.68
Radiology technocrats dealing with patients	3.0	0.22	1.54
presence of devices with ability to perform all medical tests	4.0	0.14	0.98
presence of safe radiology Devices	5.0	0.26	2.34
presence of lab technocrats personnel	4.0	0.2	1.8
presence of radiology technocrats personnel	4.0	0.2	1.8
presence of back up devices	3.0	0.12	0.6
Presence of exercised crew.	5.0	0.08	0.72

Regarding the planned temperance rating, it was observed that the lowest laborers' temperance was found in a lot of execution parts like radiology technocrats dealing with patients, lab technocrats dealing with patients, presence of back up devices. The rest of execution elements accomplished the temperance.

The amelioration factor shown in table 4 was computed by subtracting the execution outcome of the PHH crew from its planned execution outcome. This difference was divided by 5 to give the amelioration factor, for example: the amelioration factor for hard duty devices in the hospital was:

$$(5- 4.6) / 5 = 0.08 \quad (1)$$

Regarding the amelioration factor, it was noted that the highest improvement needed to be emphasized was found in presence of safe radiology devices. The lowest improvement needed to be done was found in hard duty devices and presence of exercised crew.

The overall weighting has been calculated by multiplying the importance weighting by the amelioration factor as illustrated in the table 4, For example; the overall weighting for presence of back up devices was:

$$0.12* 5 = 0.6 \quad (2)$$

Regarding the overall weighting, it was noticed that the presence of safe radiology devices had the highest priority to start with because it had the highest overall weighting. The presence of back up devices had the lowest priority to start with because they had the lowest overall weighting.

The targets which are the final section of HOQ were found. They stated the conclusions drawn from the information existed in the entire HOQ. They consist of three parts:

- Technical priority
- Competitive benchmarking
- Targets

The technical priority was obtained by summing the product of the overall weighting shown in table 4 and the interrelations value shown in table 3 as shown in table 5. For example; the technical priority for Training and instruction was calculated as follow:

$$[(0.0*0.8)+(1.68*3.0)+(1.54*3.0)+(0.98*1)+(0.0*2.34)+(1.0*1.80)+(1.0*1.80)+(0.6*0.0)+(0.72*9.0)=20.72 \quad (3)$$

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Table 5.Technical priority, competitive benchmarking and targets

		Training and instruction	Hiring more crew	Duration of medical instrumentations purchasing process	Existence of adequate budget	Training on communication skills	Quality is the medical instrumentations purchasing criteria
Technical Priority		20.72	44.82	30.12	78.1	40.5	41.04
Benchmarking	PHH	Low 30 %	Need hiring 3 more persons in lab, radiology and biomedical engineering (BME) departments	Taking long time (More than 5 months)	There is no enough budget	Little communication skills courses provided to the crew	Adopting the Quality standards in medical instrumentations purchasing
	JHI	Medium60 %	Need hiring 4 more persons in lab, radiology and BME departments	Taking long time (More than 4 months)	There is no enough budget	Little communication skills courses provided to the crew	Adopting the Quality standards in medical instrumentations purchasing
Targets		High 100 %	Hiring 4 more persons in lab, radiology and BME departments	The duration of the medical instrumentations purchasing process must be not more than 3 weeks	Existence of Enough budget	Supplying weekly communication skills courses provided to the crew	Must adopting the Quality standards in medical instrumentations purchasing

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It was noticed from the previous table that the existence of adequate budget had the highest technical priority so it should be thought of it firstly and trying to solve its problems like having sources of financing the purchasing of medical devices, it was also noticed that the Training and instruction had the lowest technical priority so it was not crucial one.

The competitive benchmarking illustrated the deliberate of the technical needs identified for the execution aspects of PHH and JHI in table 5. This illustrated the relative technical position of execution deliberates of PHH and identified the aimed grades of execution to be achieved. The competitive benchmarking was obtained through direct observations of the execution part. For example; regarding the Training and instruction, it was found that there were 30% in PHH and 60% in JHI. Table 5 illustrates the competitive benchmarking.

It was showed from table 5 that, the situation of PHH in all execution parts was not better than that in JHI but there were some cases like existence of adequate budget, training on communication skills and training on communication skills, where both situations were the same.

The final phase of HOQ was a set of engineering target magnitudes to be met by the required execution deliberates. The procedures of constructing this matrix qualified these targets to be set and prioritized based on a comprehension of the laborers' needs, the competitor's execution and infirmary current execution. It was needed to draw on all this data when deciding on these values [1].

The targets were obtained by monitoring the execution of PHH and JHI in each execution section and comparing them to the typical situation known by the expertise perspectives. For instance; regarding the hiring of more crew, it was found that it is needed to hire 3 more persons in lab, radiology and BME departments in PHH and 4more persons in lab, radiology and BME departments in JHU. Table 5 shows the targets.

It was illustrated from the table that some targets were not achieved like existence of adequate budget. On the other hand a lot of targets were achieved like quality is the medical instrumentations purchasing criteria. Some targets needed a lot to do to be met like the duration of medical instrumentations purchasing process.

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