TECHNIQUES FOR ANALYZING CUSTOMER FEEDBACK

A Thesis by

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The following faculty members have examined the final copy of this thesis for form and content, and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Science, with a major in Industrial Engineering.

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DEDICATION

To my grandparents, Mr. Syed Abdul Basit and Mrs. Late Akbarunissa Basit,
and to my parents, Mr. Ali Hussain and Syeda Rabia Hussain,
who have invaluably supported and encouraged me in every step of my life.
Their blessings and prayers are the reason for my hard work and success.

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ABSTRACT

Surveys are an effective way of collecting customer feedback. Open-ended survey questions capture important dimensions of the respondent's experience. The purpose of this study was to compare the critical incident technique (CIT) and the concept mapping approach (CMA) with respect to their ability to identify major customer requirements and the time required to complete each analysis. A case study was performed to identify students' requirements of in class presentation. Answers to the open ended questions were analyzed using the two techniques. Results of this case study indicated that the CIT appears to be more appropriate for scenarios where continual participation from members of the survey population is not feasible. Otherwise, the CMA would be chosen for analyzing written comments.

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LIST OF ABBREVATIONS

CIT	Critical Incident Technique
CMA	Concept Mapping Approach
CVR	Content Validity Ratio
MDS	Multi-Dimensional Scaling
SDT	Semantic Differential Technique
SQ	Service Quality
VOC	Voice of the Customer

CHAPTER 1

INTRODUCTION

Achieving quality requires a clear definition of customer requirements. Service quality (SQ) is widely regarded as a driver of corporate marketing and financial performance (Buttle, 1996). SQ is defined as the ~~"~~extent of discrepancy between customers' expectations or desires and their perceptions" (Zeithaml, Parasuraman, & Berry, 1990). Customers perceive quality positively if service providers meet or exceed their expectations.

It is essential to maintain quality in service provided as it has direct relations with customer retention and satisfaction. Understanding the voice of the customer (VOC) requires collecting customer's views on quality that include customer needs, expectations, perception, and satisfaction. Capturing the VOC helps in understanding the wants and needs of the customer and assists in improving the service provided. Juran and Godfrey (1999) summarized a number of techniques to capture the voice of the customer. These include making telephone calls to customers, visits to individual customers, special arrangements with individual customers, focus groups, and surveys.

Surveys collect information from individuals in a systematic way. Surveys can be conducted using questionnaires or by interviewing individual customers. Typically, a questionnaire survey consists of closed-ended and open-ended questions. Closed-ended questions have predetermined answers, and respondents rate their responses on a satisfaction scale provided. In open-ended questions, respondents are provided with questions and space to express their experiences in their own words. Closed-ended questions are directed to the point, focused, and quicker to code and analyze. Meanwhile, they limit the respondent from adding remarks and explanations (Cohen, Manion, & Morrison, 2007). Open-ended questions overcome this

limitation, and help capture specific perceptions of the customers and discover various requirements from their experience (Sproull, 1988). However, in some cases they can lead to irrelevant and redundant information requiring more time from respondents to enter a response (Cohen *et al*., 2007).

Different techniques can be used to analyze closed-ended questionnaires including univariate tests, T-tests, and multicriteria satisfaction analysis (Grigoroudis & Siskos, 2002). The qualitative data received from open-ended questions is not easy to analyze, as it is difficult to measure the meaning of such responses. Some techniques useful in analyzing open-ended responses are the critical incident technique (CIT) (Flanagan, 1954), semantic differential technique (SDT) (Snider & Osgood, 1969), and concept mapping approach (CMA) (Jackson & Trochim, 2002).

The objective of this study was to compare two of the major techniques—namely critical incident and concept mapping—used in analyzing customers' responses to open-ended questions. The following section offers a review of the literature pertaining to surveys, critical incident, and concept mapping. Section 3 represents the research objectives and methodology. Section 4 represents a case study where the two techniques were utilized to identify students' requirements of in-class presentations, followed by the summary and conclusions in Section 5.

CHAPTER 2

LITERATURE REVIEW

Quality is addressed in various manufacturing, health, education, service, and non-profit organizations. The definition of quality has never been consistent, as it differs in the context to where it is applied. Reeves and Bednar (1994) discussed various definitions of quality including value (Abbott, 1955), conformance to specifications (Gilmore, 1974), conformance to requirements (Crosby, 1979), fitness for use (Juran & Bingham, 1974; Juran & Gryna, 1988), loss avoidance (Taguchi, cited in Ross, 1989), and meeting or exceeding customers' expectations (Parasuraman, Zeithaml, & Berry, 1985). Gryna, Chua, and DeFeo (2007) proposed two dimensions of quality that derive customer satisfaction and loyalty, as shown in Table 1.

TABLE 1

DIMENSIONS OF QUALITY IN MANUFACTURING AND SERVICE INDUSTRY
(SOURCE: GRYNA *ET AL.,* 2007)

Manufacturing Industry	Service Industry
Features	
Performance	Accuracy
Reliability	Timeliness
Durability	Completeness
Ease of use	Friendliness and courtesy
Serviceability	Anticipating customer needs
Esthetics	Knowledge of server
Availability of options and expandability	Appearance of facilities and personnel
Reputation	Reputation
Freedom from Deficiencies	
Product free of defects and errors at delivery, during use, and during servicing	Service free of errors during original and future service transactions
All processes free of rework loops, redundancy, and other wastes	All processes free of rework loops, redundancy, and other waste

These two dimensions are features and freedom from deficiencies, which are termed differently in manufacturing and service sectors. Features refer to the quality of design. These have a direct

effect on sales income, as increasing the quality of the design will result in higher costs. Freedom from deficiencies refers to quality of conformance. This has a major effect on costs by reducing complaints, scrap, and rework. By increasing the quality of conformance, customer complaints and dissatisfactions are reduced, thus resulting in lower costs.

Quality in service provided is directly linked to customer satisfaction and retention. Juran and Godfrey (1999) discussed a few techniques to measure customer satisfaction:

1. Telephone calls to customers - Calls are made to customers, and their experiences with the service provided are recorded to obtain a general impression of quality, which can lead to a specific action.
2. Visits to individual customers - Periodic visits by a representative of the company are made to major customers to learn about customer experiences and to answer their specific questions.
3. Special arrangements with individual customers - Special arrangements with a few customers are established to obtain in-depth information of the customer experience with the product or service.
4. Focus groups - In order to understand the needs of the customer, companies sponsor meetings of small groups of customers to discuss product requirements. These groups consist of eight to ten customers who meet for a few hours to engage in this type of discussion.
5. Surveys - Questionnaires are developed to assess various attributes of the product/service. Customers are asked to enter their responses on the satisfaction scale provided or by adding their written comments and remarks.

2.1 Survey Process

Surveys use structured questioning to map out perceptions, using samples from the population frame, into data that can be statistically analyzed (Kenett, 2006). To conduct a survey, it is important to follow specific procedures systematically. Biemer and Lyberg (2003) explained the survey research process, a flow chart of which is shown in Figure 1.

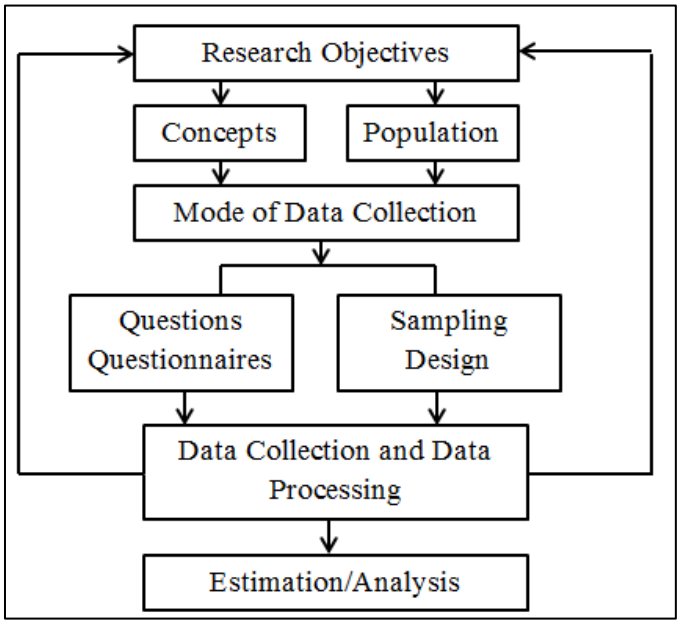


Figure 1. Survey process (Source: Biemer and Lyberg, 2003)

The survey process starts by determining the research objectives and defining a few research questions that the survey is aimed to answer. The selected target population is a "group of people for whom the study results are applied and about which inferences can be made from the survey results" (Biemer and Lyberg, 2003). Next, the mode of administration of surveys is determined. Surveys can be administered using "questionnaires that are paper or email based, conducting face-to-face or phone interviews, Internet, or SMS-based surveys and video conferencing" (Kaplan, Kennett & Raanan, 2003). The questionnaires are designed based on the research objectives and the mode of administration selected. Finally, the data collection and

processing plans are developed by identifying the process of conducting a survey, and collecting and coding the data. According to the plans developed, data is collected and analyzed using the techniques that are applicable to the research objectives defined.

2.2 Quality of Results

Quality of research relates to correspondence between the social scientist's findings and the phenomena as experienced by the people in the field. It also pertains to the controllability of the research process that leads to the findings. ―Quality is linked with reliability and validity both in quantitative and in qualitative research" (Kirk & Miller 1986).

2.2.1 Validity

Validating a survey refers to measuring how well the survey assesses what it was set out to assess. It is essential to document validity while evaluating new survey instruments or while applying established surveys to new populations. Few of the widely used methods are face validity, content validity, criterion validity, and construct validity. Content validity is ―the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose" (Haynes, Richard, & Kubany, 1995).

Lawshe (1975) proposed a method to measure the content validity utilizing a *content evaluation panel* consisting of people knowledgeable about the area of research. Here a content validity questionnaire is given to raters having the constructs and items to be rated on a three-point scale. The scale has ratings of 3 = Essential, 2 = Useful but not essential, 1 = Not necessary. A content validity ratio (CVR) is calculated using equation (2.1):

$$\text{CVR} \approx \frac{n_{e-\frac{N}{2}}}{\frac{N}{2}} \tag{2.1}$$

Where n_e is the number of panelists indicating ―essential," and N is the total number of panelists.

To validate a test, a CVR value is computed for each question, and the questions are either retained or eliminated based on the values, as shown in Table 2.

TABLE 2

MINIMUM VALUES OF CVR AND CVR_T, ONE-TAILED TEST, P = .05
(SOURCE: LAWSHE, 1975)

Minimum Values of CVR and CVR*t* One-Tailed Test, *P = 0.05*	
Number of Panelists	**Minimum Value ***
5	0.99
6	0.99
7	0.99
8	0.75
9	0.78
10	0.62
11	0.59
12	0.56
13	0.54
14	0.51
15	0.49
20	0.42
25	0.37
30	0.33
35	0.31

For example, from Table 2 it can be seen that if a content evaluation panel consists of 5 panelists, a minimum CVR of 0.99 is required. Dwivedi, Choudrie, and Brinkman (2006) conducted a content validity test to validate the content of a broadband adoption survey instrument. A total of 95 items for 15 constructs was identified from the literature. A content validity questionnaire was generated and given to 12 academic experts. Responses from the experts were collected, and CVR values were determined at a statistical significance of 0.05. The average CVR value for the ten constructs retained fell between 0.83 and 0.56. This showed that

the constructs had a high level of content validity and that the items were representative of the construct universe.

2.2.2 Reliability

In any set of data collected, error is a possibility. The error should be minimized so that the data presents a more accurate reflection of truth. Conceptually, reliability is defined as ~~"~~the degree to which measures are free from error and therefore yield consistent results" (Peter, 1979, p. 6).

The common approaches for estimating the reliability are test retest, equivalent forms, and internal consistency. The most widely used method to measure internal consistency is the alpha coefficient referred to as Cronbach's alpha (1951). It measures how well the individual items complement each other in their measurements of different aspects of the same variable or quality (Litwin, 1995). The alpha coefficient is calculated using

$$\propto = \frac{k}{k-1}\left(1 - \frac{\sum s_i^2}{s_T^2}\right) \tag{2.2}$$

Where k is the number of items, s_i^2 is the variance of the i th item, and s_T^2 is the variance of the total score formed by summing all items (Bland & Altman, 1997)

Reliability levels vary depending on the purpose of the research. Peterson (1994) documented the recommended magnitudes of reliability coefficients obtained in the empirical studies, which are presented in Table 3. The alpha values recommended by Nunnaly (1978) are widely used for market research, also as shown in Table 3. A reliability level of 0.7 is acceptable for preliminary research and 0.8 for basic research. A higher level of reliability ranging from 0.9 to 0.95 is recommended for applied research.

TABLE 3

RECOMMENDED RELIABILITY LEVELS
(SOURCE: PETERSON, 1994)

SELECTED RECOMMENDED RELIABILITY LEVELS

Author	Situation	Recommended level
Davis (1964, p. 24)	Prediction for individual	Above .75
	Prediction for group of 25–50	.5
	Prediction for group over 50	Below .5
Kaplan and Saccuzzo (1982, p. 106)	Basic research	.7–.8
	Applied research	.95
Murphy and Davidshofer (1988, p. 89)	Unacceptable level	Below .6
	Low level	.7
	Moderate to high level	.8–.9
	High level	.9
Nunnally (1967, p. 226)	Preliminary research	.5–.6
	Basic research	.8
	Applied research	.9–.95
Nunnally (1978, pp. 245–246)	Preliminary research	.7
	Basic research	.8
	Applied research	.9–.95

After the validity and reliability of the survey are determined, data is collected using the survey instrument. Appropriate techniques are applied to analyze the data. In the following sections, the critical incident technique and concept mapping approach are used to analyze responses to open-ended questions.

2.3 Critical Incident Technique

The CIT is a widely used qualitative research method, which is considered an effective investigative and exploratory tool. Flanagan (1954) detailed the evolution and procedures of the CIT. It has frequently been used in industrial and psychological disciplines. It has also been applied across various disciplines including nursing (Dachelet, Wmett, Garling, Craig-Kuhn, Ken, & Kitzman, 1981), job analysis (Stitt-Gohdes, Lambrecht, & Redmann, 2000), education and teaching (Lemare & Sohbat, 2002), marketing (Keaveney, 1995), psychology (Cerna, 2000), and various other fields.

Researchers have used different terminology for the CIT while following Flanagan's method, such as the critical incident report (Kluender, 1987), critical event technique (Kunak, 1989), critical incident analysis (Gould, 1999), critical incident exercise (Rutman, 1996), critical incident study technique (Cottrell, Kilminster, Jolly, & Grant, 2002) and many more cited in the CIT literature and its related research. Flanagan (1954) stated that the critical incident technique ~~"d~~does not consist of a single rigid set of rules governing such data collection; rather it should be thought of as a flexible set of principles that must be modified and adapted to meet the specific situation at hand." He suggested the following five steps: (1) general aims, (2) plans and specifications, (3) collecting the data (4) analyzing the data, and (5) interpreting and reporting the results.

1. General aims - The general aim of the activity should answer two questions: What is the objective of the activity? and What does the person expect to accomplish by engaging in the activity? (Butterfield, Borgen, Amundson, & Maglio, 2002). The aim of the activity can be achieved by consulting experts and supervisors in the area of study, since different people involved in the activity will have different views towards its aim. They stated that ~~"t~~he most useful statement of aim seem to center on some simple phrase or catch word which is like a slogan or character." The objective then is to get a handful of experts to agree on these aims.
2. Plans and specifications - To formulate a functional description of an activity, precise instructions are given to the observers. The specifications that need to be established before collecting the data are as follows:
    a. Defining the situations to be observed.
    b. Deciding on the relevance of the situation to the general aim.

c. Identifying the extent of effect the incident has on the general aim.

d. Deciding on who will be making the observation.

By having all observers follow these specifications, consistency among observers and objectivity for the observations being made can be achieved.

3. Data Collection - Data can be collected by having expert observers gather information by observing people performing the task in the context of research. It is not feasible to have experts collect the data in all kinds of situations. Flanagan (1954) discussed other data-collection methods such as individual interviews, group interviews, questionnaires, and record forms. The views of the customers can be collected in narrative form or by using questionnaires. Customers can rate a particular aspect on a given scale and also write down the experiences in their own words. In the CIT, the number of critical incidents observed is considered the sample size, not the number of participants in the study. The important aspect here is to ensure that the entire content of the activity being researched has been described and captured.

4. Analyzing the Data - There is no defined way to describe the experience or construct. Three stages can be used to create a categorization scheme that describes and summarizes the data in a useful manner by ~~-sa~~crificing as little as possible of their comprehensiveness, specificity, and validity":

   a. Selecting the frame of reference that is useful in describing the incidents.

   b. Inductively developing a set of major area and sub-area headings.

   c. Selecting one or more levels along the specificity-generality continuum to use in reporting the requirements.

Hayes (1998) discussed the categorization process in a simplified form. He stated that a critical incident describing customer requirements should have two characteristics: it should be specific, and it should describe the service provider in behavioral terms (or) describe the service or product with specific adjectives. After the critical incidents are identified they are formed into clusters and termed *Satisfaction Items*, which reflect the content of their incidents. In similar fashion, clusters of satisfaction items are formed and are labeled as *Customer Requirements*, which reflect the specific quality dimensions. A hierarchical relationship among the critical incidents, satisfaction items, and customer requirements is shown in Figure 2.

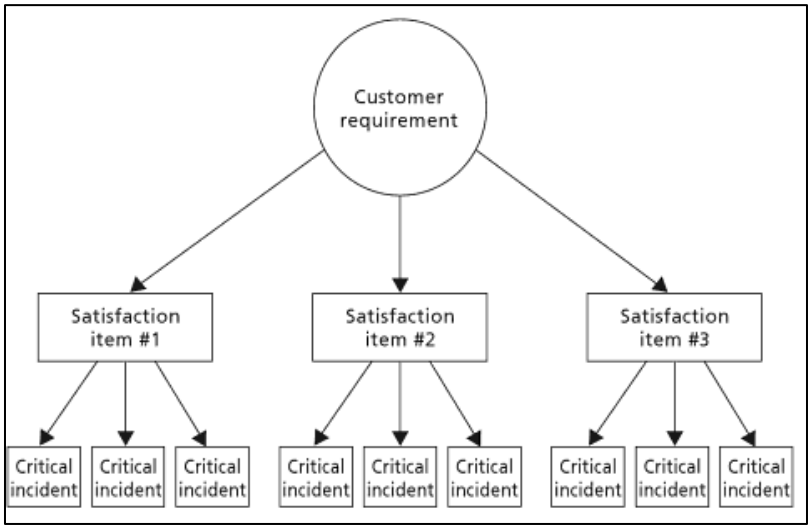


Figure 2. Hierarchical relationship between customer requirements, satisfaction items, and critical incidents (Source: Hayes, 1998)

Hayes (1998) gave an example of customer requirements obtained in a banking industry by using the CIT. Ten people who had interactions with the bank's service were interviewed, and the information was collected. A total of 146 critical incidents were identified. They were clustered to form ten satisfaction items. Furthermore, the

satisfaction items were grouped into four customer requirements. A customer requirement called –Overall Satisfaction" was identified in the case where the satisfaction items were less specific; it represented service on the whole and did not focus on a particular quality dimension. Figure 3 represents a few of the identified critical incidents, satisfaction items, and customer requirements.

Responsiveness of Service

I. I waited a short period of time before I was helped
II. The service started immediately when I arrived

Speed of Transaction

III. The teller handled transactions in a short period of time
IV. The teller took a long time to complete my transaction

Availability of Service

V. He financial consultant was available to schedule me for an appointment at a good time
VI. My appointment with the financial consultant was at a convenient time

Professionalism

VII. The teller talked to me in a pleasant way
VIII. The teller was very personable
IX. The teller carefully listened to me when I was requesting a transaction
X. The teller knew how to handle the transaction

Overall Satisfaction with Service

I. The quality of the way the teller treated m was high
II. The way the teller treated me met my expectations
III. I am satisfied with the way the teller treated me

Figure 3: Customer requirements in a banking service (Source: Hayes, 1998)

5. Interpreting and reporting - Flanagan (1954) suggested that researchers should examine the four steps discussed earlier and identify the possible biases. He advocated discussing the limitations, making explicit the nature of judgments, and emphasizing the value of the

results in the final report. He indicated that the researcher should not only point out limitations but also check the degree of credibility and the value of the final results.

2.3.1 Credibility/Trustworthiness Checks

Credibility can be evaluated in different ways. Few of the methods proposed involve forming reliability panels (Di Salvo, Nikkel, & Monroe, 1989), using face validity and triangulation (Skiba, 2000), and asking experts to examine the categories (Ellinger & Bonstrom, 2002). Hayes (1998) discussed two methods: inter-judge agreement and comprehensiveness of the customer requirements.

1. Inter-judge agreement - The ~~"in~~ter judgment agreement" is the percentage of incidents two judges place under the same category of customer requirements. The index ranges from 0 to 1. If the index value is nearing 1, then this indicates that there is a high level of agreement between the judges. An index of 0.8 is used as a cutoff in determining customer requirements. If the values are on the lower side, then the judges discuss the disagreements and come to a conclusion. A third judge can be used in the case of disagreement, in order to highlight the difference between both judges and lead to a consensus.
2. Comprehensiveness of customer requirements - It is essential to capture the voice of the customer comprehensively. If the categorization process is deficient and does not capture all requirements, then the overall process will be ineffective. Hence, it is essential to establish the quality of the content of critical incidents. This process involves separating ~~"te~~n critical incidents" before the categorization process. After the critical incident process is completed, the ten critical incidents are fit into the categories identified. If

none of them are omitted, the categories identified are considered a comprehensive list of the customer requirements being determined.

Andersson and Nilsson (1964) studied the job of grocery store managers in a Swedish grocery company. A total of 1,800 critical incidents were obtained by conducting interviews and using questionnaires. They studied several reliability and validity aspects of the CIT method, which included the reliability of data-collecting procedures, comprehensiveness, categorization control, and centrality of the critical incidents to the job. After classifying two-thirds of the critical incidents, 95% of sub-categories were found. They discovered that the method of collecting the data or conducting interviews had no effect on the results. The stability of the sub-category was determined by repeating the categorizing procedure. They concluded that the ~~in~~formation collected by this method is both reliable and valid."

Ronan and Latham (1974) studied the job performance of pulp wood producers. They examined three reliability measures: inter-judge reliability, inter-observer reliability and intra-observer reliability. They also checked the four validity measures: content validity, relevance, concurrent validity, and construct validity. Their findings supported those of Andersson and Nilsson (1964), stating that ~~th~~e reliability and content validity of the critical incident methodology are satisfactory."

2.3.2 Uses of Critical Incident Technique

The critical incident method can be used to prepare a checklist and evaluate the effectiveness of a job performed. Konigsburg (1954) carried out a case study to develop an instructor's checklist using CIT and compared techniques to record observations. They distributed the Purdue Rating Scale for Instruction and the checklist developed from the CIT in a class. The correlation coefficients evaluated between the total scores from both instruments was

0.29. They also found that the planned performances of 46 pre-determined behaviors were better reflected by the results found from the checklist developed using the CIT when compared to results from Purdue Rating Scale for Instruction.

Gordon (1950) developed a standard flight check for an airline transport rating. This was one of the first applications of critical incidents for developing proficiency measures. Data from airline accidents were merged with critical incidents that were reported by airline pilots to develop the measures of proficiency. The earlier check yielded 63% agreement, and the new check yielded 88% of agreement on making decisions to pass or fail a pilot on a flight test.

The critical incident technique has a lot of strengths. Gremler (2004) discussed the advantages and limitations of the CIT. This inductive methodology identifies new factors that could have been missed by other investigative methods. It provides rich data of original user experiences, which can be explored in detail to understand the behavior of customers (Serenko & Stach, 2009). The limitations of CIT are that the researchers might misunderstand the data and misinterpret the customer's comments. The reliability and validity of the findings might be affected by ambiguities in data coding. The respondents might have a memory lapse of the event that occurred if the information is collected after a long period of time.

2.4 Concept Mapping Approach

The CMA is used to analyze the qualitative text data. Researchers can code and represent meaning in text data based on information collected from the customers. This multi-step method utilizes original customer responses as units of analysis. Pile sorting is used to "code" the data, and individual conceptual schemes are aggregated quantitatively. The data structure is merged by using multi-dimensional scaling (MDS) and cluster analysis of the coded data. It can be utilized

to develop closed-ended questionnaires. It offers the researcher an ability to make the most out of the qualitative text data.

Jackson and Trochim (2002) discussed five steps involved in the concept mapping process: ~~(~~a) creating units of analysis, (b) sorting units of analysis into piles of similar concepts, (c) running the multi-dimensional scaling analysis of the pile-sort data, (d) running the cluster analyses on the MDS coordinates to decide on a final cluster solution, and (e) labeling the clusters". The data for analysis can be gathered by conducting surveys with open-ended questions. These five steps are discussed in detail below:

1. Creating units of analysis - Responses received from the open-ended questionnaires are used to form units of analysis. A unit of analysis consists of a sentence containing only one concept. Units can be picked directly from the responses. If the responses are in paragraphs, they can be unitized by splitting the paragraphs into sentences. This helps in retaining all the concepts, and the data would be ready for sorting. Unitizing can be done by two or more researchers, and inter-rater reliability checks can be performed. The result of unitizing process is a set of single concept statements that are printed on cards for sorting.
2. Sorting - In this step, sorters are selected to code the units into piles of similar statements (Afifi & Clark, 1996). Sorters are asked to put each card in a pile that they feel has similar statements. There is no limitation to the number of cards that can be put in a pile. However, each card can be used only in one pile. If they feel a statement does not match with any of the existing units, then it can be left out in order to avoid junk in the final cluster analysis. It is recommended that the respondents perform the sorting process so that the misinterpretation of sentences by the researchers is eliminated, and the

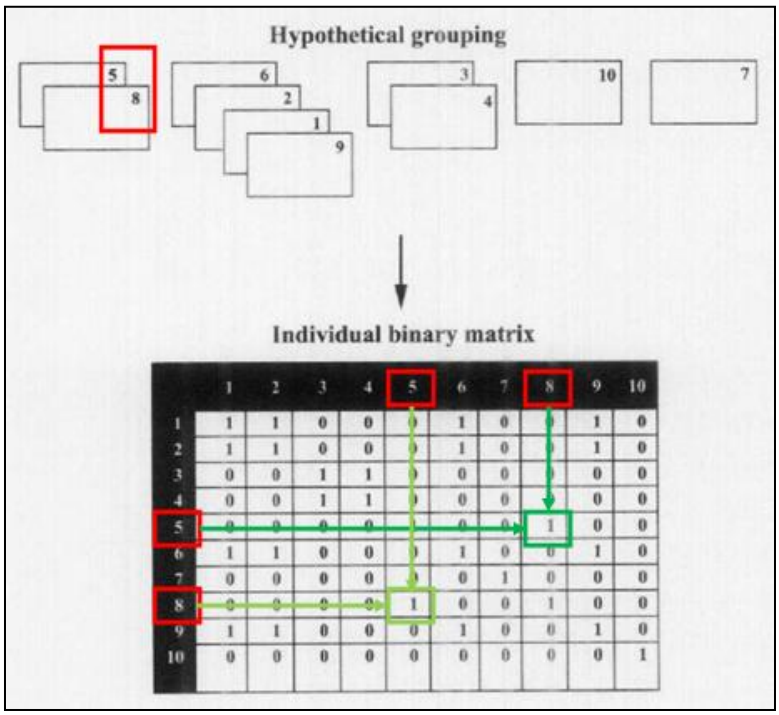
representativeness of the structure emerging out of the MDS analysis is ensured. It is not always possible to have respondents' sort the units due to availability and time. Proxy sorters can be substituted for sorting after careful selection of the sorters. The sorters can be selected using the following criteria:

a. How their backgrounds and experiences are similar/different to the respondents' and the influence on their interpretation of units.
b. Any theoretical background/understanding about the research topic that they have in common with the respondents and how it might influence the interpretation.
c. The degree to which existing theoretical frameworks can provide a basis for comparison in gauging the degree of difference between respondent content and proxy sorter groupings.

After the sorting is complete, the sorters are asked to give an appropriate name for each pile representing the content of the units.

3. Multi-dimensional scaling (MDS) - A binary square matrix is created for each sorter with the number of rows and columns equal to the number of units. Each cell is filled with —1" if the units for that row and column are placed together by the sorter; if not, then the cell is filled with ~~0~~". An example of the binary matrix of an individual sorter is shown in Figure 4, which shows that the cards numbered ~~5~~" and ~~8~~" are placed under one pile. In the square matrix, the cell with ~~r~~ow 5 and column 8" and ~~r~~ow 8 and column 5" are numbered ~~1~~". This indicates that the sorter placed cards numbered ~~5~~" and ~~8~~" under one pile. By combining the individual binary matrices, a similarity matrix is obtained. The highest similarity value is noted, and an arbitrary number greater than the noted value is subtracted from the matrix to obtain a dissimilarity matrix. The matrix is given as

an input for MDS, from which the coordinate estimates and a two-dimensional map of distances between the statements are obtained. The statements on the map are represented by points; closer points indicate how similar the statements were judged by the sorter.



	1	2	3	4	5	6	7	8	9	10
1	1	1	0	0	0	1	0	0	1	0
2	1	1	0	0	0	1	0	0	1	0
3	0	0	1	1	0	0	0	0	0	0
4	0	0	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1	0	0
6	1	1	0	0	0	1	0	0	1	0
7	0	0	0	0	0	0	1	0	0	0
8	0	0	0	0	1	0	0	1	0	0
9	1	1	0	0	0	1	0	0	1	0
10	0	0	0	0	0	0	0	0	0	1

Figure 4. Binary square matrix obtained after sorting (Binge *et al.*, 2002)

4. Choosing the final cluster solution - The aim of this step is to determine the number of clusters that represent the final solution of the data. Statements are grouped by hierarchical cluster analysis using Ward's method on the basis of their coordinates in the two dimensions of the MDS retained (Ketchen & Shook, 1996). "This type of cluster analysis is helpful in identifying categories when the structure of categories is not already known" (Afifi & Clark, 1996). "The output of the analysis generates two decision tools (Boster, 1994):

   a. A list of the statements in the cluster solution (Carley, 1993).

   b. The merging of clusters for each cluster solution (a list version of a dendogram). "

The cluster solutions are examined to determine the appropriateness of the merging or splitting of statements.

5. Labeling clusters - Clusters are labeled by examining the statements in each. Appropriate labels are given to the cluster based on the content of statements in each cluster. This identifies the customer requirements being determined.

2.4.1 Reliability and Validity of Concept Mapping Approach

Trochim (1993) discussed various reliability measures for concept mapping. The widely used method is the test-retest correlation. In concept mapping, participants are asked to sort the statements on two different occasions, and two similarity matrices are generated. The matrices can be given as an input to the MDS and the two reliability coefficients computed. The disadvantage of this method is that it requires twice the amount of data collection, and participants need to show up twice, which is not feasible in all situations. It assumes that the responses in the second testing are independent of the first testing. Split-half reliability can be estimated by splitting the group of participants into two sub-groups. Two similarity matrices and MDS maps can be obtained, and by correlating them, the split-half reliability can be estimated. The advantage of this method is that it is easy to perform. Cronbach's alpha can be calculated to estimate the reliability of the concept mapping. Another way of finding the reliability is to determine the correlation between each person's sort matrix and the total similarity matrix. This is called the average individual-to-total reliability. The multi-dimensional scaling and cluster analysis used offer strength to the validity of the CMA.

CHAPTER 3

RESEARCH OBJECTIVES AND METHOLODOGY

This chapter provides an overview of the research objectives and methodology that was followed to complete the analysis.

3.1 Research Objectives

Surveys containing closed- and open-ended questions were conducted, and the responses received for the open-ended questions were recorded. The two techniques discussed in the literature, critical incident technique and concept mapping approach, were used to analyze the responses. CIT sorts the responses into critical incidents based on specific characteristics, which are then clustered to form satisfaction items, as discussed in Chapter 2. The satisfaction items are further clustered to identify customer requirements. The CMA identifies customer requirements by sorting the data into piles and analyzing the piles with the aid of software by performing multi-dimensional scaling and cluster analysis.

The objective of the research is to compare the CIT and CMA with respect to the following:

1. Completeness, i.e., their ability to identify major customer requirements. This aspect will be evaluated based on the customer requirements identified in the literature.
2. Timeliness, i.e., the time to complete the analysis and report the results. This will be accomplished by recording the time to screen the written comments, unitize them, form appropriate clusters and identify customer requirements.

3.2 Research Procedure

The following procedure was followed in order to achieve the research objectives:

1. A survey was designed and validated using the content validity approach. A pilot study was conducted, and the internal consistency of the instrument was confirmed.
2. Customer requirements were identified by analyzing the responses using the two techniques.
3. A credibility check of comprehensiveness was performed while using CIT.
4. Customer requirements obtained were compared with the standard requirements given by the Purdue College of Education (http://www.education.purdue.edu/) in order to compare the completeness of the two techniques.
5. The time to complete the analysis, which includes sorting the responses, unitizing them, forming clusters, and identifying customer requirements, was recorded in order to compare the timeliness of the two techniques.
6. An appropriate technique will be recommended based on the results obtained from the comparisons.

CHAPTER 4

CASE STUDY

A class of 35 graduate students was chosen to participate in this study. The course instructor selected a set of published papers as reading assignments for the class. Groups of three to four students were selected to prepare an in-class presentation highlighting important concepts and representing the issues addressed in each paper. Each group was allowed 20 minutes for presentation and 10 minutes to answer questions from the rest of the students. A survey was designed to measure students' satisfaction with the presentations. Content validity was measured using an evaluation panel consisting of five engineering professors from Wichita State University. Questions that received a content validity ratio of 1 were retained, and the final survey consisted of seven closed- and three open-ended questions, which are included in Appendix A. Pilot tests indicated an internal consistency (Cronbach's alpha) of 0.82. Seven surveys were conducted over the semester, resulting in 528 statements in response to the three open-ended questions. Both the CIT and CMA were used to analyze these statements to identify the students' requirements of in-class presentations.

4.1 Analysis using CIT

Responses to the questions were examined, and repetitive statements were eliminated. In addition, responses that described more than one perception were divided into an appropriate number of statements, as shown in Figure 5.

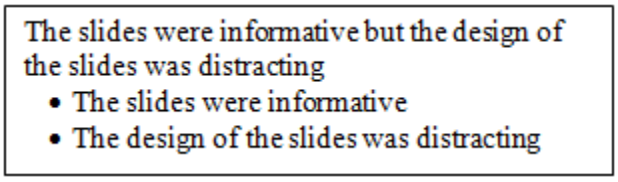


Figure 5. Statements describing more than one perception

By examining the statements, a total of 59 critical incidents were obtained. Following the method recommended by Hayes (1998), ten critical incidents were separated. The remaining critical incidents were categorized into satisfaction items based on their contents. Figure 6 shows an example of three critical incidents categorized into one satisfaction item.

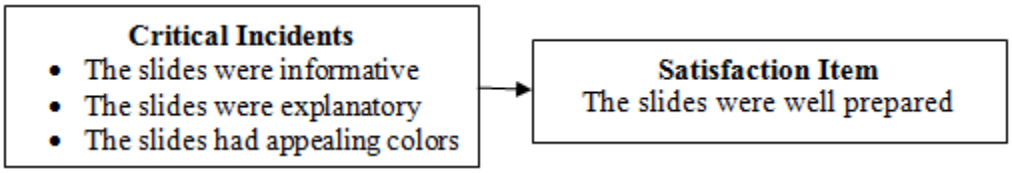


Figure 6. Critical incidents categorized into satisfaction items

A total of 13 satisfaction items were identified. Similarly, these satisfaction items were grouped into student requirements based on the requirements they reflect as shown in Figure 7.

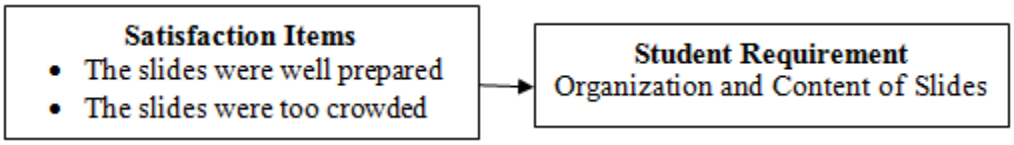


Figure 7. Satisfaction items categorized into student requirements

The final analysis resulted in identifying the seven requirements as shown in Table 4. These requirements were able to encompass all ten critical incidents verifying the comprehensiveness of the requirements identified. The detailed list of critical incidents, satisfaction items and student requirements identified in the process are shown in Appendix B.

TABLE 4

STUDENT REQUIREMENTS USING CIT

S. No	Student Requirements
1	Organization and Content of Slides
2	Use of Figures and Graphics
3	Use of Examples
4	Clarity of Speech
5	Ability to Finish on Time
6	Ability to Answer Questions
7	Team Cooperation

The requirements identified were compared with the standard requirements given by Purdue College of Education (http://www.education.purdue.edu/), as shown in Appendix C. From the checklist, it can be seen that content accuracy, sequencing of information, and effectiveness were merged into the category –Organization and Content of Slides" in CIT. An additional requirement, –Use of Examples," was identified in comparison to the checklist, and none of the requirements found using CIT were left out. This verified the completeness of the requirements obtained using CIT.

4.2 Analysis using CM

Following the five-step procedure recommended by Jackson and Trochim (2002), a total of 81 units of analysis were identified in the first step. Examples of the units identified are shown in Figure 8.

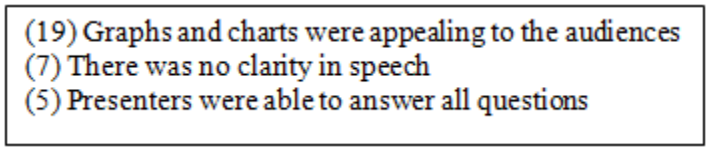


Figure 8. Units of analysis

The units with their numbers were printed on cards for sorting. Eight students from the class volunteered to do the sorting. Each student was given a packet of 81 cards, Post-it® notes to put labels on the piles, and rubber bands to bind the piles and labels. Students were given instructions to sort similar units into piles and propose labels for each pile. The information was used to develop individual binary matrices for each student volunteer. A similarity matrix was developed by combining the eight matrices. The highest similarity score was 8. An arbitrary number 10 was chosen and subtracted from the similarity matrix to obtain a dissimilarity matrix. Figure 9 represents a portion of the matrix.

S.No	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S1
S1	0	9	10	10	10	10	10	8	10	9	
S2	9	0	10	10	10	10	10	7	4	10	
S3	10	10	0	2	2	3	9	10	10	8	
S4	10	10	2	0	2	3	9	10	10	8	
S5	10	10	2	2	0	3	9	10	10	8	
S6	10	10	3	3	3	0	9	10	10	9	
S7	10	10	9	9	9	9	0	10	10	9	
S8	8	7	10	10	10	10	10	0	8	10	
S9	10	4	10	10	10	10	10	8	0	10	
S10	9	10	8	8	8	9	9	10	10	0	
S11	10	10	10	10	10	10	7	10	10	9	

Figure 9. Dissimilarity matrix (81 x 81) (partially shown)

The lower triangular matrix was used as an input for multi-dimensional scaling in SPSS 17 (IBM SPSS, 2008). The MDS generated the two-dimensional map, as shown in Figure 10. In the map, each point represents a statement. For example, point S7 represents *Statement 7: There was no clarity in speech*. The points that mapped closer to each other indicate a greater tendency of being grouped together in the opinion of the students. To determine the appropriate number of clusters that represent the final solution for the data, hierarchical agglomerative cluster analysis in SPSS 17 was used on the MDS map coordinates. The analysis generated six clusters with units that clustered together based on their similarity. The units in their respective clusters were examined and given labels that represented the student requirements being identified.

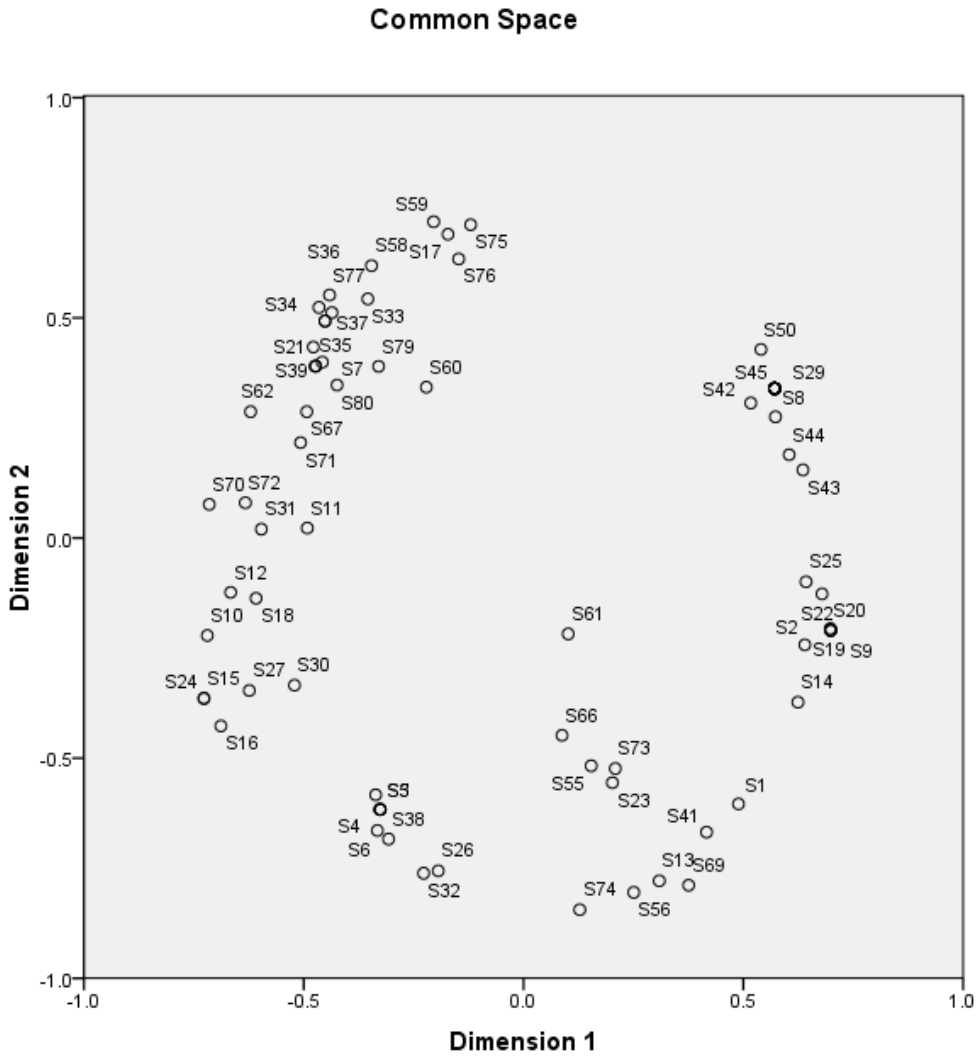


Figure 10. Two-dimensional map from distance matrix using MDS

Figure 11 shows a graphical representation of the clusters on the map retained from MDS. By analyzing the cluster placements on the two dimensions, the axis of the map can be interpreted: the x- axis might be interpreted as "presenter vs. presentation," and the y-axis might be interpreted as "information vs. communication."

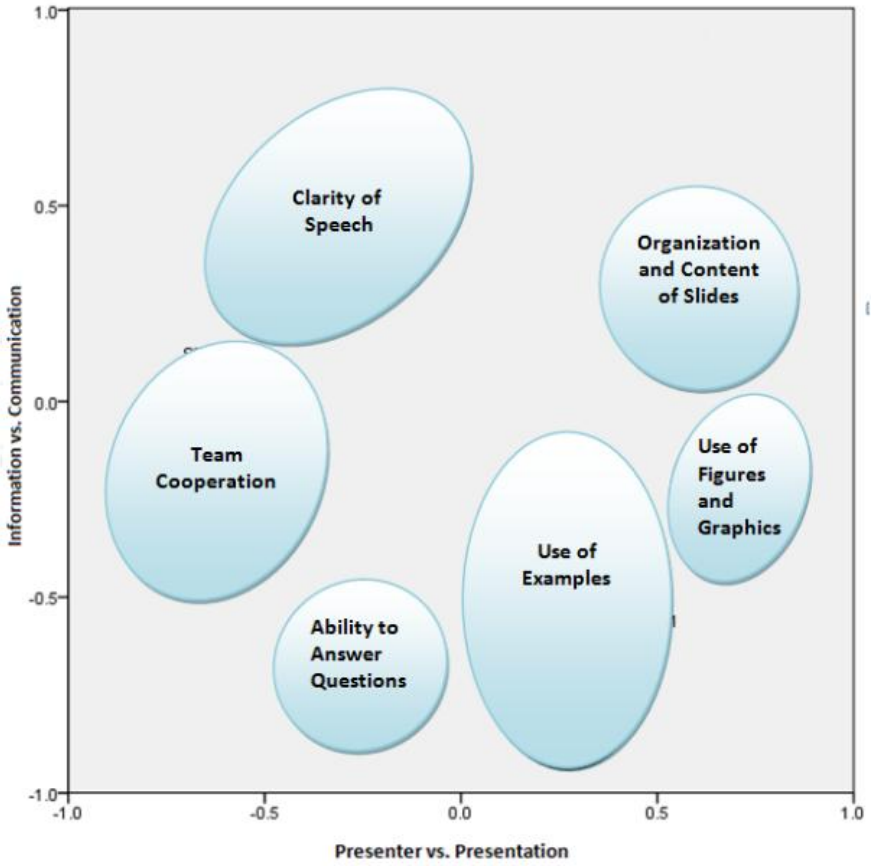


Figure 11. Clusters representing student requirements

The above requirements were compared with the standard requirements given by the Purdue College of Education (http://www.education.purdue.edu/). From the requirements, it can be seen that spelling and grammar, content accuracy, sequencing of information, and effectiveness were merged into ―Organization and Content of Slides" in the CMA. An additional requirement Use of Examples was identified in comparison to the checklist and none of the requirements found using CMA were left out. This verified the completeness of the requirements obtained using CMA.

4.3 Comparison

The responses received from the open-ended questions were analyzed using the two techniques. The issues faced while collecting responses from the participants were the

willingness to provide detailed answers other than –good" or –bad" and the ability to express their opinions in meaningful sentences. In some instances, complex statements were divided into two or three statements, with each referring to different concepts. The total number of statements was too large due to repetition of responses, and not all statements met the requirements of the two techniques. In filtering the total number of statements, identifying critical incidents appeared more restrictive than identifying the units of analysis. This is evident by the fact that from the same set of responses, 59 critical incidents were identified as opposed to 81 units of analysis in concept mapping. The critical incident technique does not call for continual involvement of the participants; moreover, it has an internal step to verify the comprehensiveness of the results obtained.

On the other hand, the concept mapping approach allows continual involvement of the participants in sorting the statements and labeling the clusters. This assures the completeness of results and minimizes the researcher's bias. However, as the number of units increases, the burden on the sorters tends to increase. Also, a similar effect has been observed regarding the size of the matrices. The chance of making data entry errors and the overall time it takes to produce the similarity matrix tends to increase. These difficulties have been eased to a great extent with the fact that CMA is a computer-aided technique. This significantly reduces the time to analyze the matrix and produce a concept map. The total number of units should not exceed 200, as the software utilized does not support a larger number of units. The procedure followed in the CMA tends to cluster the statements directly into the requirements, whereas the CIT provides a trace of the satisfaction items that contribute to the requirements. This is of special value in deploying the requirements while preparing for future presentations. In the CMA, the requirement –Ability to Finish on Time" was confounded with –Team Cooperation" and

–Organization of Slides." This shows that requirements identified using the CMA is more comprehensive than those obtained using the CIT.

The time required in collecting and documenting the responses was common to both techniques. In the CIT, responses were required to satisfy the two conditions to be qualified as a critical incident. This required more time, since close attention had to be paid in sorting the statements into critical incidents. The categorization process was time consuming, since it required rearranging incidents until satisfactory results were obtained. In the CMA, the initial process of forming units of analysis was straight forward. However, it was tedious and time consuming to create the dissimilarity matrix for each sorter because the total number of units was large. A considerable amount of time was consumed in entering the data and rechecking it to avoid data entry error by the researcher. The matrix was given as an input into software for analysis; therefore, the analysis time was significantly reduced.

CHAPTER 5

SUMMARY AND CONCLUSIONS

A survey was designed to collect responses from students and analyze them in order to determine the requirements of in-class presentation. The survey was evaluated using the content validity approach, and pilot tests were run to determine the internal consistency of closed ended questions. The final design included seven closed-ended and three open-ended questions. Surveys were conducted in a class of 35 graduate students, and the responses from open-ended questions were recorded. The critical incident technique and the concept mapping approach were used to analyze the responses.

Using the CIT, six student requirements were identified, while the CMA yielded seven requirements. Completeness of the results from the CIT rests totally on the skills and knowledge of the researcher. The time required for analysis depends on the total number of responses collected. The CIT appears to be more appropriate for scenarios where continual participation from members of the survey population is not feasible. Otherwise, the CMA would be the technique of choice, especially when the researcher does not want to impose bias or force statements into preconceived requirements. Here the task of sorting and labeling the clusters was completely performed by participants from the population to assure completeness. A majority of the researcher's time was spent in creating the dissimilarity matrix required for multi-dimensional scaling and cluster analysis. These quantitative techniques added to the objectivity of results. The analysis time was significantly reduced by utilizing appropriate software in creating clusters.

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APPENDICES

APPENDIX A

SURVEY FOR IN-CLASS PRESENTATION

IME 854: Quality Engineering
Fall 2010

In-Class Presentation Evaluation

Topic: _____ Date: _____

Please evaluate each others' presentations; this can help you improve your own.

#	Question	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
1	I am interested in the topic and idea presented.	☐	☐	☐	☐	☐
2	The presentation was well-prepared.	☐	☐	☐	☐	☐
3	The presentation helped explain the major concepts of the paper.	☐	☐	☐	☐	☐
4	Members of the group had equal chance to participate in the presentation.	☐	☐	☐	☐	☐
5	Enough time was allowed for discussion.	☐	☐	☐	☐	☐
6	The group successfully answered all questions.	☐	☐	☐	☐	☐
7	Overall, I am satisfied with the group's presentation skills.	☐	☐	☐	☐	☐
8	What did you like most about the presentation?					
9	What did you like least about the presentation?					
10	In what ways would you like to see this presentation improved?					

APPENDIX B

STUDENT REQUIREMENTS USING CIT

[1] Organization and Content of Slides

I. The slides were well- prepared
1. The slides were informative
2. The slides were explanatory
3. The slides looked complicated
4. There was no connection between the slides
5. The slides were not proof-read
6. The slides were precise
7. The slides had unnecessary details
8. The slides had appealing colors
9. The color and design of slides were distracting

II. The slides were too crowded
10. Some slides contained too many words
11. The slides were not over crowded with data
12. The slides were too many in number

III. The presentation was informative
13. The presentation did not have unnecessary details.
14. There were discrepancies in the information presented
15. The presentation was not very informative

IV. Presenters were knowledgeable about their subject
16. The presenters completely understood the concept of the paper
17. The presenter's speech did not match the information on the slides
18. The presenters did not completely understand the logic behind the concept

V. The presenters performed additional research
19. The concept was not presented completely due to lack of research
20. The presenters did not determine key areas and cover them in more depth

VI. The explanations were good
21. The concepts were explained thoroughly with enough details.
22. The paper was explained in depth
23. The concepts explained were not in detail

[2] Use of Figures and Graphics

VII. The graphs and charts were appealing to the audiences
24. The flow charts made it easy to understand the presentation
25. The figures and flow charts were difficult to understand

26. The presentation did not have enough graphics.
27. The pictures were too small and so they needed to be enlarged

[3] Use of Examples

VIII. All the concepts were explained with examples
28. The examples were well related to the concept
29. Real time examples helped to explain the concept
30. Not enough examples were used for the easy comprehension of concepts
31. The examples were too difficult to understand
32. Did not discuss the examples in the question answer session
33. Videos were not shown as examples

[4] Clarity of Speech

IX. The presenters lacked clarity in speech
34. The presenters spoke clearly
35. The presenters spoke at a good volume
36. The presenters were too loud
37. The presenters were not audible
38. The pronunciation of the presenters was not good
39. The presenters spoke in a monotonous way
40. The presenters spoke like a cassette player.

X. The presenters kept the audience's attention
41. The presenters seemed very passionate and excited
42. The presenters were not interactive
43. The presenters communicated ineffectively
44. The presenters spoke to the screen and not to the audience

[5] Ability to Finish on Time

XI. The presentation was completed on time
45. The presenters needed a longer time frame
46. The presenters did not stick to the time
47. The presentation had a very good flow and speed.

[6] Ability to answer questions

XII. The question answer session was interesting
48. The presenters tried to answer question to the best of their knowledge
49. The presenters answered all questions
50. The answers to questions were not impressive
51. The presenters did not answer the questions directly

52. The presenters were not prepared for the questionsThe presenters gave incorrect answers
54. The presenters did not take time to listen to the question

[7] Team Cooperation

XIII. The team had good coordination
55. The team had good continuity
56. The team lacked coordination between group members
57. The team did not give equal opportunities to all group members

APPENDIX C

STUDENT REQUIREMENTS FROM PURDUE COLLEGE OF EDUCATION

Group Name: _____

Title of Presentation: _____

CATEGORY	Excellent-4	Good-3	Satisfactory-2	Needs Improvement-1
Content - Accuracy	All content throughout the presentation is accurate. There are no factual errors.	Most of the content is accurate but there is one piece of information that seems inaccurate.	The content is generally accurate, but one piece of information is clearly inaccurate.	Content confusing or contains more than one factual error.
Sequencing of Information	Information is organized in a clear, logical way. It is easy to anticipate the next slide.	Most information is organized in a clear, logical way. One slide or piece of information seems out of place.	Some information is logically sequenced. An occasional slide or piece of information seems out of place.	There is no clear plan for the organization of information.
Effectiveness	Project includes all material needed to give a good understanding of the topic. The project is consistent with the driving question.	Project is lacking one or two key elements. Project is consistent with driving question most of the time.	Project is missing more than two key elements. It is rarely consistent with the driving question.	Project is lacking several key elements and has inaccuracies. .Project is completely inconsistent with driving question.
Use of Graphics	All graphics are attractive (size and colors) and support the topic of the presentation.	A few graphics are not attractive but all support the topic of the presentation.	All graphics are attractive but a few do not support the topic of the presentation.	Several graphics are unattractive AND detract from the content of the presentation.

Text - Font Choice & Formatting	Font formats (color, bold, italic) have been carefully planned to enhance readability and content.	Font formats have been carefully planned to enhance readability.	Font formatting has been carefully planned to complement the content. It may be a little hard to read.	Font formatting makes it very difficult to read the material.
Spelling and Grammar	Presentation has no misspellings or grammatical errors.	Presentation has 1-2 misspellings, but no grammatical errors.	Presentation has 1-2 grammatical errors but no misspellings.	Presentation has more than 2 grammatical and/or spelling errors.
Cooperation	Group shares tasks and all performed responsibly all of the time.	Group shares tasks and performed responsibly most of the time.	Group shares tasks and performs responsibly some of the time.	Group often is not effective in sharing tasks and/or sharing responsibility.

Delivery	Members spoke at a good rate, volume and with good grammar. They maintained eye-contact while using, but not reading their notes.	Members spoke a little faster or slower than necessary, or too quietly or loudly. They used acceptable grammar. They maintained eye-contact, but relied too much on their notes.	Members spoke at a good rate and volume, but used poor grammar. They relied heavily on their notes.	Members demonstrated having paid little attention to rate, volume or grammar. They read nearly word for word from notes.

(Source: http://www.education.purdue.edu/)