# Resolving Food Wastage Using House of Quality

*Saroj Koul[*] and Hima Gupta[**]*

## ABSTRACT

*House of Quality (HOQ) is a conceptual tool for mapping attributes from one phase of the design process to the next. It is a valuable instrument in helping understand the role of different entities, the general flow, and the type of information within the design process. However, there is a major drawback with the potential to affect decisions earlier in the design process so that later failures of the product are unlikely to be traced.*

*With an effort to discuss these limitations and explore its effect empirically as tested at one of the residential university where students want to find taste in all the food, they consume on campus. Relevant data (primary and secondary) allows for both a qualitative and quantitative analysis. Various quality parameters which are responsible for fluctuation in the food consumption trends are identified for developing the HOQ through which the main factors leading to the deterioration of quality standard have been identified.*

**Keywords:** Quality Function Deployment (QFD), House of Quality (HOQ), Voice of Customer (VOC), Customer Needs, Product Development, Performance Measures, Food Wastages, Survey, India

## INTRODUCTION

Quality management has set standards for most industries across the globe. In the present era of cost-efficiency and selective investments, the need for proper resource allocation and cost-effectiveness is looked at while performing any task whether it involves a simple task or a job involving complex processes. In addition to this, every step in the process that is performed has increasingly improved the quality of the end product that is produced for the consumers. In several sectors, including aviation, manufacturing, transportation, logistics, and pharmaceutical industry, very high-quality standards are set. The slightest change in their measures could render the processes and functions imperfect with few resulting in danger to human life.

Quality function deployment (QFD), a globally admired quality management philosophy-cum-tool is often used to improve quality, reduce development and pre-production costs, increase

* Professor, OP Jindal Global University, Sonipat Narela Road, Near Jagdishpur village, Sonipat, Haryana, NCR of Delhi, India
E-mail: skoul@jgu.edu.in

** Professor at Indira Institute of Management Pune, Pune
E-mail: hima.gupta@indiraiimp.edu.in

organization capabilities, and makes the business sector/industry more competitive. QFD seeks to improve the quality of the products thus aiding fast decision-making with regard to the final product.

In the following sections, we shall first analyze the QFD process for its many associated benefits and several disadvantages. Next, for investigative experimentation, a QFD is proposed to be constructed keeping in purview the benefits and disadvantages of QFD in an India setting. Food safety in an Indian setting will be surveyed for the collection of primary data for exploratory purpose wherein "food wastage" is growing at an alarming rate globally and calls for thoughtful attention. Employing the QFD tool will serve twofold—first, in re-assessing the disadvantages of QFD, and second, in confirming that the tool thus developed ensures a quality system that mitigates the food wastage thus improving the quality of food supplied.

## QUALITY FUNCTION DEPLOYMENT

Quality function deployment, established in the early 1970s at a Japanese shipbuilding firm is believed to have later migrated to the Japanese auto industry and then to the US auto industry by the mid-1980s. Its objective was to provide a systematic way of dealing with the various complexities and trade-offs inherent in all of the design decisions faced by product developers.

While, John R. Hauser & Don Clausing (1988) have given a descriptive explanation about HOQ being a conceptual map which provides a means for inter-functional planning and communication, many QFD practitioners believe that it is best carried out by an active cross-functional team whose job it is to complete one or more of a series of matrices which lead to a set of insights into how best to create a winning product or service and how to prioritize their research and development activities going forward. Today, it is used in almost every type of industry and application conceivable–be it a product or a service, and consumer (B2C) or for commercial (B2B) purpose Hauser (1993).

Though it takes in a good deal of effort, several benefits are derived by the use of QFD, such as: (1) permitting teams to prioritize the developmental activities in a systematic and analytical way that puts the customer first, (2) allowing cross-functionality the support of all major functions within the organization in an orderly participative way toward a common view, (3) provision for "audit trail" for all project participants, and (4) allowing stretching the team's thinking as to which activities are most critical toward creating a winning product or service (Hauser & Clausing, 1988).

Quality function deployment's main component, the HOQ, is used both as a stand-alone tool (Kaldate et al., 2003) as well as the integrated tool in larger design processes (Olewnik et al., 2004). By utilizing QFD, the product development fulfils the customers' needs (Hauser & Clausing 1988; Bergquist & Abeysekera 1996). Further, Fung et al., (2003) indicate that the use of QFD results in "achieving maximized overall customer satisfaction." The goal in QFD is to translate customer demands into target values for the product characteristics.

Even though the QFD management tool is good at improving the design and minimizing the costs of manufacturing, it has several disadvantages. Also, some operational problems hint if QFD indeed leads to "better" products, as is often claimed. At its root, the HOQ is a conceptual tool



for mapping attributes from one phase of the design process to the next. It allows a clear flow of information on a node-by-node basis in the design process from the identification of "perceived need" node all the way through the "manufacturing" node.

A limitation of the HOQ is the probability to affect decisions early in the design process, that later failures in the design or market success of the product are unlikely to be traced. This limitation results from the attempt to specify quantitative relationships in the mapping of customer attributes to technical attributes, i.e. mapping from the "perceived need" node to the "specification" node.

Another disadvantage is that a QFD exclusively focuses on quality and interrelated metrics while overlooking other critical factors that include the cost, product life cycle, strategy and the company's strength in technology potentially leading to trade-offs and resulting in a product that is not optimally designed. Olewnik & Lewis (2008) highlighted HOQ's flaws because of the potential designers' interpretation of HOQ results that is viewed as a critical limitation on the results of method which can lead to invalid and poor decisions.

Again for a successful QFD, market surveys become critical in gathering insights into and perceptions of customers. And, much depends on the effectiveness of the survey process. If queries and questionnaires do not collect the right information, the wants, needs or the wow factors, the customer contentment will be missed. Intangible statistical results, not being the real representations, can eventually harm the product design. Further, the consequences of inaccurate survey results have to be taken care of, if the organization carries QFD practices.

Yet another shortcoming with QFD is the hypothesis that the customer needs can be captured, documented, and shall be remaining stable over the duration of the whole process. As customer needs may vary suddenly without notice; adapting to a dynamic market needs can only get complex, confusing, and inflated. Hence, a QFD can only complicate matters further.

Carnevalli & Miguel (2008) have reviewed 157 published articles on QFD produced between 2002 and 2006. Articles were classified and coded resulting in the identification of several tangible benefits and difficulties. While under the category of methodological difficulties making matrices, matrix size and difficulty generated by the product to be developed are more prominent; the six external difficulties in not meeting prerequisites included lack of support of upper management, company structure, lack of focus on project, lack of knowledge about the product, difficulty in identifying clients need, and lack of QFD team engagement. Research is needed on how to reduce the difficulties of using QFD.

Generally, refining the QFD and the HOQ is an ongoing effort. Several methodologies to improve the HOQ end results have been proposed, such as applying fuzzy-logic, neural networks, and Taguchi method (Bouchereau & Rowlands, 2000); checking the internal consistency (Shin et al., 2002); and employing fuzzy-logic upon the imprecise nature of relationships (Ramasamy & Selladurai, 2004).

## FOOD WASTAGE

The Global Food Safety Initiative (GFSI) was originally set-up as a result of food safety scares in early 2000 with purpose to continuously improve food safety management systems and ensure

confidence in the provision of safe food to consumers worldwide (Umali-Deininger & Sur, 2006; Neff et al., 2015). The GFSI-recognized quality certification schemes (currently including the British Retail Consortium (BRC), International Features Standard Food (IFS Food), Foundation for Food Safety Certifications (FSSC 22000), Canada Good Agricultural Practices (Canada GAP), Global Good Agricultural Practices ( Global GAP), Global Red Meat Standard, Global Aquaculture Alliance Seafood Processing Standard, Primus Global Food Safety (Primus GFS), and Safe Quality Food) are all representatives of the six Sigma quality approach (World Bank, 2005).

Food wastage, the world over is growing and calls for serious attention. According to the Sustainable Development Goal 12 at Food and Agriculture Organization (FAO) at the United Nations (2017), 1.3 billion tons of food is being wasted every year while almost 800 million people go hungry. The alarming rate at which food is being wasted is not only harming the economy but the ecosystem as a whole. Increasing food wastage is creating about 3.3 billion tons of ozone harming gasses, subsequently extremely upsetting the nature.

Developing countries including India are paying increased attention to food safety, because of growing recognition of its potential impact on public health, food security, and trade competitiveness. Increasing incomes, a growing middle class, increased urbanization and literacy, and a population highly tuned to international trends fueled by the information technology boom are creating a large consumer base giving increasing value to food quality and safety. Improving food safety systems, to meet domestic and export requirements, however, face a number of policy, regulatory, infrastructural, and institutional obstacles.

According to Mandapaka & Kukkamalla (2015) food wastage can be reduced through innovations and researches. The aim should be on producing food in appropriate quantity and whenever necessary. Also, producing excess food habitually generates waste that contaminates the environment. Baran & Yıldız (2015) QFD structure for improving the design of products and services at a fast food restaurant has accordingly substantiated the customers' introduction and implementation of the reliable system in food and beverage management that has a positive effect on the image for the company. In other studies, Costa et al. (2001), and Joshi et al. (2013), have utilized QFD for the identification, prioritization, and determination of the requirements of the consumers which would help in the elimination of the occurrence of wastage. The approach used for developing the model had identified the significance of recognizing signs of waste or what's in the waste HOQ. There are high priority areas where the waste is taken as inputs in the causes of HOQ. Lee & Lee (2012) have used QFD to find the quality factors that are used for the development of the food waste disposer which reflects the needs of the consumer. The HOQ built shows the correlation between consumer characteristic and engineering characteristic (written by investigating the consumer needs based on the consumer complaints through a survey).

Lipinski et al. (2013), discussed food wastage having detrimental effects on the economic and environmental aspects. While economically they represent, wasted invested leading to decreased farmers' income and increased consumer expenses; environmentally, it leads to the emission of greenhouse gases and inefficient use of water and land. They also suggested that such big inefficiencies suggest big saving opportunities and the possible approaches which can be followed to counter food wastage.



Parfitt et al. (2010), in their paper have reviewed global food wastage in relation to prospects of feeding a population of 9 billion by 2050. There exists a significant gap in understanding food wastage implications of the swift development of Brazil, Russia, India, China and South Africa (BRICS) nations. Results indicated that losses were much higher in the post-harvest stage in developing countries and that too of perishable foods.

Looking at the rate at which food wastage is increasing in a country like India, it is the need of the hour to formulate strategies in order to counter it (Bhandari, 2017). Utilizing the QFD methodology, keeping in view the identified benefits and pitfalls of QFD, a structured survey has been conducted to develop the HOQ to understand the factors on which the quality could be enhanced and how important are the factors to mitigate the food wastage.

## RESEARCH METHODOLOGY

A study was conducted to explore the factors which could be countered to mitigate the wastage of food at a university Mess Facility run at a privately held university cafeteria. The study is undertaken to explain how quality management can reduce food wastage in the mess by developing a QFD. The "what" and "how" parts for the HOQ were determined by a survey.

The data for this study were collected over a range of 100 students at the residential university campus of diverse demographic origin. A questionnaire of 18 questions was floated and the respondents were asked to choose a weighting for each question. Each question depicted a factor that would be relevant for mitigation of food wastage. Questionnaire or the survey ranges from personal details to individual tastes and preferences, type of menu, as well as hygiene and ambiance of the mess. To avoid complexity, respondents were not asked about back-end processes like procurement and supply chain operations.

The results of the questionnaire were used in analyzing and identifying the common themes which were used for building the HOQ. The questionnaire was structured in a way which would bring out the major factors which would help in mitigating the food wastage at the facility.

Some of the respondents were on-going or former mess committee members and that provided a new angle from both theoretical perspectives as well as measurement of certain parameters of quality management principles which are essential for optimizing the food wastage in the campus. Mainly, the questionnaire was designed keeping in mind the elements such as the number of

**Table 1: Factors Identified for "What" of HOQ and "How" of HOQ**

| *Factors for "What" of HOQ* | *Factors for "How" of HOQ* |
|---|---|
| • Taste of Food | • Estimate the No. of Students (Quantity) |
| • Freshness of Food | • Expert Chefs for Special Food Items |
| • Temperature of Food | • Quality of Raw Material |
| • Food Variety Supplied by the Mess | • Condition of Machines/Equipment |
| • Offers by the Nearby Food Corners | • Optimize the Number of Items |
| • Availability of Nutritional Food | • Availability of Food at the Counter |
| • Combination of Food Menu | |
| • Waiting Time at the Mess | |

students residing in the university, average number of students taking meals during workings days and weekends, menu varieties, mess atmosphere, food safety, quality standards, etc. The questionnaire consisted of 18 questions (Annexure-A) which included personal questions as well as questions subject to different factors that need focus to mitigate the food wastage. Carefully chosen factors identified for "what" of HOQ and "how" of HOQ are listed in Table 1.

## PRESENTATION AND ANALYSIS OF DATA

Out of 18 questions, depending on the weightage marked by the respondents eight factors were used to develop the "what" and six factors were used to develop the "how" of HOQ Table 1. Of the total respondents' majority were male. It was found that the maximum weightage was given to taste of food, the freshness of food, and temperature of food.

1. According to the survey, 92% of the students say that plate waste contributes to maximum waste (Figure 1).

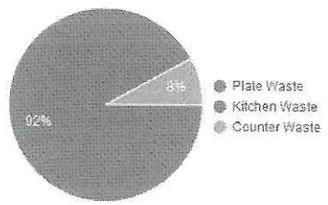



**Figure 1: Plate Waste vs Maximum Waste**

2. Lack of taste is a most important factor among the students for the creation of plate waste (Figure 2).

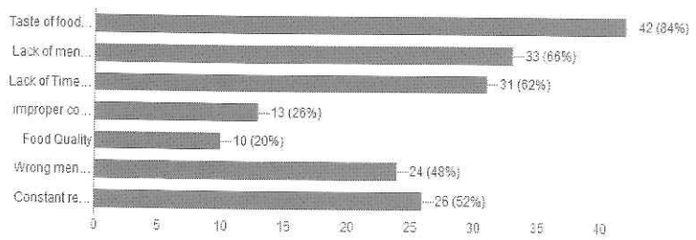



**Figure 2: Factors for Creation of Plate Waste**

3. Food appearance counter hygiene is a most important factor among the students for the creation of counter waste (Figure 3).

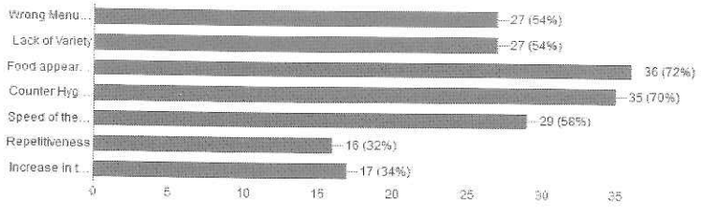



**Figure 3: Factors for Creation of Counter Waste**



4. The mess facility provided the excel data on food wastage for the second quarter of 2017. On the base of the data, a dashboard and filtering were created and it was observed that maximum food wastage occurs on Wednesday. Figure 4 depicts the same.

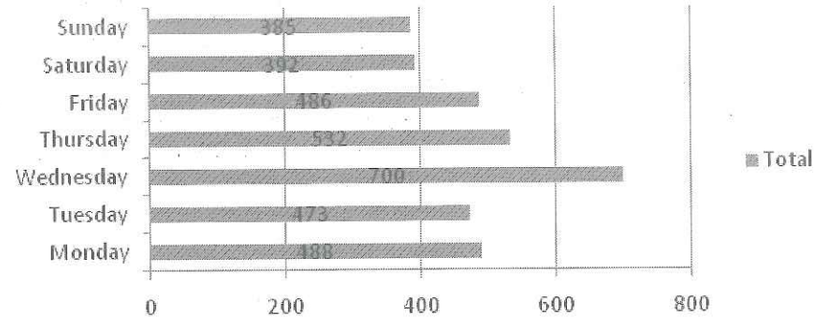



**Figure 4: Factors for Creation of Plate Waste**
(Classification of Food Wastage on the Basis of Different Days in a Week)

5. The second graph created using the data given by the mess facility clearly states that the food wastage quantity frequently ranges from the 105-125 kilograms followed by 126-150 kilograms.

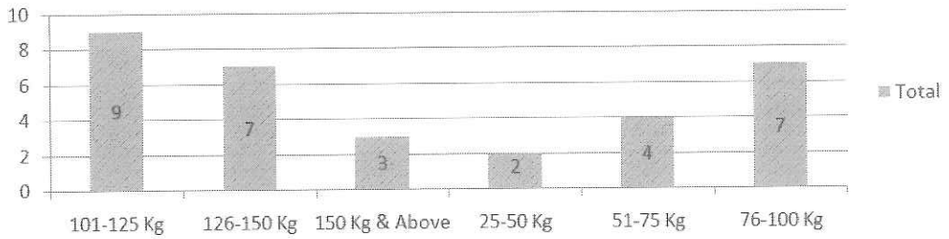



**Figure 5: Category Based Classification of Food Waste**

## IMPLICATIONS AND RECOMMENDATIONS

As inferred from the HOQ, factors such as taste, freshness, and temperature of food matters the most to the respondents. In addition, after developing the HOQ, we find few factors such as "Expert chefs for special food items," "Condition of machines/equipment," and "Optimize the number of items" which could be focused on to improve quality in order to mitigate the food wastage.

Next, as seen in the HOQ, taste, freshness, and temperature of the food were the prime factors that were considered by the respondents. If these factors would be taken care of then the students would be lured to have mess food only, where by countering food wastage. Few important factors like meal estimation, the presence of expert chefs for special dishes, the condition of machines, quality of raw materials, etc. from the mess facility if considered, then there would be a smooth flow of kitchen processes, less wastage of food by optimizing waiting time.

Food wastage is high when there is any fest or other big events in the campus. This is mainly due to the operation of various food trucks and stalls. As a result, the mess facility staff faces

difficulty in demand forecasting on these days due to constant fluctuations in a number of students having food served in mess. This leads to increase in counter waste.

Lack of hygiene in the mess caused by entry of dogs and others rodents is also another factor why students are skipping meals served in the mess. Cleanliness of the plate is an additional critical factor that hinders students from having food from the mess.

Plate waste also increases due to hectic schedules as students rush by having only half of the meal taken by them on the plate. On certain days foods wastages are high due to wrong menu combinations and less preferable menu variety.

Constantly fluctuating cooking standardization and repetition of the menu is another factor behind food wastage. Counter waste also increases due to high waiting time.

Lack of proper and healthy nutrients is also another factor why students skip a meal in the mess. Poor quality of materials used in food also increases the waste as it creates a negative impact on overall taste and appearance. Increase in a number of counters due to special conferences and guest lecturers also leads to food wastage as it is difficult to forecast the demand on the basis of consumption patterns of delegates, visitors, and students involved in organizing these events. Through Dashboard analysis it was found that maximum food wastage occurs on Wednesday on the basis of given samples of 30 days when food wastage quantity ranges frequently from 101-125 kilograms according to analysis.

## RECOMMENDATIONS IN LINE WITH THE IDENTIFIED PITFALLS ANALYZED OF THE LITERATURE ON QUALITY FUNCTION DEPLOYMENT

1. Implement strict and standard quality framework for procurement of daily raw materials and food ingredients. Also, issue the strict quality framework to the suppliers.
2. Closely keep a watch on eating pattern and menu combination and variety on Wednesdays to identify the reason behind mass wastage of food.
3. Investment in latest and sophisticated plate cleaning technologies.
4. Ensure counters are constantly cleaned. Restrict the entry of animals (dogs or cats) and other rodents through the implementation of strict restrict on hygiene and cleanliness. Also, implement penalty policies in case a student is found to litter the mess or encouraging the entry of animals.
5. Ensure chefs are properly trained to ensure standardization in the cooking of similar cuisines to avoid fluctuation in taste and overall food quality (Stanka et al., 1999).
6. Take regular student surveys to ensure most appropriate menu combination and variety. It will also help mess facility to avoid repetition of certain cuisines constantly.
7. Special counters with appropriate size on the basis of scale of the conferences and guest lecturers should be procured to optimize the wastage. Special counter sizes on the basis of scale are required as mess facility is forced to use fully filled large counters during the events with small footfall which leads to the creation of food wastage.

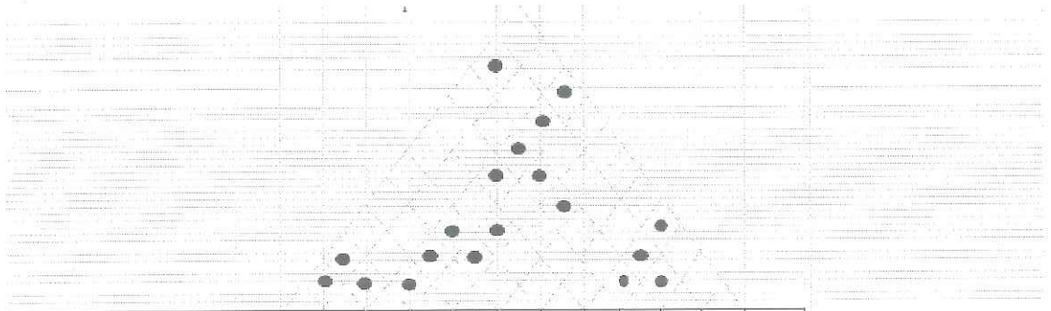


8. Implement McKinsey's 7S Framework (Singh, 2013). Authors have created the specific framework for the mess staff employed by mess facility (Annexure B) to redesign the process in order to create an adaptive environment for top management staffs, chefs, and front-end staffs. This will also create an overall accountability (Flynn et al., 1995).

## CONCLUSIONS

The HOQ created proves that taste of the food and cleanliness at the mess facility is the major factor behind food wastage (Figure 6). Other leading factors behind food wastage include speed of the service, menu combination; cleanliness of the plate, etc. Food stalls and trucks operating on campus due to frequent events have made it difficult for mess facility to accurately forecast the footfall in the mess leading to increase in counter waste. Thus, this study on food wastage at a mess facility of a residential university emphasizes that with proper and agile planning, adopting strict hygienic policies food wastage quantity can be reduced to large extent. For this frequent surveys among all stakeholders need to be conducted.

This will also enable mess facility to enhance demand forecasting on daily basis for each meal. Mess facility team should also experiment various combination of demand forecasting techniques such as Delphi, naïve forecasting, moving average, executive opinion, etc. to come up with a most optimum solution. Mess facility should adopt lean and six sigma practices to increase its overall



| USER NEEDS/USER ATTRIBUTES/REQUIREMENTS/ WHATS | RELATIVE IMPORTANCE WEIGHT | | | | | | | | | | TOTAL IMPORTANCE WEIGHT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cleanliness of the Plate | 0.05 | | | | ★ | | | ★ | | | 308.06 | |
| Menu variety | 0.07 | | ◯ | | ★ | ◯ | | | ● | | 307.07 | |
| Proper Cooked | 0.08 | ★ | | ★ | | | | | | ★ | 293.08 | |
| Appearance of the food item | 0.07 | ◯ | + | ● | | | | | | ★ | 283.07 | |
| Speed of Service | 0.07 | ★ | | ★ | | ◯ | | | + | | 372.07 | RANK 3 |
| Taste | 0.08 | ★ | ★ | ★ | | ● | | | | ◯ | 420.08 | RANK 1 |
| Menu Combination | 0.06 | ◯ | | ★ | ★ | | ★ | | ★ | | 321.06 | |
| Cleanliness of the Mess | 0.08 | | | ● | ★ | | | | | ★ | 400.08 | RANK 2 |
| Storage Hygiene | 0.08 | | ● | | ★ | | | | ◯ | | 230.08 | |
| Food Temperature | 0.07 | ● | | | ★ | ★ | | | ★ | | 295.07 | |
| Meeting Food Quality & nutritional Standards | 0.08 | ★ | ★ | ★ | ★ | ★ | | | ★ | | 278.08 | |
| Repetition of food items in the same week | 0.09 | | | ★ | | | | | ★ | | 259.09 | |
| Kitchen Hygiene | 0.08 | | | | ★ | | | | | ● | 320.08 | |
| Counter Hygiene | 0.08 | | | | ★ | | | | | ★ | 275.08 | |
| Relative Weight TOTAL | 1 | | | | | | | | | | | |
| IMPORTANCE WEIGHT TOTAL | | 33 | 33 | 84 | 83 | 44 | 14 | 9 | 83 | 72 | 16 | 26 |

| | | |
|---|---|---|
| ★ | Extremely Correlated | 9 |
| ● | Very Correlated | 7 |
| ◯ | Moderately Correlated | 5 |
| + | Weakly Correlated | 3 |
| ▽ | Very weakly Correlated | 1 |

**Figure 6: QFD for the Food Wastage at a Mess Facility (Author's view)**

efficiency and effectiveness to improve its speed of services. Awareness drive has to be done among the students and staff to reduce the food wastage through telecasting various videos related to food wastage in the mess and how it can create a negative impact in a country like India where the large population still has no access to the food. Therefore, optimization of wastage is essential for feeding others who have no access to food and from the company's perspective it can reduce the daily cost of operation increasing the profitability.

The conclusions provide motivation for improving upon the conceptual soundness of the QFD tool for supporting design. In the authors' view, the QFD method has the potential to overcome most of the limitations and go beyond conceptual mapping. A "design-of-experiment" approach to identify the relationship values at all levels utilizing "conjoint analysis" (Dolan, 1990) is still work-in-progress.

## REFERENCES


Baran, Z., & Yıldız, M. S. (2015). Quality function deployment and application on a fast food restaurant. *International Journal of Quality & Reliability Management*, *6*(9), 122-128.

Bergquist K, & Abeysekera J. (1996). Quality function deployment (QFD): A means for developing usable products. *International Journal of Industrial Ergonomics*, *18*(4): 269-275.

Bhandari, G. (2017). Assessment of food wastage in hostel messes: A case of NDRI, Karnal. *Indian Journal of Economics and Development*, *13*(1), 59-64.

Bouchereau, V., & Rowlands, H. (2000). Methods and techniques to help quality function deployment (QFD), *Benchmarking: An International Journal*, *7*(1): 8-20.

Carnevalli J. A., & Miguel, P. C. (2008). Review, analysis and classification of the literature on QFD: Types of research, difficulties and benefits, *International Journal of Production Economics, 114*(2): 737-754.

Costa, AIA, Dekker M., & Jongen W. M. F. (2001). Quality function *deployment* in the food industry: A review, *Trends in Food Science & Technology*, *11*: 306-314.

Dolan, R. (1990). Conjoint analysis: A manager's guide, *Harvard Business School Cases*, Harvard Business School, Boston, MA.

Flynn, B. B., Schroeder, R. G., & Sakakibara, S. (1995). The impact of quality management practices on performance and competitive advantage, *Decision Sciences*, *26*(5), 659-691.

Food and Agriculture Organization (FAO), United Nations (2017). Sustainable development goal 12: Ensure sustainable consumption and production patterns, retrieved (August 29, 2017) from http://www.fao.org/sustainable-development-goals/goals/goal-12/en/

Fung R. Y. K., Tang J., Yiliu Tu P, & Chen Y. (2003). Modelling of quality function deployment planning with resource allocation. *Research Engineering Design*, *14*: 247-255.

Hauser, J. R. (1993). How Puritan-Bennett used the house of quality. *Sloan Management Review*, *34*(3), 61-70.

Hauser, J. R., & D. P. Clausing (1988). The house of quality. *Harvard Business Review*, *66*(3), 63-73.

Joshi, C. K., Rao, S., & Choudhary, V. (2013). Analysis and minimization of industrial wastages by applying quality function deployment (QFD), *International Journal of Emerging Trends in Engineering and Development*, *4*(3): 376-385.

Kaldate, A., Thurston, D., Emamipour, H., & Rood, M. (2003). Decision *matrix* reduction in preliminary design, *ASME Design Engineering Technical Conferences*, Chicago, IL.





Kukkamalla, P. K., & Mandapaka, R. T. (2015). Food safety evaluation and food waste management–An Indian perspective, *Research & Reviews: Journal of Food and Dairy Technology*, *3*(2), 25-29.

Lee, J. K., & Lee, T. Y. (2012). Analysis of product quality characteristics using QFD for food waste disposer development from customer perspective, *Journal of the Korea Safety Management and Science*, *14*(1): 201-208.

Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., & Searchinger, T. (2013). *Reducing food loss and waste*, World Resources Institute, Washington, DC, 40.

Neff, R. A., Spiker, M. L., & Truant, P. L. (2015). Wasted food: U.S. consumers' reported awareness, attitudes, and behaviors. *PLoS ONE*, *10*(6).

Olewnik, A., Hammill, M., & Lewis, K. (2004). Education and implementation of an approach for new product design: An industry-university collaboration, *ASME Design Engineering Technical Conferences*, Salt Lake City, UT.

Olewnik, A., & Lewis, K. (2008). Limitations of the house of quality to provide quantitative design information, *International Journal of Quality & Reliability Management*, *25*(2), 125-146.

Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains: Quantification and potential for change to 2050. *Philosophical Transactions of The Royal Society*, 3065-3081.

Ramasamy, N. R., & Selladurai, V. (2004). Fuzzy logic approach to prioritize engineering characteristics in quality function deployment (FL-QFD), *International Journal of Quality & Reliability Management*, *21*(9): 1012-1023.

Shin, J. S., Kim, K. J., & Chandra, M. J. (2002). Consistency check of a house of quality chart, *International Journal of Quality & Reliability Management*, *19*(4): 471-484.

Singh, A. (2013). A study of role of McKinsey's 7S framework in achieving organizational excellence, *Organization Development Journal*, *31*(3): 39-50.

Stanka, T. P., Goldsby, T. J., & Vickery, S. K. (1999). Effect of service supplier performance on satisfaction and loyalty of store managers in the fast food industry, *Journal of Operations Management*, *17*(4): 429-447.

Umali-Deininger, D., and Sur, M., (2006). *Food Safety in a Globalizing World: Opportunities and Challenges for India*, In World Development Report 2008: Agriculture for Development, *25*(2-3): 321–335, Publisher: World Bank, Washington, D.C.

World Bank (2005). Food Safety and Agricultural Health Standards: Challenges and opportunities for developing country exports, Report No. 31207, *Poverty Reduction and Economic Management Sector Unit*, Washington, D.C.

# ANNEXURES

## ANNEXURE A

**Survey Format**

Following were the research questions:

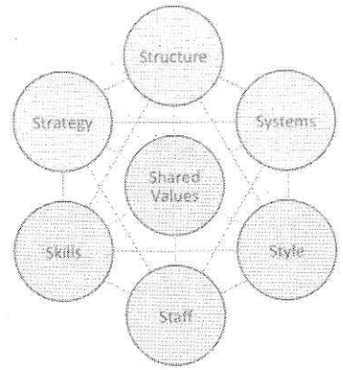
1. Where do you think mess facility's food wastage come from?
   (a) Counter Waste
   (b) Plate Waste
2. What is the main reason for the plate waste?
   (a) Counter Waste
   (b) Plate Waste
3. What do you think are the reasons are the counter waste?
   (a) Lack of Variety
   (b) Counter Variety
   (c) Speed of Service
   (d) Increase in a number of counters due to multiple events at the university.
4. What do you think are the reasons for the plate waste?
   (a) Taste of Food Item
   (b) Food Quality
   (c) Wrong Menu Combination
   (d) Lack of Time Due to Class Schedule
   (e) Constant Repetition
   (f) Lack of Menu Variety
5. How much does taste matter to you?
6. How much does variety in menu options signify to you?
7. Do you think that the food is properly cooked?
8. How does the appearance of the food attract you?
9. Rate the food quality standards of mess facility.
10. Rate the kitchen hygiene on campus run by mess facility.
11. Rate the counter hygiene on campus run by mess facility.
12. Rate the storage hygiene on campus run by mess facility.
13. How much does the cleanliness of the mess matter to you?
14. Does the temperature of warm/cold food important for you?
15. Rate speed of service.
16. How often do you prefer to have the similar set of menus in the same week?
17. How clean are the plates given by mess facility to students?
18. Is the combination of food items served important? Rate.

*Note:* Rate scale in the survey ranges from 1-9 with1 as most satisfied and 9 as most dissatisfied.



## ANNEXURE B

**McKinsey's 7S Framework for the Mess Staff (Author's view)**




**Strategy**

- Overall cost efficiency
- Quality focused food with healthy nutrients.
- Reduce food wastage.
- Strong resource and development (R&D) department.

**Structure**

- Designing and following a proper hierarchical order to enhance transparency and flow of information.

**Systems**

- Establishing a strict code of conduct for employees as well as top-level management to create agility in overall operations by avoiding casual work approach.

**Shared Values**

- To focus on building relationship with customers, partners, suppliers, and employees.
- To establish strong corporate governance.

**Skills**

- Proper training and continuous evaluation should be carried out by the management to ensure effectiveness and efficiency of the employees.

**Style**

- Establishment of ethical cooperative culture in the organization and between suppliers, buyers, and employers.

**Staff**

- Establishing knowledgeable human capital to enhance adaptability in rapidly changing environment."