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The Application of Quality Function Deployment for Environment (QFDE) to Design Vertical Lifting Devices in the Healthcare Industry

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Abstract

This research aimed to design vertical lifting devices in the healthcare industry. The Quality Function Deployment for Environment (QFDE) was applied to design vertical lifting devices that can meet user needs. Regarding the methodology, the first step was to examine information about the users who are the staff at the blood component preparation department of the Blood Transfusion Centre in Srinagarind Hospital, Khon Kaen and to study the design of vertical lifting devices which have an appearance and a function that meet user needs in order to specify a sample group. Second, the researcher identified Voice of Customer (VOC) and drew up questionnaires to determine the importance ratings of user requirements. Moreover, the user needs and the importance ratings were analyzed by QFDE. This technique consisted of 2 matrixes: (1) Planning Matrix that translated user needs into technical specifications and (2) Part Deployment Matrix that translated technical specifications into technical goals which applied to design vertical lifting devices that fulfill user needs. The results of research indicated that the top five most important technical targets are qualified device controllers (18.54%), strong and non-slip wheels (18%), eco-friendly materials (16.05%), a flexible system (12.64%), and durability of parts (11.07%).

Keywords: Quality Function Deployment for Environment (QFDE), Vertical lifting devices, Voice of Customer (VOC)

1.Introduction

To perform roles in blood banks, it is essential for the staff to provide safe blood to patients. In addition, one of the factors affecting blood supplies is accurate and standard operating procedures since they improve the accuracy of the laboratory results and leads to compatible and safe blood for patients. Regarding the preparation of blood components, antigen – antibody reactions are essential to provide patients with safe blood because these interactions are a fundamental principle of red blood cell phenotyping. The blood component preparation consists of red blood cell phenotyping, compatibility testing, antibody screening, and antibody identification. Furthermore, transfusion medicine services relate to pediatric patients with Hemolytic Disease of the Newborn HDN, patients with transfusion reactions, and blood selection and preparation that are compatible and safe for patients. As a result, the staff should have practical training in performing tasks in blood banks together with understanding and interpreting laboratory results; these skills are beneficial to undertake the blood component preparation and help patients losing blood due to injuries or surgical operations and suffering from diseases that make them need blood or blood component transfusions. As many scientists have not discovered a substitute for blood yet, peoples need to donate blood for one another. Therefore, the Blood Transfusion Centre of Srinagarind Hospital, Khon Kaen, has a main duty towards blood supply and donation in order to treat patients. Additionally, it also offers other medical services such as hematological analysis, treatment of bleeding, the clinical microscopy section, the immunology section, the microbiology section and the blood bank. Importantly, the services are based on an international and medical technology standard so as to provide test results accurately and quickly (Topanthanon, T., 2017).

The World Health Organization (WHO) offered guidance on blood supplies. That is, there should be enough safe blood and blood products for countries' requirements. In other words, each country should have blood donation by around 2 - 4% of the population. In Thailand, a blood donation rate that meets Thai patients' needs is 3% of the population or about 1,950,000 units. Furthermore, blood donors should voluntarily donate their blood without expecting anything in return.

The Blood Transfusion Centre of Srinagarind Hospital, Khon Kaen, has set a clear objective of providing sufficient blood and blood components to patients in Northeastern Thailand according to the WHO standards in the adequate amount of blood for patients and the number of blood donation. Apart from the improvement in blood supply, technology should be enhanced to make the blood services in the countries safe and operate in the same standard. Similarly, the Blood Transfusion Centre standardized donor selection according to a national blood policy which begins by selecting blood donors from low-risk populations and screening blood donors. According to the WHO standard, all donated blood should be screened for syphilis, hepatitis B, hepatitis C, and HIV by using standard blood screening technology. From domestic and overseas research, it showed that the leading cause of work-related musculoskeletal injuries is manual lifting activities. Moreover, the report of the Health and Safety Executive (2008) pointed out that 104,301 employees had work-related musculoskeletal injuries. In this statistics, 2 in 5 employees, representing an injury rate of 301.7 cases per 100,000 employees, carried injuries resulting from lifting and took sick leave over 3 days. At the same time, the study of the Australian Bureau of Statistics indicated that lifting objects which accounted for 1 in 3 injured employees was the most common cause of workplace injuries. This result is in line with the report of the U.S. Bureau of Labor Statistics Speaking of Thailand, the annual report (Workmen's Compensation Fund) showed that the number of employees with heavy lifting injuries was 845 out of a total of 9,132,756 registered employees in the Workmen's Compensation Fund. In other words, there were 9.3 heavy lifting-related injuries per 100,000 employees. From the study of the National Institute for Occupational Safety and Health, Water et al. suggested that people should not lift an object heavier than 23 kilograms and should decrease the maximum weight to 4-5 kilograms if there are risk factors involved such as lifting height, distances between the front of a body and an object while lifting, body motions while lifting, frequency, duration, postures during the lift. However, the staff have to lift 12 blood bags weighing 12 kilograms into a centrifuge during the blood component preparation. Additionally, the cumulative frequency of the lift is 300-500 times per day.

As a result, the researcher aims to examine the weight of a load that is suitable for the staff and make eco-friendly lifting devices. By doing so, the researcher designs vertical lifting devices used to lift blood bags vertically and assesses the maximum weight limit that doesn't damage the staff health while lifting. Moreover, this study suggests practical guidelines on manual lifting activities of employees in the healthcare industry.

2. Literature Review

Speaking of Quality Function Deployment for Environment QFDE, Arash A. (2009) state that it is a method of environmentally conscious design; this technique is adapted from Mohan, K. R., Lohit, H.S., Manas R. M., & Basheer, A.Md. (2012) shows that QFDE consists of four phases (See Figure 1). The principle of each phase can be summarized as follows:

phase I: customer requirements are collected and then translated into technical specifications. After that, the relative importance of the technical specifications is evaluated. For example, S. Sirisoonthorn (2010) deploy a rating score with a weighted score based on customer requirements. Second, the objective in the include;

Section A1 is on the left side of the quality house.
It is the part that shows the needs of customers.

Section B1 or planning matrix is on the right side of the quality house. It gives visibility to the status of the product compared to competitors. or see the level of satisfaction that customers have with the product and service.

Phase II: is to determine the relative importance of part characteristics derived from the technical specifications in Phase I. In this stage, Shih, H.S. & Chen, S.H. (2013) use the rating scale to analyze the relative importance of each component of a product.

Phase III: focuses on developing approaches to design improvement.

Lastly, Phase IV is to select the practical Mohan, K. R., Lohit, H.S., Manas R. M., & Basheer, A.Md. (2012) approach by comparing environmental effects. applies an environmental effect analysis to study how each approach affects design improvement.

Hence, QFDE is a method of analyzing user requirements and applying them to design a device that can fulfill users' needs and function properly.

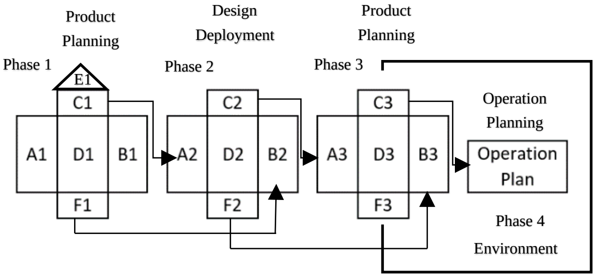


Figure 1 Correlation of the four phase QFD matrix

With the QFDE technique, the 2 matrixes were analyzed: the Planning Matrix and the Part Deployment Matrix. The relationship between these matrixes is demonstrated in Figure 2. (S. Sirisoonthorn, 2010)

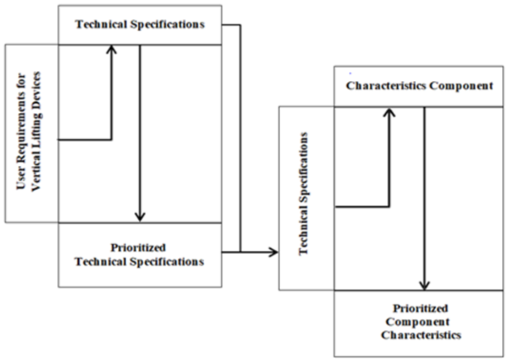


Figure 2. The Relationship between the Planning Matrix and the Part Deployment Matrix

external structure of the devices was made of ecofriendly materials and had the appearance which satisfied the needs of the users. In the centrifugation process, the devices met a technical standard of the Blood Component Preparation Section (Maguad A B., 2009).

The vertical lifting device users consisted of the staff at the Blood Component Preparation Section of the Blood Donation Room, the Blood Storage Laboratory, the Blood Screening Laboratory, the Tissue and Stem Cell Laboratory. This is because these staff directly contact blood. The roles of the staff involved in blood donation are shown in Table 1.

The dominant factor is that there are only 3 staff who have responsibility for the preparation of blood components. Moreover, they face with a problem about lifting a blood bag which weights at least 1 kilogram per bag. As one centrifuge can contain 12 blood bags, they have to lift around 12 kilograms per run. With an 8-hour workday, the average weight that the staff lift per day is 288 kilograms. Performing the manual lift increases risk of suffering from Musculoskeletal Disorders (MSDs) that cause injuries to hands, wrists, arms, shoulders, and especially low back which results from improper lifting techniques and repetitive lifting for a lengthy period.

Table 1 Roles of people involved in blood donation

Process	Doctor	Nurse	Blood Donor	Laboratory Staff
Blood Donation Centre (Internal/External)	Examining	Preparing equipment used in the blood collection process	Contacting staff	Preparing equipment used to store blood
Role	Coordinating with nurses/ staff	Drawing blood	Receiving service provided by nurses	Analyzing blood and Sending blood test results to doctors
History Taking	Determining whether donors can donate their blood	Receiving doctors' comments	Receiving doctors' comments	Doctors analyze blood test results.

3. Methodology

3.1 The Specifications for Designing Vertical Lifting Devices

Vertical lifting devices involve the path traveled that determines height and inclination measured from a horizontal line. The types of the path traveled are a horizontal path, a vertical path, an inclined path, a straight path, and a curved path. The QFDE technique were applied to design vertical lifting devices. Furthermore, the

The medical technologists together with the medical technician assistants analyzed the performance of the Blood Transfusion Centre of Srinagarind Hospital, Khon Kaen and found out that there was not enough staff to work against time and meet different requirements depending on patients' symptoms. In case of injuries, blood banks have to urgently send required blood to patients. On the other hand, if a required blood type is not available, blood banks have to ask for blood donation from general people or patients' family members with the same blood type. Obviously, this is a crucial moment between life and death for patients. After collecting blood, the staff have to screen donated blood according to universal and medical technological standards so as to produce accurate blood test results. As a result, they are responsible for the preparation of blood components which can be divided into several steps as shown in Figure 3.

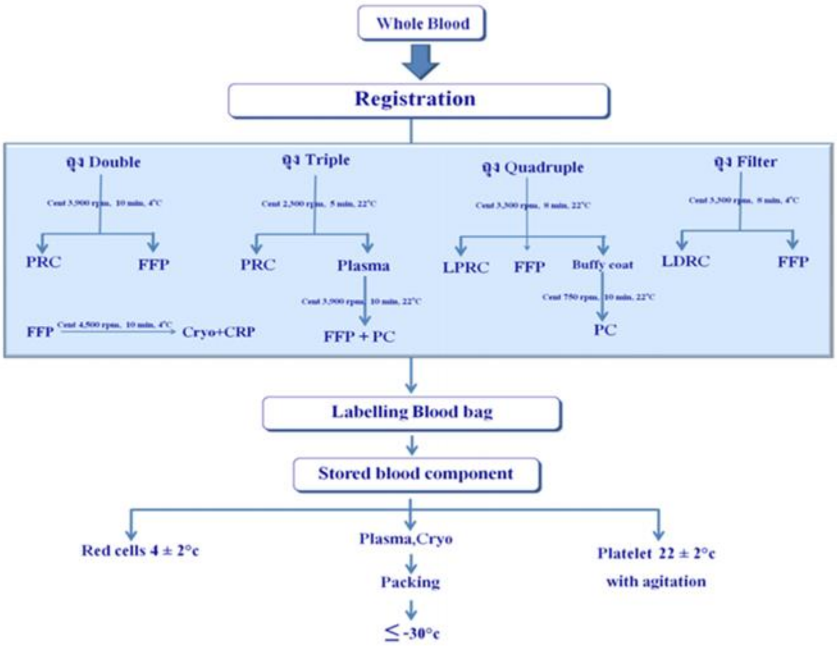


Figure 3 The Blood component preparation

Centrifuges are a device using a centrifugal motion of a sample substance or a motion in a centrifugal field to add a gravitational force to a suspension in a solution or to separate insoluble substances or sediment from a solution. Figure 4 indicates the staff using the centrifuge to separate blood components.

3.2 The Voice of Customer Survey

The researcher carried out in-depth interviews to collect data on the Voice of Customer (VOC). Moreover, the descriptive approach was deployed so that the interviewees could freely express their requirements for vertical lifting devices. After that, the researcher took notes of user requirements. In addition, the notes were analyzed and edited for clarity by the university teachers, the experts in vertical medical lifting devices, and the senior staff of the Blood Test Room in the Blood Transfusion Centre who have professional experience of the blood component preparation. The data was used to create the questionnaires on determining an importance rating of each VOC item. After that, the questionnaire results were applied to QFDE (Joompha, W., & Pianthong, N. 2018).

VOC items were organized by an affinity diagram so that they could be easily applied to the questionnaires concerning importance ratings and the QFDE technique. After that, the questionnaires were circulated to the vertical lifting device users in order to survey the attitudes of the users towards each VOC item. Furthermore, the Index of Item-Objective Congruence (IOC) was used to evaluate validity of the questionnaires. At the same time, the Cronbach's alpha or coefficient alpha was used to measure reliability of the questionnaires. In addition, a sample size also plays a role in reliability since the smallest sample size can ensure the reliability of the study. The use of the small sample size results in more errors than that of the large sample size. As a result, the study applied Yamane’s formula to calculate the minimum possible sample size in order to ensure the reliability of the returned questionnaire. The formula for a sample size calculator is shown in Formula 1 (Joompha, W., & Pianthong, N. 2018).

$$n = \frac{N}{1+Ne^2} \qquad \text{Formula 1}$$

Where: n is the minimum possible sample size.
N is the population size.
e is the allowable error.

Figure 4 The staff using the centrifuge to separate blood components

3.3 The Analysis of User Requirements

3.3.1 The analysis of the reliability of the returned questionnaire is to consider the questionnaires that the users returned in order to assess the reliability of the attitude scale questionnaires via the Cronbach's alpha as shown in Formula 2 (Joompha, W., & Pianthong, N. 2018).

$$r_{tt} = \frac{k}{k-1}\left[1 - \frac{\Sigma s_i^2}{s_t^2}\right] \qquad \text{Formula 2}$$

Where: r_{tt} is coefficient alpha.
k is the total number of questionnaires.
s_i^2 is the variance of a score of each item.
s_t^2 is the variance of the total scores.

The value of the reliability indicates the trend in the importance ratings derived from questionnaire responses. If the reliability is high, the margin of error for the questionnaire scores will be low. On the other hand, if there is low reliability, the margin of error for the questionnaire scores will be high.

3.3.2 The Analysis of Importance Ratings of User Requirements

A geometric mean was used to calculate importance ratings. This is because it is useful to be a central tendency when a data set does not have a zero and a value that is much higher than the others. A mean is most likely to approximate a central tendency when a data has positive values. The calculation of the geometric mean is demonstrated in Formula 3 (Joompha, W., & Pianthong, N. 2018).

$$IMO = \sqrt[n]{a_1 x a_1 \ldots a_n} \qquad \text{Formula 3}$$

Where: a_i is the i[th] term in the sequence (i = 1, 2, ..., n)
n is the number of sample data

The calculation of the importance ratings was applied to all of the returned questionnaire. In addition, the VOC items and the importance ratings were the input data for the QFDE technique.

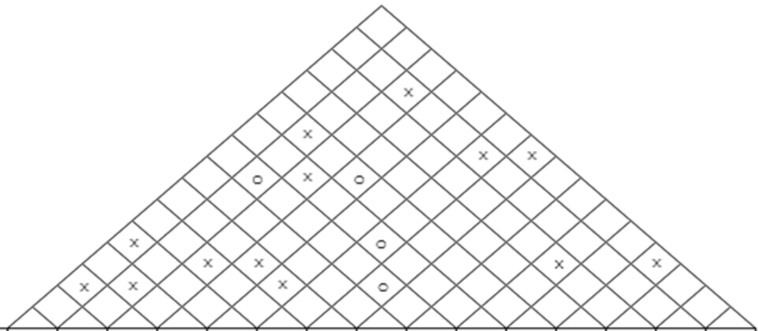
The requirements of the users with the importance ratings were shown on the left of the Planning Matrix. The user needs were translated into the technical specifications which written in technical terms to describe attributes of the devices. The technical specifications extensively cover all requirements of users. In addition, one technical specification could be correlated with many needs of users. After that, the results of the first matrix were input into the Part Deployment Matrix. In so doing, the technical specifications were translated into the part characteristics which would be deployed to design the devices (Patil, Sh.S., Gopinath C. & Suresha,S. 2016).

By analyzing each matrix. or the House of Quality (HOQ) shown in Figure 5, it can be seen that the left side of the house is the list of the user requirements and the top is the technical specifications. In the middle of the house, it indicates the assessment of the relationships between the user requirements and the technical specifications. The symbols used to weigh the relationships are as followed: 9 refers to a strong relationship, 3 refers to a medium relationship (Sinthavalai, R. & Ruengrong, S. 2018).

The results from the analysis of the matrixes were divided into the technical specifications to satisfy user needs and the importance weight of each technical specification in order to indicate the extent to which the requirements were fulfilled according to the importance weights.

3.3.3 The Design of the Device

In this process, the part characteristics derived from the QFDE technique were deployed for the device design. 3D drawing program AutoCAD 2011 was used to create a virtual version of the device. After that, a prototype was produced.



Symbols of Correlation Roof
"o" for Positive Correlation
"X" for Negative Correlation
Blank for Correlation

Movement Of Target Value
↑ for Maximize
↓ for Minimize
O for Hit a Target

		Technicl Specifications	Weight of the device	Price	Parts number of	Impact strength	Appearance	Ddisassemble be easy to dand assemble	Accuracy in vertical movement	Energy-saving device	Lifetime of the device	Easy to be installed	Operates safely	Provides a maintenance manual	Eco-friendly materials	Easy to be cleansed	Materials that can be bought in local sources
		IMP	↓	↓	↓	↑	↑	O	↓	↓	↑	O	↑	O	↑	O	O
Function	capability to make a required movem	3.96		3						3	9						
	capability to stop at a required positi	3.44				3							9				
	long-lasting and continuous use	3.54							9					3			3
characteristics	shape strong structures and modern	4.17		3	1		3	1	9		3		3		3		1
	easy assembly	4.04	9	3	3		3	3	3						1		3
	reasonable price	3.24	3					9				9	3			3	
Material	durable materials	3.84		9	3		3		3	3			3			9	3
	non-rusting materials	3.54		3		9	3						9				
	friendly materials eco	3.16							3								9
Safety	operates safety	3.92				9							9	3			
	parts contains safety	3.49				3							9				
	easy t be maintained	3.58			3						3				9		
Convenience	dmove be easy to	3.96								3					9		
	dcleanse be easy to	3.83	3									3			3		
	ediastall be easy to	3.64		3				3			9			9		3	
Raw score			57.6	92.6	38.6	87.9	46.8	56.4	103	35.3	91.7	40.7	142	55.1	95.9	55.2	66.9
Weight (% relative Importance)			5.4	8.69	3.61	8.25	4.39	5.29	9.62	3.31	8.6	3.81	13.4	5.17	9.00	5.18	6.27
														11	3	10	7

Figure 5 The Example of Matrixes Used for QFD

4. Results and Discussions

4.1 The Results of the Analysis of User Needs

The results from the analysis of user requirements seem to be the most crucial part of the study since it was used for the QFDE technique. The results are as follows:

4.1.1 The VOC from the device users

34 users working at 16 wards took part in the VOC survey. After that, the VOC items were interpreted and sorted to make a diagram representing the correlation of each item. The VOC items are shown in Figure 5.

After that, all of the user needs were used to create the questionnaires so as to find the importance ratings of each requirement. From the analysis of the questionnaires, it shows that the users can comprehend questions in the questionnaires. As a result, the researcher sent 337 questionnaires to the nurses, the nursing assistants, the staff, and the experts in medical
equipment at the Blood Transfusion Centre.

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From the result, it demonstrates that the number of the returned questionnaire has to be at least 183 in order to represent all samples at the Blood Transfusion Centre. In the study, 248 questionnaires were returned; this number is more than the minimum possible sample size.

According to the calculation of the sample size, it indicates that the minimum possible sample size is 183 from 337 device users. The margin of error amounts to 0.05. The calculation is shown in Formula 4 (Joompha, W., & Pianthong, N. 2018).

$$n = \frac{337}{1+337(0.05^2)} = 183 \qquad \text{Formula 4}$$

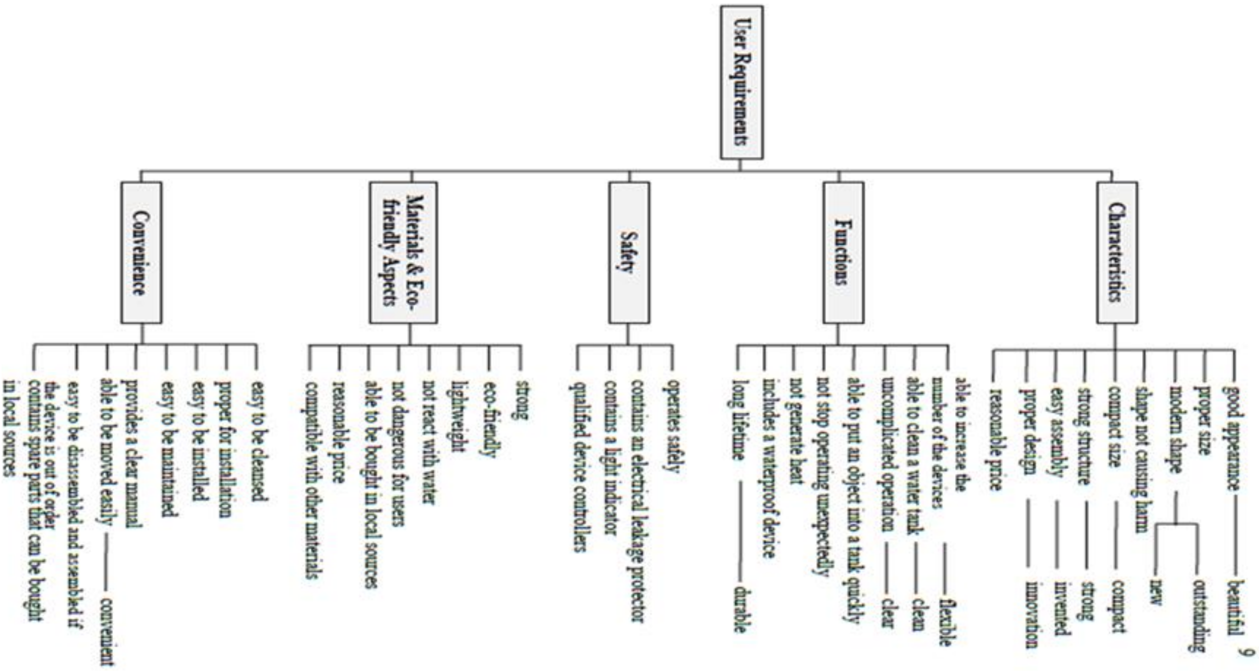

Figure 6 The Tree Diagram of the Device Specifications Based on User Needs

After that, the reliability of the returned questionnaire was calculated as shown in Formula 5 (Joompha, W., & Pianthong, N. 2018).

$$248 = \frac{337}{1+337(e)^2} ; e = 183 \qquad \text{Formula 5}$$

The result indicates that the reliability of the returned questionnaire is 0.968. Therefore, the data from these questionnaires can be used to measure the importance ratings. In addition, the margin of error is 0.032.

4.1.2 The Calculation Result of the Importance Ratings of User Needs

The data of the returned questionnaires was used to analyze the reliability via the Cronbach's alpha. From the calculation result, the reliability of the returned questionnaires is 0.957. This means that the margin of error is low. Therefore, this data was used to calculate the importance ratings based on the geometric mean. The result is shown in Figure 6. Furthermore, the user needs together with the importance ratings will be used to analyze the Planning Matrix of the QFDE technique.

4.2 The Results of the Application of QFDE

The result from the QFDE technique consists of 2 parts: The Planning Matrix and the Part Deployment Matrix.

4.2.1 The Analysis of the Planning Matrix

In this process, the researcher collaborated with the experts to identify the technical specifications that can meet user needs and to determine the direction of device design and ways to improve the device in the future. The result of the Planning Matrix is shown in Figure 7.

The weight of the technical specifications, called Raw Score, indicates how well the technical specifications fulfill user requirements. The researcher compared the weights of each technical specification to measure the importance weights. The calculation of the importance weights based on a comparison of "the length of the devices" is as follows (Ji, P., Jin, J., Wang, T. & Chen, Y. 2014).

The weights of the technical specifications (Raw Score) concerning "the length of the devices"

= Σ (a score of the relationship between the user needs and the technical specifications X the importance ratings) The next step is to use the calculation results.

The relative importance weights of the technical specifications regarding "the length of the devices"

= (Raw Score / Sum of the Raw Score) X 100%

The calculation result shows that the technical specifications with the top 3 highest relative importance weights are a position of movement (18.54%), continuous operation (18%), and eco-friendly materials (16.05%), respectively. Furthermore, these relative importance weights will be applied to the Part Deployment Matrix. The analysis of the second matrix is carried out in the same way as that of the Planning Matrix. fulfill the user needs the most or to what extent the part characteristics should be taken into account.

Movement Of Target Value
↑ for Maximize
↓ for Minimize
○ for Hit a Target

	Part characteristics		Positionitself precisely	Ddurability of parts	Able to operate for 8 hours	A size of a motor proper for movements	Non-rusting materials	A clear maintenance manual	Includes an on/off controller system	Includes the small number joints	A Qualified control system	Includers wheels for movements	Qualified circuit breakers	Includers an indicator light	
		IMP	↑	↑	↑	↑	↑	○	↑	↓	↑	○	↑	○	
Function	Cleanse a water tank thoroughly	17.86	9		3	1			1						
	Long lifetime	9.84		9			3				1				
	Price of the device	8.15	3		3		1						3		
characteristics	Strong	7.84		9			3								
	Cleanse a tank quickly	7.58	3		9	1			9						
	Resistant-corrosion	6.75		1			9								
Material	Friendly-eco	6.38					1	3							
	Provides a maintenance manual	6.27				1		3					3		
	Target values	6.19			9				9						
Safety	Qualified device controllers	5.02									9		1		
	Able to be moved easily	4.00										9			
	Electrical leakage protecor nincludes	3.90											3		
Convenience	Use durable materials	3.86		3			3				3				
	Ncludes an indicator light turning on white operating	3.73												9	
	Not corrode easily	2.61		1			3								Total
Raw score			207.9	180.1	202	31.71	124.2	37.95	141.8	0	66.6	36	59.98	33.57	1121.76
Importance weight (% Relative)			18.54	16.05	18	2.83	11.07	3.38	12.64	0	5.94	3.21	5.35	2.99	100
Rank			1	3	2	11	5	8	4	12	6	9	7	10	
	Target values		Qualified device controllers	Structures made from ecofriendly materials	Strong and non-slip wheels	A proper size of motor	Durability of parts	A clear maintenance manual	A flexible system	Uses the least number of knots and screws	A qualified control system	Includes a base to be moved easily	Includes a brake	Includes an indicayor light	

Figure 7 The Relationship Matrix of the Part Deployment Matrix

4.2.2 The Analysis of the Part Deployment Matrix

From the analysis of the Part Deployment Matrix in Figure 7 and the relative importance weights of part characteristics, it can be seen that the part characteristics with the top 3 highest relative importance weights are qualified device controllers (18.54), strong and non-slip wheels (18), and structures made from eco-friendly materials (16.05), respectively.

The analysis of the Part Deployment Matrix results in the part characteristics deployed for the design and the relative importance weights of the part characteristics. Moreover, it indicates which part characteristics can

4.3 The Design of the Device

The results of the device design are as follows

4.3.1 The Device Consists of 3 Main Components:

The device design is the implementation of the part specification obtained through QFDE analysis as a design data using a 3D design program in the virtual design of the device and defining materials for use in prototyping. Because this product is specialized, therefore, when designing materials that are environmentally friendly, it features light weight, rust resistance, strength and requires minimal energy consumption. The researcher chose to use Aluminum as the main building which is a soft and light metal that does not have a lustrous appearance. Due to the thin layer of oxidation that occurs quickly when exposed to air, Aluminum metal is not toxic, not magnetic and not produce a spark. Pure aluminum has a tensile strength of approximately 49 million Pascals (MPa) and 400 MPa if it is alloyed. Aluminum has a density of 1/3 that of steel and soft copper is easily ductile.

It can be easily machined and molded. And has the ability to resist corrosion and durability to be a prototype device. in Figure 7.

The questionnaires were sent to the users in order to survey their satisfaction with the prototype of the vertical lifting device. The result shows that the satisfactory level of 187 sample users is quite high as the satisfaction scores of all items reach over 6.5% such as good appearance (6.67%), comfortable (6.80%), not disturb users' work process (7.55%), safe (7.84%), able to be moved easily (7.51%), and structures made from ecofriendly materials (7.74%).

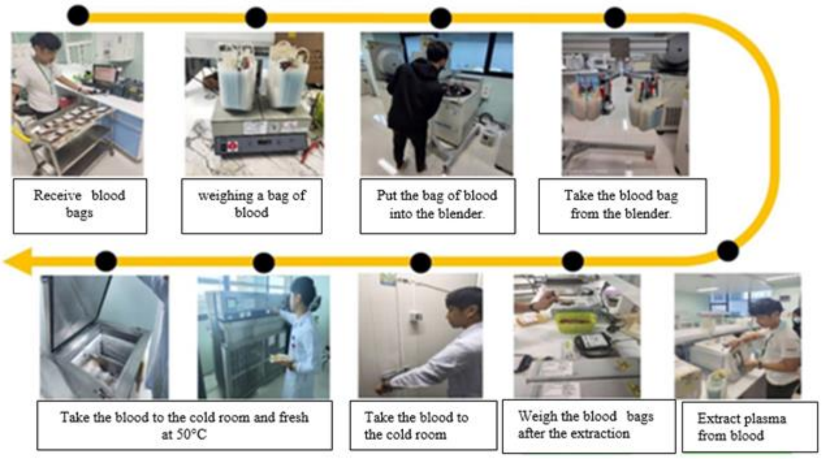

Figure 9 The Operation Process Chart

Regarding the operation process in Figure 9, the Process Chart is used to describe the process since it is an essential tool for recording data thoroughly and concisely. Moreover, it consists of symbols, descriptions, and lines. Apart from expressing a production process in detail, this tool also helps an analyst fully comprehend every step in the production process and leads to the better work processes. In fact, the Process Chart can be divided into many charts; this research deployed the Flow Process Chart.

Figure 8 Parts of the Vertical Lifting Device

4.4 The Satisfactory Level of the Device

5. Conclusion

In the preparation of blood components which sometimes are specific to certain types of patients through a centrifuge, the staff have to lift blood bags manually. This task is a risk factor for Musculoskeletal Disorders (MSDs) that cause injuries to hands, wrists, arms, shoulders, and especially low back which results from improper lifting techniques and repetitive lifting for a long period. As a result, the researcher made the vertical lifting device that properly operates as a labor-saving device and fulfills user requirements. In the study, the data was gathered from the staff at the Blood Component Preparation Section, the scholars, and the experts before being analyzed to determine important factors in the device design. From the matrixes of QFDE, it indicates the top five most important technical targets, including qualified device controllers (18.54%), strong and non-slip wheels (18%), eco-friendly materials (16.05%), a flexible system (12.64%), and durability of parts (11.07%).

It is significant to design a device that is compatible with skill and experience of device users. In so doing, problems about using a device are reduced while user satisfaction is increased. The application of QFDE to design the device used in the blood component preparation has an ultimate aim to fulfill user needs and perform the task correctly. Importantly, the user needs are the most crucial part and fundamental data of the study. The sample users are the staff at the Blood Component Preparation Section. Speaking of the VOC, it demonstrates that there are many kinds of user requirements. Therefore, all of the needs were sorted and then analyzed in collaboration with the experts in patient under investigation. After that, the researcher distributed the questionnaires so as to measure the importance ratings of each user requirement. Next, the user needs and the importance ratings were analyzed through the Planning Matrix and the Part Deployment Matrix, respectively. Moreover, the experts also took part in this analysis process. The results from QFDE indicate the aspects able to meet the user requirements. As a result, the part characteristics derived from QFDE were applied to determine the direction of the device design. In conclusion, the QFDE technique is beneficial to investigate user needs and identify design characteristics that comply with the requirements: both data can be used to develop the design in the future.

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