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Original Article

Application of quality function deployment for designing and developing a curriculum for Industrial Engineering at Prince of Songkla University

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Abstract

A Quality Function Deployment (QFD) technique is used to design a curriculum for Industrial Engineering (IE) at Prince of Songkla University (PSU). This paper shows a systematical step-by-step application of the QFD. This analysis focuses both on external evaluators of the university, companies that hire graduates and students' parents, and internal evaluators of the university, the student themselves and faculty. Survey data from 232 stakeholders were used in the QFD analysis in order to identify the requirements most valued by them. Results indicate that the stakeholders are looking for the graduates' abilities in the area of productivity improvement, knowledge application, production planning and control, quality management and control, and manufacturing management. Further, the QFD is used to translate the key requirements into an effective curriculum. It can be concluded that the QFD is a useful tool for designing a curriculum for higher educational institutions.

Keywords: quality function deployment (QFD), curriculum, house of quality

1. Introduction

In the recent years, universities in Thailand have expanded at a rapid rate. This expansion has increased concerns about maintaining the quality of the graduates (Mazur, 1996). The vital link between the quality of undergraduate education and competitiveness in the global economy is a very essential issue. Universities are now facing an increased pressure on how to construct their programs more attractive. An effective curriculum is one of the most important factors in order to have an attractive and desirable program. To obtain the valuable curriculum, Quality Function Deployment (QFD) is employed as a useful tool for developing the curriculum. The QFD technique provides a systematic method of determining customer needs, prioritizing, and translating them into product design parameters (Brackin and Rosers, 1999). The House of Quality (HOQ) is one of the QFD products, which correlates customer requirements (what's) to a large variety of means (service elements or, how's) by which customer desires can be satisfied. The HOQ matrix arranges important data in such a way that establishes criteria for a successful customer satisfaction (Koksal and Egitman, 1998).

2. Method

2.1 Sample group

The study group consisted of employers, faculty, students, and students' parents. Of 1,073 stakeholders selected to participate in a questionnaire survey, 232 responded (response rate of 22 %). Among the respondents were 88 (13%) employers, 63 (37%) students, 65 (36%) students' parents, and 16 (84%) faculty.

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2.2 Objective and Procedure

The objective of this research is to design an effective curriculum for Industrial Engineering (IE) at Prince of Songkla University (PSU) in HatYai, Thailand. To accomplish the goal, the QFD technique is employed for this research. There are four steps to carry out this research.

Step 1: Stakeholders identified

The stakeholders are classified into 4 groups: employer, faculty, student, and the students' parent. The employer and students' parent are the external evaluators, while the faculty and student are the internal evaluators of the university.

Step 2: Customers' voices collected

In order to develop the graduate's knowledge and abilities to satisfy the stakeholder needs, the stakeholder requirements are gathered. To obtain this information, in-depth interviews with twenty-five stakeholders are conducted. They consisted of 13 employers, 5 students, 5 faculty, and 2 students' parent. The criteria for the selections were based on their experiences and voluntaries. An affinity diagram (Figure 1) and a comprehensive questionnaire are used to collect and analyze the information. A group of researchers, IE seniors, graduate students, alumni, and potential employers developed the questionnaire. The questionnaire contains three main categories: knowledge, skills, and personality. The final questionnaire was analyzed by three IE educational experts and three experienced employers. The rate of importance in the questionnaires is a rating of the stakeholders' demands on a scale from 1 to 5, with 5 being most important and 1 being relatively low important. In this study, the Cronbach alpha was employed to represent its reliability. It was 0.86 for the final questionnaires.

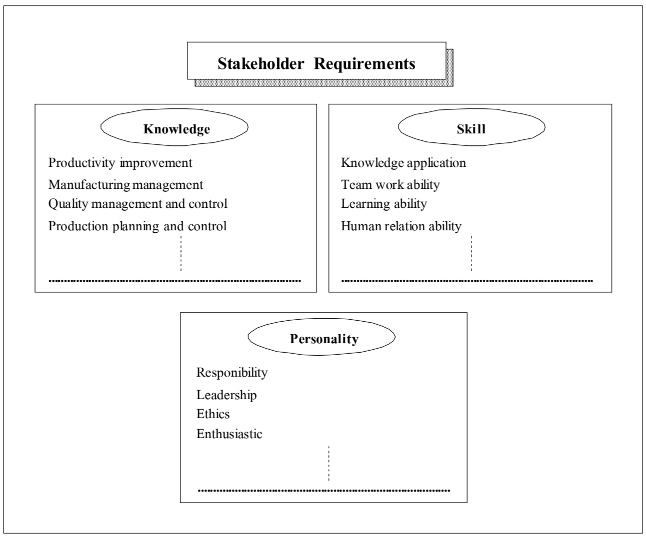


Figure 1. Illustration of the affinity diagram

Step 3: Stakeholder requirements ranked

In order to arrange a priority in the stakeholders' needs, an Analytic Hierarchy Process (AHP) is applied. According to the results provided by the questionnaires, each representative's importance ratings are expressed in an AHP matrix. Subsequently, the AHP matrices are aggregated within each stakeholders group by calculating the geometric mean of the stakeholders importance weights (Saaty, 1986). In order to complete this task, the stakeholder importance weights were multiplied by stakeholder requirement values, which results in the stakeholder requirement importance weight.

Step 4: House of quality of curriculum planning constructed

A House of Quality matrix is constructed to analyze the relationship between stakeholders requirements (What's) and service element (How's). Figure 2 shows The HOQ construction (Cohen, 1995). The quality council determines the relationship values between stakeholder requirements and service element. Correlations between each pair of service element are indicated at the roof of the HOQ. These indications show that the service elements affect the performance of each other's. The important values for each curriculum design feature are found by multiplying the relationship values with the corresponding stakeholder requirements importance weights, and adding all these values column-wise. Then, these proposed changes should be implemented. Successful procedures should be standardized.

The HOQ involved assessing the stakeholders needs, the graduate's characteristics of the external and internal customers. and how their needs have been incorporated into the curriculum design. The tasks of building the house of quality were as follows (Chen and Chen, 2002):

Task 1: The stakeholder requirements were identified through a survey and interviews with several stakeholders. The most mentioned items were listed as the "Stakeholder Requirements (What's)".

Task 2: The values of stakeholder requirements importance weights were assigned by the stakeholder survey. They were multiplied by the stakeholder requirement, value

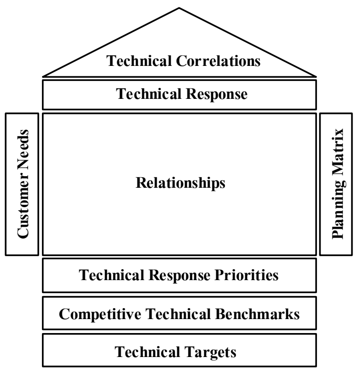


Figure 2. Illustration of the HOQ constructed

which is ranked by a group of experts.

Task 3: The important curriculum design features, service elements (How's), are classified into two groups: learning contents and learning experiences.

Task 4: A group of experts determines the relationship between the stakeholder requirements and service elements. It provides a listing of how the service elements represent each employer's needs on a scale of 1, 3, and 9. The rating scale 1 represents a slight or possible relationship, 3 represents a moderate relationship, and 9 stands for a strong relationship.

Task 5: The absolute weight is determined by multiplying the cell numbers (row) by the corresponding importance values (last row) for each curriculum design feature. For example, the absolute weight of "F" = (9*5) + (1*4) + (3*3) + (3*2) + (1*1) = 65

Task 6: The relationship between "What's" and "How's" is represented by the sign ■ for a possible relationship and by ⦿ for a strong relationship. The example of the HOQ Matrix is present in Figure 3.

3. Results and Discussions

A total of 423 stakeholders (out of 1,073, 39.42% response rate) participated in the questionnaire survey for this research. The questionnaire consists of 22 knowledge requirements, 24 skill requirements, and 21 personality requirements. In this study, the variable analysis was 0.91 for the stakeholder requirements. The use of the AHP process enabled a better handling of the different stakeholder groups in the prioritization of their requirements (Chou, 2004). The stakeholder importance weights, which resulted from the AHP, are presented in Table 1. They are further used in developing the HOQ.

The result of the HOQ matrix is presented in Figure 4. The five most important requirements (What's) as perceived

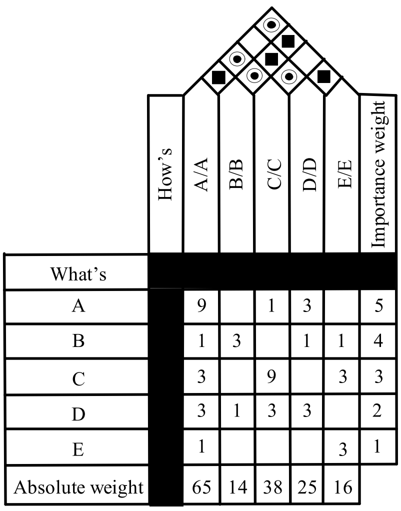


Figure 3. Illustration of the HOQ Matrix showing an example. Further explanations in the text.

Table 1. Stakeholder importance weights

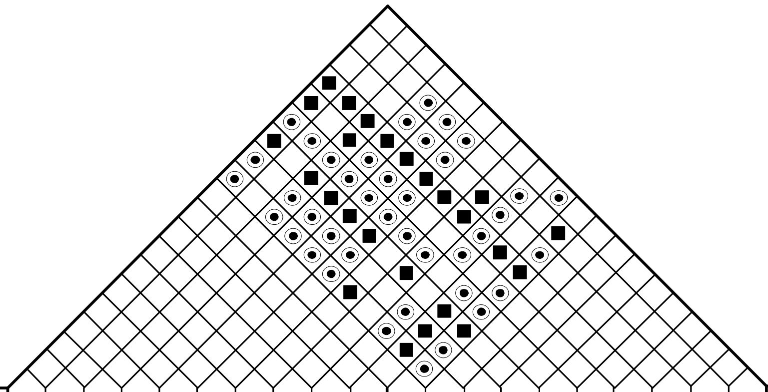
Stakeholder Importance Weights			
Employer	Student	Parent	Faculty
0.326	0.277	0.099	0.298

by stakeholders are the ability in the area of productivity improvement, knowledge application, production planning and control, quality management and control, and manufacturing management. According to this study, the service element (How's) is classified into 2 categories: learning contents and learning experiences. The classes Industrial Engineering project, productivity and engineering management, quality control, business management, and industrial work-study valued as the top five most important learning contents. With respect to the learning experiences, the practical training, collaboration with the industrial sector, field trip, participation in knowledge ability and case studies/ example are the top five most important ones. The results are not surprising, since the Industrial Engineering project, productivity and engineering management, practical training, and field trip are the primary teaching strategies in engineering schools worldwide.

4. Conclusions

Quality Function Deployment can be used in the curriculum development process. It is a simple, very effective, and efficient tool, yet powerful of discovering key characteristics of a successful curriculum (Downing and Downing, 2004). Being proactive and using the QFD principles properly will help the faculty to identify instructional designs and technical concerns early in the design process. Utilizing QFD early in the planning stages of a curriculum will maximize the learning process, which can lead to a stronger learning experience and increased knowledge for students and faculty.

This research considers a methodological quality improvement of the IE curriculum at PSU. The methodology proposed is based on an adaptation of the QFD applied to a higher educational institution. The results suggest that in order to improve the IE education, emphasis must be concentrate on the area of the learning contents: The Industrial Engineering project, productivity and engineering management, quality control, business management and industrial work-study. Regarding the learning experiences, practical trainings, collaborations with the industrial sector, field trips, participations in knowledge ability, and case studies or examples are the vital issues to be considered. Although the QFD is more effective than other techniques in determining customer needs and translating them to the service element, the main problem of using QFD is in managing and analyzing large relationship matrices. This is because they involve both high numbers of requirements and high numbers of



"How's vs How's"
Relationship Level
Strong relationship = ⊙
Possible relationship = ■

"What's vs How's"
Relationship Level
Strong relationship = 9
Moderate relationship = 3
Slight or Possible relationship = 1

	What's \ How's	Logistics and Supply Chain Management	Industrial Plant Design	Production Planning and Control	Productivity and Engineering Management	Industrial Work Study	Cost Analysis	Entrepreneurship	Industrial Engineering Project	Quality Control	Business Management for Engineering	Report / Presentation	Practical Training	Test / Quiz	Field Trip	Assignment	Seminar by Specialist	Collaborate with industrial sector	Question and Suggestion	Case Study / Example	Participation in knowledge activity	*Customer Needs Importance Weights*	*Importance Ranking*
		Learning Contents										*Learning Experiences*											
Knowledges	Productivity improvement	3	3	1	9	3	3	1	3	9	1		3									3.12	1
	Production planning and control	1	3	9	3	1	1	3	3	3	3		3									2.90	3
	Quality management and control	1		1			1	1	3	9			3									2.89	4
	Manufacturing management	9	3	3	9	3	3	3	3	3	3		3									2.82	5
	Industrial work study		3		3	9	1		1				3									2.69	8
	Safety and environmental management	1	3			3		1	3		3		3									2.19	14
	System and industrial plant design	1	9	1	1	3	1	1	1				3									2.00	17
	Economy and cost analysis	1	1	3	3		9	3	3		3		3									1.98	18
	Operation Research	3	3	3					1				3									1.94	19
Skills	Knowledge application							3			1	3	3	1	3	3	3	9	3	3	3	3.00	2
	Analytical thinking								9			3	3	3	3	3	3	3	9	9	1	2.70	7
	Team work ability								3		1							3			1	2.60	9
	Decision making ability								3				3					3		1		2.60	9
	Learning ability								3		3	3	9	9	9	9	9	9	9	9	9	2.52	10
	Human relation ability								3	1	1		9		1			3			3	2.38	12
	Continuous improvement				3	3			3	3			1		3		1	3	1	1	3	2.35	13
	Communication ability								3		3	9	1	9				1	1			2.11	15
Personalities	Ethics							1	9		3		1									2.80	6
	Responsibility								9		3	1	3		3	3		3			1	2.45	11
	Enthusiastic								3			9	9	9	9	9	3	3	3	3	9	2.01	16
	Vision and attitude				3			3	1		1		3		9		3	1	3	1	3	1.81	20
	Patient and industrious		1	1		3	3		3	3	3		1		3		1	1				1.79	21
	Leadership								3		3		3					1	1			1.70	22
Absolute Weight		52.5	68.8	59.2	90.7	69.9	51.5	50.5	188	86.1	78.3	64.2	182	54	96.3	65.2	67.4	108	68.8	86.8	95.1		
Importance Ranking		8	6	7	2	5	9	10	1	3	4	9	1	10	3	8	7	2	6	5	4		

Figure 4. Illustration of the HOQ with “What’s” versus “How’s”

service elements. A way to overcome this problem is to reduce a project into a set of sub-projects in order to simplify the relationship matrices.

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