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Quality Function Deployment for Service: A Case Study of Enhancing the Planning Statement of a Utility Company

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ABSTRACT

Throughout the years, the Quality Function Deployment (QFD) method has significantly developed and was widely implemented for developing products and services in both industrial and service sectors. Each new QFD application often presents an opportunity for practitioners to think about other areas where QFD concept could be used. In this paper, a methodology is developed to facilitate a new QFD application to customer need analysis and quality improvement in the service industry. The objective is to improve the quality of the 5-Year Planning Statement (5YPS) for the asset management of a major utility company. The 5YPS in presented in a strategic report which the utility company develops and delivers to stakeholders and regulators. The report outlines the company's asset management plan and project-based capital expenditure. Thus, the focus of improvement is on the report's technical content in terms of proposed projects and asset management initiatives. Quality improvement of such plan is highly needed to address the frequent comments raised by customers due to the multiple nonconformities in previous reports. To this end, various enhancements are made to the conventional QFD model to make it more operational and workable in such service application. In addition, several business and quality tools are used in the construction of the QFD House of Quality (HoQ) including Process Mapping, SIPOC chart, Work Breakdown Structure (WBS), Pareto Analysis, and Brainstorming. The methodology was successfully used to improve the planning statement of a major utility company. The enhancements are recommended based on a thorough review of the feedback received from the customers on the reports submitted yearly to regulators by the department of asset management from 2007 to 2010. The study found that the customers were not fully satisfied by the submitted reports. Consequently, the company has exerted significant efforts over the last 4 years in order to meet customers' expectations through costly and time-consuming adjustments, re-work, and report changes. The proposed approach utilizes QFD to enhance the company's planning statement (the technical content of the strategic report) and to avoid these excessive costs. The proposed procedures could be used as a framework to improve other types of planning statements and strategic reports developed by other departments of the utility company as well as by other similar companies in the manufacturing and service sectors.

Keywords: Planning Statement, Quality Function Deployment, Service Quality,Utility Service.

1. INTRODUCTION

Many companies are increasingly adopting Total Quality management (TQM) tools and methods to enhance customer service, increase operational effectiveness, and improve profitability. A key principle of TQM is to be customer-driven when developing new products/services as well as when enhancing existing ones. Quality Function Deployment (QFD) has been proven as a powerful TQM tool for capturing the Voice of Customer (VoC) when designing or improving products and services and translating that into technical and non-technical features and functions in order to meet or exceed customer expectations. It is a planning tool that helps various enterprises to listen and understand the wants and needs of customers and find out possible means to accomplish these requirements efficiently and effectively.

QFD was first developed in Japan in the late 1960s by YojiAkao and Shigeru Mizuno as a tool for integrating quality into the development of products and services[1]. QFD was aimed at delivering products and services that efficiently satisfy customers[2,3]. QFD applications include enhancement of products and services of companies in many industries[4]. Details of QFD application to real-world problems can be found in [5]. An extensive review of QFD literature can be found in [6].

Nowadays, QFD application in the industry has extended to become a systematic process for capturing customer requirements and translating them into process changes that must be met throughout the supply chain (sourcing, purchasing, operations, warehousing, distribution, logistics, support, and after sale service). QFD can also serve as a decision-making methodology that helps in modeling and making complex decisions during the process such as sourcing decisions, resource allocation, supplier/customer relations, etc.

Moreover, QFD, when applied successfully, can lead to a significant reduction in product/service/system development costs. To this end, researchers and practitioners have developed the needed software tools and techniques for turning QFD into a comprehensive system to assure quality and customer satisfaction in both products and services.

As a result, QFD has become an established methodology that is widely used to translate the Voice of Customer (VoC) or customer needs (the WHATS) into its means of accomplishment (the HOWS). In tangible products, this often include the translation of desirable qualities into product technical and non-technical features and functions while in services they include process enhancements and service improvements. The voice of the customer contains the declared and even hidden customers' needs. It can be captured through questionnaire, observation, open sessions,

social media, and so many other ways. For cases where customers are professional bodies, other organizations, or regulators questionnaire and brain storming sessions are highly recommended. Based on the VoC, actions are set to enhance the product/service so that the new design/model meets or exceeds customer needs and expectations. This can be accomplished incrementally or at one step based on technical difficulty and the available time and cost.

QFD provides a structured methodology for the accomplishment of customer needs. To this end, a House of Quality (HoQ), which is the core of QFD, is developed by identifying the engineering requirements of the product/service that are needed to meet customers' needs and specifying the relationship between them. As shown in Figure 1, the HoQ is developed using six components: (1) customers' requirements and assessment, (2) engineering requirements, (3) the relationship/impact of engineering requirements on customer requirements (center), (4) the technical correlations of engineering requirements (roof), (5) customer perceptions and market benchmark study, and (6) design objectives/priorities and targets.Developing the HoQ results in providing the designers with specific information on the set of product/service enhancements that should be implemented in order to meet the customers' requirements.Further details of QFD process and HoQ structuring can be found in[5] and [6]. Examples of QFD applications can be found in [7] and [8].

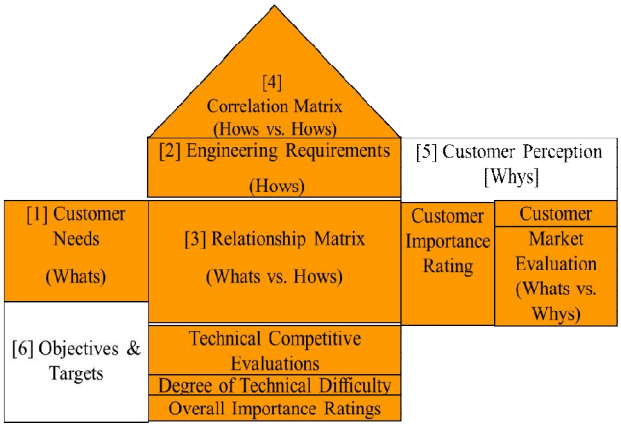

Figure 1: Components of QFD-HoQ

This paper presents a new QFD application to enhance the technical content of a strategic report in a major utility company. The objective is to improve the 5-Year Planning Statement(5YPS) reports that the utility company delivers to its customers (stakeholders and regulators) outlining its future planning and capital expenditures. This report is prepared by the Asset Management Department (AMD) of the utility company. The QFD is mainly adopted as a quality assurance tool that allows the company to respond to the comments raised by customers due to multiple nonconformities in previous reports. The objective is to provide the case company (a utility company that distributes electrical energy) with a structured methodology for listening to the voice of their customers and considering their needs when developing the technical contentof such important strategic report. The methodology selected is an enhanced version of QFD that facilitates the process of addressing customers' concerns on previous reports, identifying their desires for a quality report, and specifying and prioritizing report technical aspects that the company should concentrate on in order to meet their expectations while continuously improving quality.

2. QFD SERVICE APPLICATIONS

The QFD application to service industry is growing along with the growth of service sector and more companies are using the tool for enhancing the services provided to their customers as well as for designing new services. Common industries include healthcare, hospitability, financial institutions, law enforcement, airports, utility companies, and many others. Since QFD proved to be effective in product development of manufactured goods, it is also expected to be effective in designing services and enhancing the process of providing these services to customers. However, we need to be aware of the differences in applying QFD to manufacturing and service sectors. In a physical product context, QFD provides an interface between customer product needs and engineering or product characteristics. For the producer, these characteristics are materialized through actions taken to process operations and production requirements. In a service context, however, QFD provides an interface between customer expectations from the service and the service quality attributes such as waiting and service time, convenience, courtesy, trust, etc.

A third in-between QFD application is in services that provide customers with tangible items such as strategic reports, mail, shipped items (deliveries), food services, documents (e.g., ID and passport services), and so on. While those represent service applications of QFD, they incorporate both tangible and intangible quality attributes into the provided service. Tangibles are related to the item/product delivered and intangibles are related to the service process. For example, when delivering a strategic report to a stakeholder, QFD can be used to enhance the tangible aspects of the report such as paper quality, graphics, cover, size, etc. and can be also used to enhance the report intangible aspects that are related to its technical content such as usefulness, completeness, accuracy, credibility, and so on. Typically, the most focus is often placed on these intangible aspects of quality as they form the most value of the strategic report. Other report aspects may include its delivery method, timing, and cost of development.

Relative to the conventional products QFD applications, service applications of QFD remain limited. As discussed in [9], this is mainly due to a lack of understanding of the breadth and complexity of the customer needs that had to be integrated into product design, environment design, and delivery systems. Details of utilizing QFD in service industry can be found in [10] and [11]. Examples of QFD service applications include [12] and [8]. Anwar *et al.*[13] presented a QFD application to utility services with a case study of an electricity distribution company. In terms of reports and

documentation, QFD examples are discussed in [14] and [15].

Although QFD was applied to many aspects of service sectors, the work presented in this paper is a unique QFD application that targets the enhancement of a strategic report (i.e., the 5-year planning statement report of a major utility company). The customers feedback on the report technical content is used to derive technical solutions that the asset management department of the company can adopt to improve the overall service quality and to respond to the needs of customers (stakeholders and regulators).

3. THE PROPOSED QFD APPROACH

The methodology implemented in this paper is a result of a practical research project that was carried out as part of the Quality Engineering course in the Master of Engineering Management (MEM) program at Abu Dhabi University in collaboration with a major local utility company. The objective is to enhance the company's 5-Year Planning Statement (5YPS) report per the feedback obtained from customers (i.e., parties who receive the report). The proposed methodology used in this study is an enhancement of the typical QFD method in order to fit the nature of this unique application. Figure 2 depicts the process of developing the QFD model and implementing it to enhance the corporate-level strategic report.

As shown in Figure 2, the methodology starts by utilizing existing information and business and quality tools to develop and distribute a questionnaire, incorporate its results into the HoQ and complete its complements as presented in Figure 1, and translate the results into enhancement to the technical content of the 5YPS report.

The implementation of the proposed methodology in Figure 2 involves 5 main steps that QFD practitioners can adopt for report quality improvement. In the first step, the product is identified using SIPOC chart, the report's WBS, and Pareto Analysis. This includes presenting the rationale for selecting the 5YPS report as a target for QFD application. In the second and third steps, report customers (stakeholders) are identified and a survey is prepared and distributed to capture the VoC on the strategic report using stakeholders' feedback, similar reports, and a team-based brainstorming. The HoQ is developed in the fourth step based on structure presented in Figure 1. Finally, the results of the HoQ analysis are used to recommend specific enhancements to the technical content of the company's strategic report so that customer requirements are met.

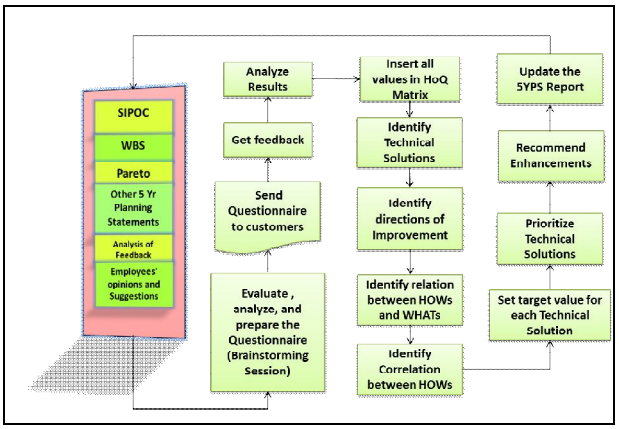

Figure 2: The QFD Methodology for the 5YPS

The proposed methodology also integrates Process mapping (PM), Work Breakdown Structure (WBS), SIPOC (Supplier-Input-Process-Output-Customer) chart, Pareto Analysis (PA), and Brainstorming into the development of the QFD model. The objective is tofacilitate the application ofQFD to the quality improvement of the 5YPS report. Process Mapping (PM) is used to better understand the process preparing and submitting the strategic report. SIPOC chart is used to outline the overall supply chain process of the product/service (report) from source (supplier) to end-user (customer). Pareto Analysis (PA) is used to prioritize the elements of the strategic report and qualify them to QFD applications. The WBS is used to illustrate the content of the strategic report developed by the utility company. Finally, brainstorming is used by the project team to identify key product/report aspects, design the questionnaire, identify technical solutions, and recommend enhancements to the 5YPS.

4. QFD OF A PLANNING STATEMENT

The proposed QFD method was applied to enhance the planning statement report of a major utility company. The company is committed to distribute high quality water and electricity services. Its core business can be summarized in the following:

1. Planning and Design of Electricity and Water Infrastructure
2. Construction of Water and Electricity Infrastructure
3. Operation and Maintenance of Water and Electricity Infrastructure

The Assets Management Department (AMD) is considered as a key component of business performance of the company due to its role and function. AMD is also responsible for communicating with external parties such as government authorities, developers, consultants, contractors, and suppliers. The key role of asset management stems from the importance of managing the company's physical asset (e.g. cables, transformer, etc.) in a way that maximizes the operational and financial benefits taking into considerations technical, economical, and environmental aspects. In addition to that, AMD is responsible for developing a robust strategic plan that has to be aligned with the interests of

different parties(stakeholders) as well as the company's interest. Thus, this study is focused at enhancing the quality of services thatAMD offers to its customers (both internal and external). The 5YPS report is the main service provided by AMD to the company's stakeholders. Figure 3 presents a map of the current process for report preparation and submission.

The study began by listing key AMD products and services and a matrix diagram is developed in order to have a holistic view on interaction between AMD and its suppliers and customers. Furthermore, all listed products were subjected to evaluation in terms of their impact on AMD performance. Given the limited time of the study, only one AMD output is selected to undergo the QFD exercise. In this case, the 5-Year Planning Statement (5YPS) report is selected for the QFD application due to its key role in the overall performance of the utility company. The report outlines the company's performance against its vision, mission and values. The report is also submitted to regulating agency as per the license issued to the company. The report is used by the regulators to:

- Check the performance of the company
- Overview the company's plans for expansion, rehabilitation, and upgrading
- Ensure the consistency of its overall plans with other companies within the group (those responsible for the generations, transmission, and distribution of electricity).

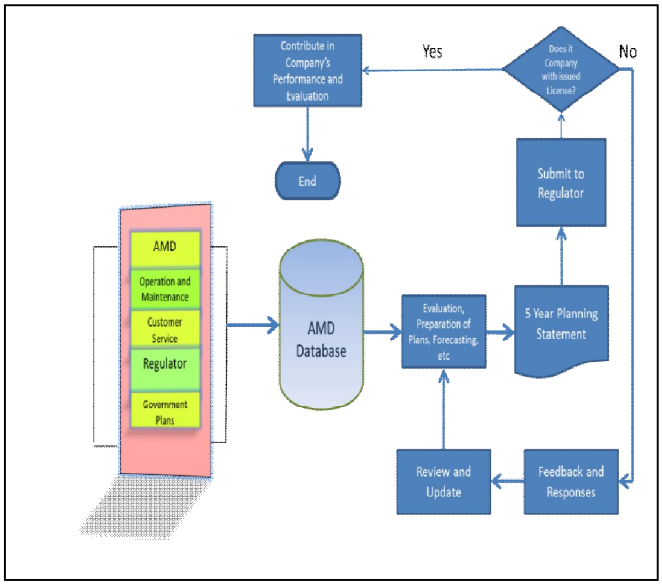

Figure 3: The Processof Report Preparation and Submission

The report VoCwas captured by conducting a survey and by reviewing the complaints received by AMD on the report in the last 4 years. The HoQ is then developed using survey results and brainstorming sessions. Finally, the outcomes of this study are analyzed and recommendations are made to improve the 5YPS report to meet customer requirements. The following is a step-by-step explanation of implementing the proposed approach to develop and customize the QFD model.

4.1Product/Service identification

A thorough review of all strategic reports is first conducted to develop a profound knowledge about AMD products and their priorities. In addition to the 5YPS, AMD issues 6 other reports yearly related to asset management performance and the business cases for new projects. However, the 5YPS report was found to be the most Critical-to-Quality (CTQ) report given its strategic importance to the company and its stakeholders and to the amount of comments received on the report from the regulator. As shown in Figure 4, three tools were used to identify the critical product/service that the team needs to focus on in its effort for service quality improvement; SIPOC chart, WBS, and Pareto Analysis.

The SIPOC chart is used to collect the company high-level information, to build knowledge about the strategic report as a key product, and to understand its supply chain. The SIPOC chart also facilitated the tracking of changes in the flow of information within the company and used to simulate the current behavior in developing the strategic report and predicting the results. The selection criteria for the strategic report as a QFD product include the following:

- Impact on company's performance against its vision, mission and values
- Regulator's compliance as per the license
- Impact on the budget
- Impact on the manpower and future requirements

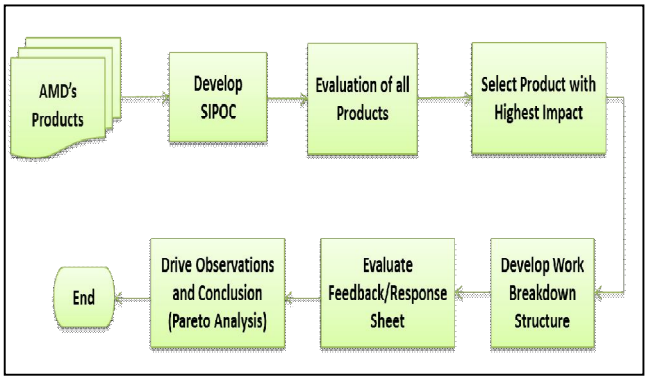

Figure 4: Procedure for Product Identification

Once the product is selected, a Work Breakdown Structure (WBS) is developed for the product (report) in order to get familiar with its content. The WBS also helps the team in designing the questionnaire that captures the report VoC and in making later enhancements to improve the report quality. Figure 3 shows the WBS for the 5YPS report of the utility company. The 5YPS report consists of the following nine chapters:

- Executive Summary
- Demand Forecasting
- Planning Criteria
- Network Expansion/Reinforcement Proposals

- Cost Estimates
- Power System Studies
- Energy Consumption and Forecast
- Asset Data
- Asset Performance

Finally, Pareto Analysis was used to prioritize the book chapters based on their importance to users. To this end, the team used the past practices and the feedback obtained from different parties who used the 5YPS report. Based on past experience with previous planning statement reports issued by the utility company from 2007 to 2010, the number of comments received from the regulator was 64, 87, 80, and 50, respectively. Pareto analysis was conducted for each report issued by the utility companies.

As shown in Figure 5, Pareto analysis for the latest planning statement report (2010 submission)identified the 20% of report chapters that need to be enhanced in order to achieve the 80% improvement in report quality. Chapters 4, 5, 8, 2, and 1 form the 80% of the total impact of the report as indicated by the report users. Thus, the focus of the report quality improvement effort should be directed at these 5 chapters.

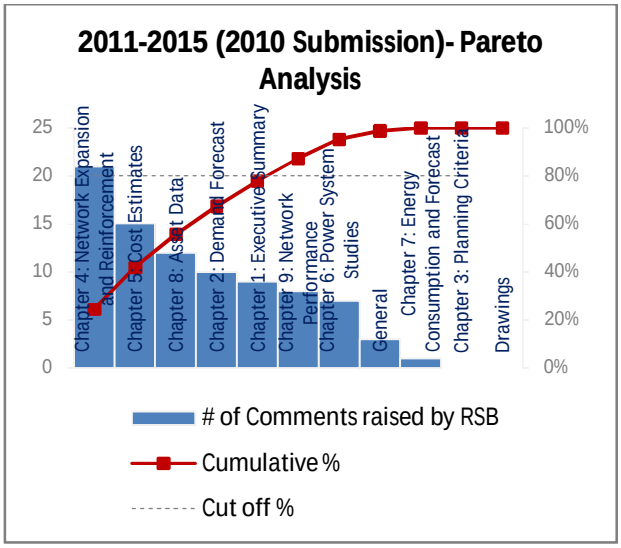

Figure 5: Pareto Analysis for the chapters of the 2010 5YPS report

4.2 Survey preparation

This step is crucial for the success of QFD application as it captures the report VoC from the report users and drive future directions for the quality improvement effort. Therefore, a thorough review of the current report structure is conducted and compared to similar reports in order to prepare the content of the user survey. The survey is then developed using the information and users feedback collected in the first step (SIPOC chart) and a brainstorming secession with the engineers responsible for developing the 5 Years Planning Statement Report (mainly from the Strategic Network Planning Section).The team agreed to divide the survey questions into the following four parts:

- General Questions: Questions that are related to report general formatting, language, coloring, figures, etc.
- Technical Questions: Questions that are related to technical content of each report section such as demand forecasting methods, cost estimates, planning design criteria, demand side management, etc.
- Ranking Questions: Questions that are related to ranking customers' needs or desirables using an importance scale that ranges from 1 (Lowest importance) to 5 (Highest Importance).
- Benchmark Questions: Questions that are related to comparing current report to those issued by competitors (i.e., 3 other local utility companies in different cities of the same country).

The survey is structured to capture the VoC of report users in the simplest manner possible. Customer feedback should provide specific recommendation regarding their experience with existing report chapters and content. Questions forms were used in the survey to collect customer importance ranking of report chapters along with benchmarking with similar reports and details of customer dissatisfaction experience with the report and any improvement suggestions.

4.3 Identification of customer requirements (VoC)

The team has used two methods of communication media to distribute the survey and capture the VoC of the report users: face-to-face interviews with reachable stakeholders and E-mails for remote customers. In total, the team distributed 35 surveys to the targeted customers but only 25 responses were qualified for the study (71.4% response rate). Male represented 80% of total respondents and female respondents were 20 %. The information collected from the surveys was organized and the set of customer requirements (VoC) is identified and fed into the HoQ matrix.

Regulator comments were classified into four parts; formatting, clarifications, suggestions, and requirements. As mentioned in the preliminary analysis, most of the highlighted regulator's comments were on the technical content of Chapter 4(Network Expansion and Reinforcement). There was also comment on budgeting and its utilization over the years. These comment and many others indicated dissatisfaction with the overall quality of the 5YPS report and verified the need for quality improvement. The utilization of QFD structured methodology starting with capturing/understanding the VoC was crucial in this regard to incorporate the customer concerns when developing the next year's 5YPS report. The HoQ matrix provides an excellent platform for translating the VoC into specific enhancements (technical solutions) of the report.

4.4 HoQ development and analysis

The HoQ is the core of QFD methodology as it integrates collected customer information with the engineering work aimed at product/service improvement. The HoQ matrix translates the voice of the customer into product specifications by relating customer "wants" to alternative product/service designs (means for accomplishing these wants) so that engineering and quality efforts can be concentrated on the most important and valuable

characteristics. Starting with the survey-based customer needs "WHATs" and the benchmark study, the elements of the HoQ matrix were developed based on the structure presented in Figure 1 and the proposed methodology in Figure 2.

This was a team-based exercise where brainstorming sessions involved subject matter experts to specify the technical aspects of the reports (design features or HOWs) that can be used to meet the customer requirements. The team has also set the relationships between the WHATs and HOWs, the correlation between the HOWs (the HoQ roof), the targets for technical requirements, the priority of technical solutions, and the recommendations for enhancing the technical content of the 5YPS report. Figure 6presents the developed HoQ matrix.

In terms of customer needs, and as indicated earlier, the results obtained from the HoQ shows that the technical content Chapter 4 (customer need No. 11) has received the highest customer rating among other report chapters. Therefore, high concentration on improving expansion proposals is highly recommended by proposing number of technical solutions. The next section outlines the technical enhancements of the report that are derived from the HoQ matrix.

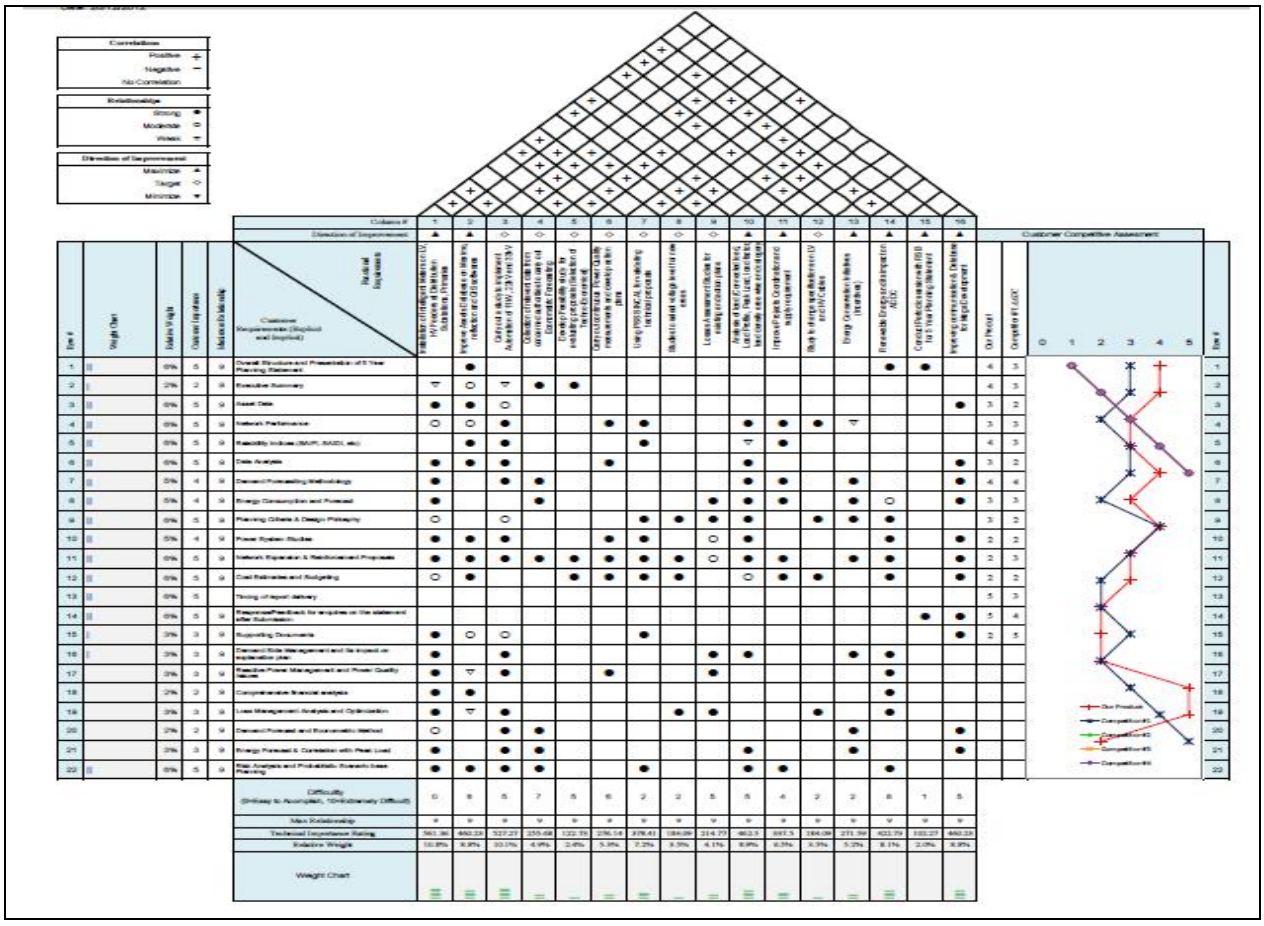

Figure 6: The developed HoQ in QFD application

4.5 Enhancement of the 5YPS strategic report

The team has used two methods of communication media to distribute the survey and capture the VoC of the report users: face-to-face interviews with reachable stakeholders and E-mails for remote customers.

This is a unique QFD application in which technical solutions are derived from the survey-based customer expectations of the content of a strategic report (5YPS). QFD worked as a chained interface between the customers and the developer of the technical content of the 5YPS report which include specific projects and service improvement initiatives. Based on the analyses of customer needs and expectation, the team was able to identify a set of report technical requirements that should fulfill these needs. As shown in the HoQ in Figure 6, target values were also set to the selected technical requirements (solutions) and these solutions were prioritize for adoption and implementation in the next 5YPS report developed by AMD of the utility company. As a result, the following report technical enhancements (solutions) were recommended:

1. Enhancement No. 1: Install intelligent meters on low voltage and high voltage distribution system
2. Enhancement No. 2: Improve assets database on Maximo, Reflection, and GIS software.
3. Enhancement No. 3: Carry out a study to implement the automation of 11kV and 22kV network
4. Enhancement No. 4: Improve communication and database for mega development

As shown in Figure 6, the first technical solution recorded the highest score and weight of relative importance (10.8%). Implementing this solution is expected to dramatically foster the overall performance of the 5YPS as more data would be drawn from these devices such as load and voltage profile, power factor, and active/reactive power. In addition to the strong relation between this technical solution and customer requirements, the data expected to be collected from the intelligent meters is essential for evaluating network capabilities and efficiencies which facilitate making decisions on new customers, getting better knowledge on system utilization and losses, assets performance, and consumer behavior.

The second technical solution is also important to enhance overall quality of the planning component of the 5YPS. Updating and improving the recommended databases provides an excellent source of information to planners and facilitates the conduction of improvement analysis and future predictions. Maximo database is considered as one of the powerful tool that is common amongst many utility companies. Reflection database provides users with information that could help in the analysis of network expansion and reinforcement. Finally, Geographic Information System (GIS) database provides data related to existing infrastructure, plots, cities, etc. which is an essential tool for strategic system planning and spatial load forecasting.

The third technical solution recommends the automation of distribution system to enhance network performance indices such as System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI)). These measures are highly influenced by the time required to restore power supply as well as the total energy lost due to interruption. In addition, this solution is considered as one of Smart Grid elements, which enable the distribution utilities to connect renewable energy resources such as the Photovoltaic (PV) system.

Finally, the fourth technical solution induces the utility company to work with other stakeholders to improve communication and database for issues related to mega development (which has significant effect on total load growth that will trigger the plans to establish infrastructure). The objective is achieving an optimized tech-economical solution that would not result in building unnecessary infrastructure, delaying the establishment of necessary infrastructure, underutilization of existing assets, or the overestimation of prices of establishing infrastructure.

The utility company plans support these QFD results in such a way that the recommended solutions are put under the implementation stage**.** To this end, the utility company has run feasibility studies and started the contracting process to install the intelligent meters and the required control devices, improve the databases, and develop the smart grid. If time and budget allows, the other technical solutions are highly recommended to be carried out in parallel with these four technical solutions as they will also result in improving the overall quality of the 5YPS. In addition, it was highly recommended to develop a strategy to develop a set of guidelines that lead to consistency in the company's approach towards achieving its mission, vision and values.

5. CONCLUSION

Utilizing QFD in a wide spectrum of manufacturing and service applications has created a robust platform to foster users to adopt such systematic approach in improving the quality of any type of product/service including technical and strategic reports. This study has presented a unique QFD application in which the quality of the 5-Year Planning Statement (5YPS) of a utility company is improved. Improvement is expressed in terms of a set of technical solution (projects and initiatives for better asset management) that are derived from the customer needs and expectations for the content of the 5YPS report. The report is developed by the department of asset management and submitted to stakeholders and regulators. In addition, this study has proven that engaging customers, while developing the 5 YPS has led to tremendous improvement in quality of the report. The proposed QFD methodology indicated thoroughly the process of collecting customer and product information, designing surveys, capturing the VoC, and developing the HoQ. Therefore, these steps could be considered as a framework for future development and quality enhancement of technical and strategic reports in both manufacturing and service applications.

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