Abstracts of Theses

(1) Graduate research assistant, Venkata Ganesh Ashish Akula, is currently working on his Master's thesis based on the research work from this project. His Master's thesis is expected to be completed by December 2018 and the thesis abstract will be submitted then.

Data on Scientific Collaborators

(1) Dr. Chen Ling, Co-Principal Investigator, Associate Professor, University of Akron
(2) Venkata Ganesh Ashish Akula, Graduate Student, University of Akron
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Technical Description of Project and Results

Through a variety of study approaches including (1) Literature review, (2) Review of best practices from other industries, (3) Review of case studies on transferring learning to behavior, (4) Phone interviews, (5) On-site interviews, and (6) Academy Evaluation System (AES) data mining, detailed recommendations were provided for Levels 1-5 evaluation processes based on Kirkpatrick model, on both continuous improvements of the existing processes and suggested future state maps, as well as data analytical strategies. The results are summarized below.

1. Level 1 Evaluation Process

The Level 1 evaluation through the EOC survey via AES is a well-established and efficient process. Minor process improvement opportunities are identified are follows:

(1) Expand the use of standardized EOC survey via AES to non instructor-led training courses.
(2) Actively track and enforce the review timelines (14 days for course coordinators/instructors and 30 days for AMA managers) to identify potential risks and take necessary actions in a timely manner.
(3) Use Average Weighted Score instead of Favorability Percentage as the performance metric for survey data analysis. This could be easily done using the existing AES, as the survey data are already in the required format. This change of performance metric will lead to the redesign of trigger point(s) for the feedback mechanism. Based on the other industry's practice, different training courses may use different trigger point(s) that is/are

most suitable for the specific courses. Once the trigger points are decided, they can be coded in AES to enable automatic triggers.

(4) Use advanced analytics (correlation analysis, contingency analysis, logistic regression model, and cluster analysis) to analyze the survey data. This could lead to insightful discoveries, which can be used to drive continuous improvement efforts. This can be done either offline periodically (easy approach) or automated in the AES (challenging approach).

(5) The use of text mining for automating the analysis of individual comments/critiques is currently immature, because the accuracy level is not high enough. It is still recommended for the review team to manually read the comments/critiques.

2. Level 2 Evaluation Process

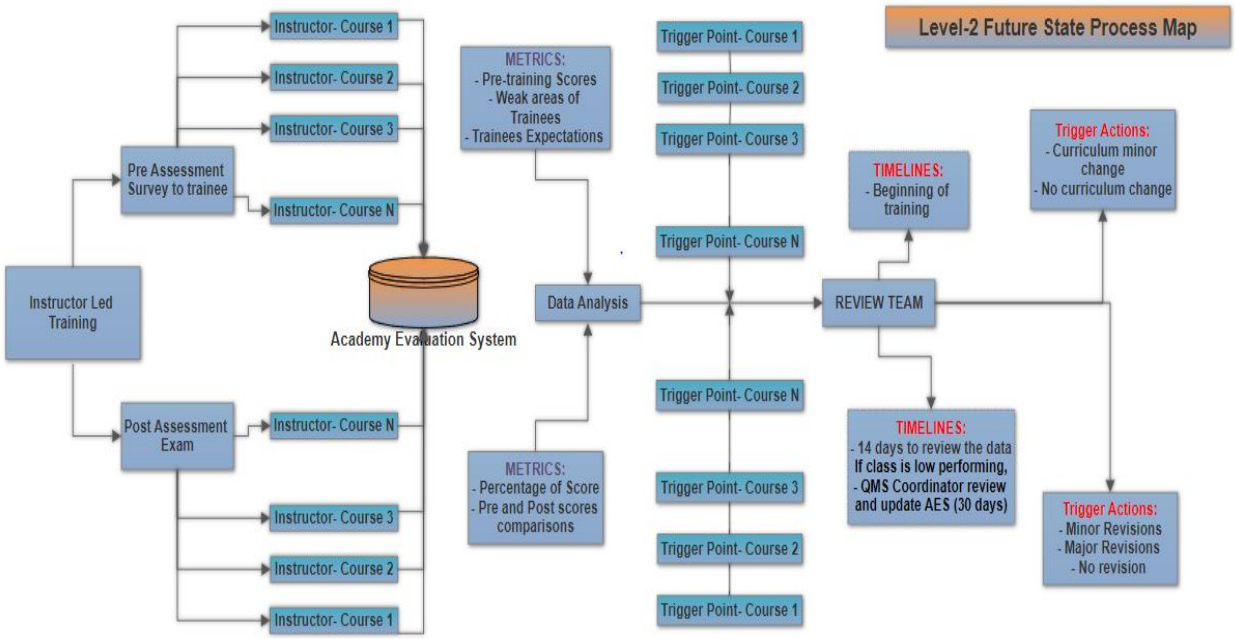
Currently, the Academy does not have a process for collecting and analyzing Level 2 data. The divisions within the Academy use objectives and develop tests/activities to determine if learning occurred in course offerings, but there is no centralized process to collect and analyze Level 2 data.

Kirkpatrick model's Level 2 measures the participants understanding to the course content by testing the knowledge and skills learnt in the training program through a Performance exam at the end of course. There are several data collection methodologies for the evaluation model. The most widely used data collections methods used in best practices in other industries are the pre and post-test assessments, interview before and after the training (which is a very time consuming process). Based on our interviews with AJI-2 customer satisfaction process stakeholders and the industry best practices, we recommend that the pre and post-test assessments is the best option considering the Academy's organizational structure and the number of students that attend the training. It would be difficult in selecting a sample of students and interviewing them to collect Level 2 data.

In the following Figure, we proposed a future state process map for the Level 2 evaluation at the Academy. Both pre-training assessment and post-training assessment need to be conducted. For the pre-training assessment, as each training course has its own training requirements and objectives, it is difficult to use a standardized instrument for pre-training assessment. It is recommended each course instructor conducts his/her pre-training assessment. This could be done using an actual assessment exam or an assessment survey that asks the trainees to answer a series of questions with ratings on their proficient levels on the relevant training tasks. In either case, the pre-training assessment results should be standardized and documented as pre-training assessment scores.

For the post-training assessment, it is recommended that the final course scores be used as the post-training assessment scores. Then, the comparison of the pre-training and post-training assessment scores should be documented as Level 2 data. Each training course could set up its own trigger point for the review process.

It is recommended to use a centralized system, such as AES, to document and track these Level 2 data.



Future State Level 2 Evaluation Process Map

3. Level 3 Evaluation Process

The Level 3 evaluation through the EOC survey via AES is a well-established and efficient process. Minor process improvement opportunities are identified are follows:

(1) Expand the use of standardized EOC survey via AES to non instructor-led training courses.
(2) Actively track and enforce the review timelines (30 days for course coordinators/instructors and 30 days for AMA managers) to identify potential risks and take necessary actions in a timely manner.
(3) Use Average Weighted Score instead of Favorability Percentage as the performance metric for survey data analysis. This could be easily done using the existing AES, as the survey data are already in the required format. This change of performance metric will lead to the redesign of trigger point(s) for the feedback mechanism. Based on the other industry's practice, different training courses may use different trigger point(s) that is/are most suitable for the specific courses. Once the trigger points are decided, they can be coded in AES to enable automatic triggers.
(4) Use advanced analytics (correlation analysis, contingency analysis, logistic regression model, and cluster analysis) to analyze the survey data. This could lead to insightful discoveries, which can be used to drive continuous improvement efforts. This can be done either offline periodically (easy approach) or automated in the AES (challenging approach).

(5) The use of text mining for automating the analysis of individual comments/critiques is currently immature, because the accuracy level is not high enough. It is still recommended for the review team to manually read the comments/critiques.

4. Level 4 and Level 5 Evaluation Process

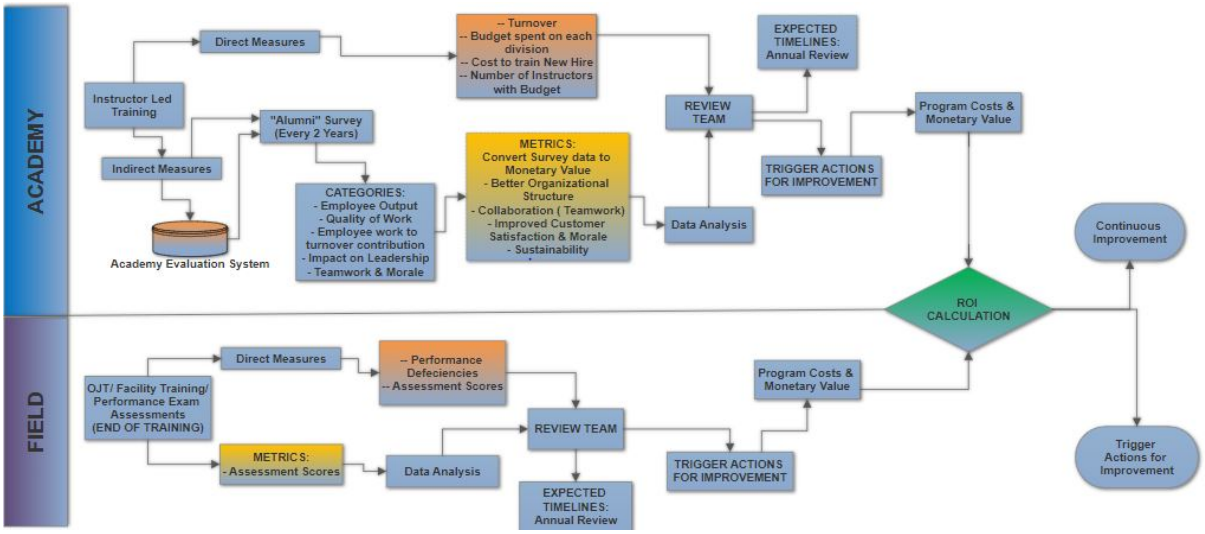
Currently, the AJI-2 and the Academy does not have a process in place to provide Level 4 and Level 5 evaluations. Kirkpatrick model's Level 4 evaluates the business results of the organization on which the training program was conducted. This level of evaluation involves deep understanding of the data obtained from Levels 1-3 and different data analytics have to be performed to obtain the results. Philip's Level 5 Return on Investment (ROI) is the ultimate level of evaluation. It compares the monetary benefits from the program with the program costs. Although the ROI can be expressed in several ways. The Phillips' model evolves from, and can be distinguished from, the earlier Kirkpatrick model by the adoption of return on investment to yield additional, critical insight. ROI allows decision makers to compare the ultimate value of a training investment with other potential investment opportunities.

From the best practices from the other industries, the data collection methodologies for level 4 and level 5 are largely based on online survey, focus group, ROI, value narration, tangible and intangible benefits. In the following Figure, we proposed a future state process map for the Level 4 and Level 5 evaluation process.

To measure the business results (level 4) and ROI (level 5), we propose to use both direct measures and indirect measures. Specifically, at the Academy, the direct measures include trainee turnover rates, division budgets, cost to train new hires, as well as the number of instructors and the associated budgets. The indirect measures can be obtained by sending out a survey to the "alumni" who successfully completed academy training and worked in the field. In the "alumni" survey, proposed questions are designed to gather information about employee work to turnover contribution, organizational structure, team work, morale, improved customer satisfaction and sustainability. Based on other industries' best practices, it is recommended the survey to be conducted every 2 years.

In the field, when the OJT, facility training, performance exam assessments are conducted, these performance assessment results can be used as Level 4 direct measures. Data analysis on these assessment results can be conducted to obtain metrics such as the assessment score summary statistics (mean, median, standard deviation, etc.), and the first pass yield. Another source of direct measures from the filed could be the documented performance deficiencies (if available). The challenge is that in the field, currently, there is not a centralized unit similar to the AMA-20 in the Academy to coordinate the data collection, analysis and review process. It is recommended further studies to be conducted to investigate the best ways to collect data from the field and establish an effective data sharing and information sharing mechanism among AJI-2, the Academy, and the field.

Furthermore, it is recommended to form a review team consisting of members from different backgrounds to review and analyze the data obtained from direct measures and indirect measures both from the Academy and the field, identify specific trigger points (such as, when employee turnover is more than 10%, or the ROI is less than 1:2, etc.), to take actions. The review cycle is recommended to be every one year.



Future State Level 4 and Level 5 Evaluation Process Map

5. Evaluation Data Analytical Strategies

Based on the data analysis results, we recommend the following data analytics strategies for the survey data analysis.

(1) Use Average Weighted Score instead of Favorability Percentage as the performance metric for survey data analysis. This could be easily done using the existing AES, as the survey data are already in the required format. This change of performance metric will lead to the redesign of trigger point(s) for the feedback mechanism. Based on the other industry's practice, different training courses may use different trigger point(s) that is/are most suitable for the specific courses. Once the trigger points are decided, they can be coded in AES to enable automatic triggers.

(2) Use advanced analytics (correlation analysis, contingency analysis, logistic regression model, and cluster analysis) to analyze the survey data. This could lead to insightful discoveries, which can be used to drive continuous improvement efforts. This can be done either offline periodically (easy approach) or automated in the AES (challenging approach).

Specifically, Logistic regression analysis was used to check the relation of the questions with the overall satisfaction rating as every question will play a major role in the trainee's perspective and we will be able to quantify which questions are adding more values to the overall satisfaction score. The outcomes from the logistic regression analysis are that we are able to identify the questions which are most significant and least significant in improving the overall satisfaction rating. The questions with least significant effect on question 14 are Q3, Q6, Q7 and Q12. The countermeasures for these outcomes are to look into the category of the question and determine the root cause for why there is less significance when compared with the overall satisfaction.

Over the three years period when the data was given, for the overall favorability percentages of all the questions, the lowest favorability percentage was 81.2% for Question 9. The improvement in the values of this question will have an impact on the overall satisfaction score, as it is one of the most significant questions in the prediction of the Question 14 responses. And this will in return improve the satisfaction score which can be converted into the tangible benefits as well as intangible benefits which can help calculate the Return-On-Investment (ROI).

The clustering analysis will help FAA in understanding which classroom falls into which cluster with specific cluster means for each of them. By looking at that it can be easily identified over the three year period which classes had fallen into a cluster with low means and high means, which will be resourceful to check what went wrong in those similar types of classes based on the responses, favorability percentage and the average weighted score.

(3) The use of text mining for automating the analysis of individual comments/critiques is currently immature, because the accuracy level is not high enough. It is still recommended for the review team to manually read the comments/critiques.

The text mining technique was most accurate when trained using survey results. The best method for improving its accuracy would be to acquire as many survey results as possible and continually use them to improve the classifier. The confusion matrix showing the results from that training shows that the classifier falsely identifies most of the comments as being negative. This is largely a result of how skewed the dataset is towards negative comments. While acquiring more survey data generally will improve accuracy, increasing the representation of positive and neutral comments will help improve this accuracy. There are other versions of text classifiers, such as random forests, which may perform better, even with the current data but more evaluation is required to determine their viability. In addition, a more rigorous feature extraction process can improve the accuracy of this tool; however, the computation time increases dramatically as the number of features extracted increases.

Another way to improve the accuracy would be to setup the tool as a semi supervised learning system. The system would be allowed to sort out positive comments, and the

persons reviewing the negative comments would mark the wrongly classified positive and neutral comments. The system preferentially identifies comments as negative and, consequently, the system is not likely to wrongly classify something as neutral or positive. After the system sorts through the input text, it would be retrained on the updated classifications of all the results it has seen. This allows the system to be utilized now and become more useful overtime.

Final Report of "AJI-2 Customer Satisfaction Process" Project

Submitted to:

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May 23, 2018

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1. Introduction

This report is the final report for the "AN005: AJI-2 Customer Satisfaction Process" project supported by the FAA Center of Excellence (COE) for Technical Training and Human Performance (TTHP). It contains (1) the review of the current FAA Technical Training (AJI-2) customer satisfaction process; (2) the study findings related to Levels 1-5 of the technical training evaluation process based on Kirkpatrick Model and data analytics strategy; (3) the other industries' best practices, and (4) a series of recommendations to be considered for continuous improvements for the future state of the AJI-2 customer satisfaction process.

1.1. Background

FAA AJI-2 is responsible for program guidance, effectiveness, technical accuracy, evaluation of technical training, coursework/curriculum development and review, maintenance, and oversight of national and FAA Academy-delivered courses. For technical training, the "customers" or "stakeholders" are the Air Traffic Controllers (ATC), the Airway Transportation Systems Specialists (ATSS), Technicians, and Engineers, throughout their careers, from new hire trainees at the FAA Academy onward.

Based on the FAA's strategic hiring needs and training requirements, AJI-2 approves and releases funding to national and FAA Academy-delivered training courses. Once the training requirements and curriculum are identified by AJI-2, FAA Academy develops the course schedule as well as staffing plan, collaboratively with AJI-2. The new hire trainees start their training at the FAA Academy, before going to the fields for On-The-Job Training (OJT) and/or Facility Training, and subsequently the certification process if applicable. Recertification (if applicable) is also conducted at various times throughout the ATC, ATSS, Technician, or Engineer's career. There is significant variation in training pathway and career path among different customers (ATC, ATSS, Technician, or Engineer). Even within the same job category, variation also exists due to the various specialties.

As the "gateway" to FAA technical training, FAA Academy plays a critical role in delivering the initial technical trainings to AJI-2 customers, mostly through its Technical Operations Division (AMA-400) and Air Traffic Division (AMA-500). The following Figure 1 shows the number of training course completions for Fiscal Year 2016 by job series in 400/500. As the reported numbers include all training completions without location information, it is possible some completions could be done via on-line training. Additionally, these numbers provided by AMA-20 (FAA Academy Training Services and Support Division) may also include the training completions for non-FAA and non-AJI-2 customers. It is because FAA academy also provides training to other non-FAA agencies.

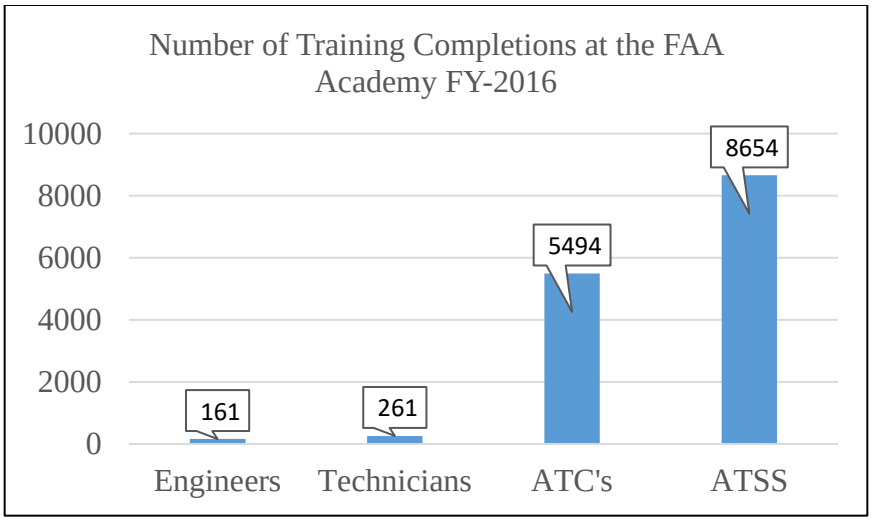


Figure 1: Total Number of Training Completions for Fiscal Year 2016

As shown in Figure 1, the most number of training course completions in Fiscal Year 2016 were for the ATSS (8,654), which includes six specialties: Automation, Communication, Radar, Navigation, Environmental, and General. Please note that the General specialty refers to the cross-disciplined ATSS who do not fit neatly in the previous five specialties. There were also nearly 5,500 training course completions for ATC. Significantly less number of training completions (161 and 261) were for the Engineers and Technicians trainees, respectively. Note that the Technicians are different than the ATSS's as they have different job responsibilities.

Table 1: Number of Training Completions for AJI-2 Customers for Fiscal Year 2016

		Fiscal Year 2016
Tech Ops	# AMA-400 ILT course completions	3112
	# AMA-400 ILT courses	94
	# AMA-400 WBT course completions	1892
	# AMA-400 WBT courses	24
	Total # AMA-400 course completions	5004
ATC	# AMA-500 ILT course completions	3949
	# AMA-500 ILT courses	23
	# AMA-500 WBT course completions	206
	# AMA-500 WBT courses	1
	Total # AMA-500 course completions	4155

From another source of data (provided by AJI-2), the above Table 1 shows the number of training course completions and training courses for Tech Ops (AMA-400) and ATC (AMA-500). These data also include the information about the types of training course: ILT (instructor led training) and WBT (web-based training). As the total number of course completions do not match the data that were provided by AMA-20 and presented in Figure 1, it is likely due to the fact that AMA-20's data may include non-AJI-2 customers who attend the training at the FAA Academy either in-classroom or via web.

The technical training courses offered by the FAA Academy for AJI-2 customers are delivered via a variety of methods:

- Instructor Led Classroom: Traditional Resident
- Instructor Led Virtual Classroom: Instructor Remote
    - Aviation Training Network (ATN)
    - Video Backhaul Network (VBN)
    - Academy Virtual Training Network (AVTN)
- Instructor Led Online Delivered: Instructor Guided
    - Blackboard
    - Adobe Connect
- Self-Paced Online Delivered
    - eLMS/e-Learning
    - Distance Learning Platforms (DLP), formerly Computer-Based Instruction
- Correspondence Study

Based on the data provided by AMA-20, the following are the breakdowns of the number of academy courses by different delivery methods and platforms. Figure 2 further illustrated the academy course counts stratified by delivery methods.

Resident	453
OAT/Field	222
ATN	21
DLP	180
eLMS	5,256
Blackboard	80
Correspondence Study	92
Total	6,304

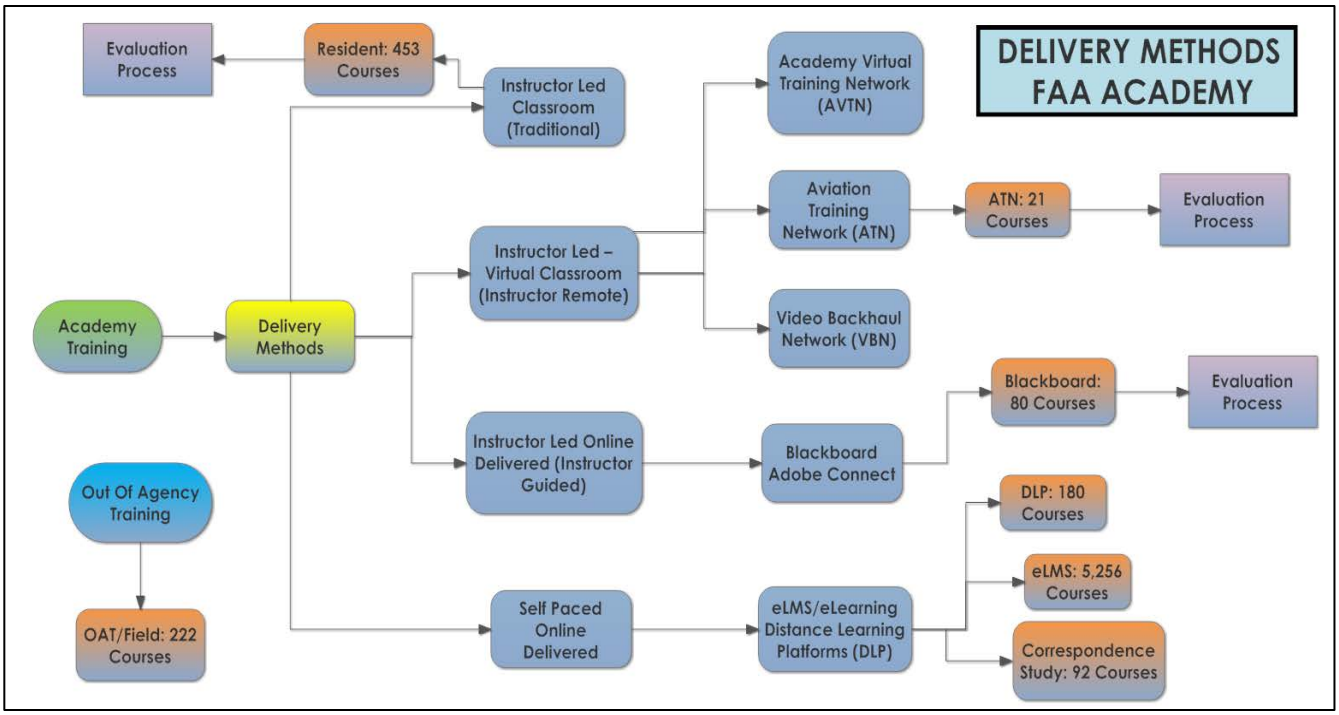


Figure 2: Number of Academy Courses/Delivery Methods (FY 2016)

Achieving the highest customer satisfaction is the ultimate goal of almost all businesses and organizations, AJI-2 is no exception. Currently, for the FAA academy delivered training courses, there are established evaluation processes based on Kirkpatrick's model's evaluation Levels 1-3 (details will be discussed in Section 2.1 and Sections 3.1.1-3.1.3). However, the Academy does not have a process in place to provide Kirkpatrick's model's Levels 4 and 5 evaluations. Furthermore, beyond the Academy training, after the trainees go to the fields, besides the Post Course evaluation conducted 90 days after the Academy training, there is no process in place to collect customer satisfaction data.

This study took place to investigate the current AJI-2 customer satisfaction process, and develop a series of recommendations on creating a comprehensive customer satisfaction process for AJI-2, which includes both the existing process enhancements, and a proposed future state process.

1.2. Study Purpose and Scope

The main purpose of this study is to recommend a comprehensive process for collecting, analyzing customer satisfaction data and creating a review and response mechanism to refine AJI-2 products and services to maximizing customer satisfaction. Specifically, the following steps were taken: (1) researching AJI-2 core products and services and identifying the current

processes for customer satisfaction data collection; (2) researching industry best practices related to customer satisfaction process; and (3) recommending an optimal implementable process and review mechanism to maximize customer satisfaction.

While most of AJI-2 technical training are conducted at the FAA Academy and the existing customer satisfaction process is based on the academy course evaluations, we focused our study on understanding the relevant customer satisfaction process within the academy through the existing evaluation methods. The involved academy divisions include: Technical Operations Division (AMA-400), Air Traffic Division (AMA-500), and Training Services and Support Division (AMA-20).

Additionally, we also extended our study scope to include the fields to capture the customer satisfaction process after academy training, although such information and data are limited. By scoping the study to include the FAA Academy and the fields, we wanted to make sure the future state AJI-2 customer satisfaction process covers the entire career span of these customers. This scope enables us to provide a comprehensive recommendation for Kirkpatrick's model's Levels 1-5 implementations.

2. Study Approach

In this section, we discussed our study approach, which includes (1) Literature review, (2) Review of best practices from other industries, (3) Review of case studies on transferring learning to behavior, (4) Phone interviews, (5) On-site interviews, and (6) Academy Evaluation System (AES) data mining.

2.1. Literature Review

To create an accurate current AJI-2 customer satisfaction process mapping, we reviewed different Orders and Notices from the FAA website portal on policies and procedures related to AJI-2 technical training and the Academy.

We initially reviewed the Orders 3000.57 (Air Traffic Organization Technical Operations Training and Personnel Certification), 3000.22A (Air Traffic Organization Outcomes-Based Technical Training), 3120.4N (Air Traffic Technical Training), with focus on the Technical Training services and Personnel Certification Authority in the academy.

Order 3000.57 helped us understand the procedures and responsibilities for the administration of the Air Traffic Organization (ATO) Technical Operations Training and Personnel Certification Programs, the guidance provided for the management, planning, conduct and evaluation of these programs. We also learnt about the Academy Technical Operations training division duties and processes. We understood about the types of training and examinations offered and conducted at the academy, the metrics and guidelines to evaluate the examinations. The clear picture of the process of training is obtained from the first step of identifying the

training requirement until the certification process. The instructor and First Level Manager (FLM) are responsible for the review of the End-of-Course (EOC) and Post-Course (PC) survey data.

Order 3120.4N (Air Traffic Technical Training) gave us an idea of instructions, standards, and guidance for the administration of Air Traffic (AT) technical training, the responsibilities of AJI Technical Training, Director of AJI-2, training administration, requirements for technical training and OJT for ATC specialists, proficiency training.

Order 3000.22A (Air Traffic Organization Outcomes-Based Technical Training) gave an overview of the requirements for the design and development of Air Traffic Organization (ATO) outcomes-based technical training from identification of the training need through delivery, evaluation, and revision of the training curriculum. We learnt about the Instructional Systems Specialists (ISS) and Subject Matter Experts (SME) who are the part of the review team for the evaluation process in Level 1 and Level 3 of the Kirkpatrick model.

After reviewing Order 3000.22A, we understood that Kirkpatrick model is the baseline for the outcomes of training at the Academy for the different levels of evaluation. Based on this observation, we started researching on the industry best practices related to the Kirkpatrick model and transferring of learning to behavior which we will discussing in the coming sections 2.5-2.6.

The Kirkpatrick Model is the worldwide standard for evaluating the effectiveness of training. The overwhelming popularity of the model can be traced to several factors:

- The model assessed the need of training professionals to understand training evaluation in a systematic way.
- Kirkpatrick insisted that information about level four outcomes is perhaps the most valuable that can be obtained.
- Function of its potential for simplifying the complex process of training evaluation, it reduces the number of variables an evaluator need to be concerned.
- The model prompted awareness of the importance of thinking about and assessing training in business terms.

There are five Levels of evaluations given by the Kirkpatrick model.

- Level 1: An End of Course (EOC) evaluation which measures the reaction of the participants to the training program on delivery metric, curriculum metric, course relevancy, performance testing.
- Level 2: Measures the participants understanding to the course content by testing the knowledge and skills learnt in the training program through a Performance exam at the end of course.
- Level 3: A Post Course (PC) evaluation sent out to the participants and their supervisors on job to evaluate the level of application of the skills learnt, certain time period after the completion of the training.

- Level 4: Evaluates the business results of the organization on which the training program was initiated. This level of evaluation involves deep understanding of the data obtained from the above three levels and different data analytics have to be performed to obtain the results.
- Philip's Level 5: Return on Investment (ROI) is the ultimate level of evaluation. It compares the monetary benefits from the program with the program costs. Although the ROI can be expressed in several ways, it is usually presented as a percentage or cost/benefit ratio. The Phillips' model evolves from, and can be distinguished from, the earlier Kirkpatrick model by the adoption of return on investment to yield additional, critical insight. ROI allows decision makers to compare the ultimate value of a training investment with other potential investment opportunities.

Table 2 lists the various common data collection methods for Kirkpatrick Model's different levels of evaluation data.

Table 2: Data Collection Methods for Kirkpatrick Model

Data Collection Methodologies				
Level – 1	Level - 2	Level – 3	Level – 4	Level – 5
-Happy sheets -Reaction sheets -Feedback forms -Verbal reaction -Post training questionnaires -Online evaluation	-Pre and Posttest -Interviews before and after(time taking) -Control group analysis -Online assessments	-Observation& interview over time -360 degree feedback -Enterprise feedback management -Online survey	-Online Survey -Focus group -ROI -Value narration	-ROI -Tangible and Intangible benefits

2.2. Review of best practices from other industries

The review of best practices from other industries helped us gather information on how various customer satisfaction data are collected, analyzed and used to take actions in the various continuous improvement processes, and what the outcomes are. These information helped us benchmark the current AJI-2 customer satisfaction process in Levels 1-3, and provided reference in the proposed future state Levels 4 and 5 processes for AJI-2 products and services. 11 such cases studies are presented below with a summary of findings presented in Table 3.

Case Study 1: Army & Air Force Exchange Services (AAFES)

The Army & Air Force Exchange Services (AAFES) brings a tradition of value, service and support to 11.5 million authorized customers at military installations in the United States. This case study describes a new process for upgraded data collection methods for level 1 and level 3 in 2005. It uses a team approach to evaluate the courses. More emphasis is being placed on the assessment process with a structured approach. The Microsoft office Share Point portal server 2003 was launched companywide in 2004, this tool provides a survey feature to administer assessments and obtain feedback from the associates who attended courses. Reports are run through excel spreadsheets and convert the data to an Access database for more detailed analysis.

Level 1:

A two-step process for 100 percent of the courses taught by Corporate University. The first step involves a pencil & paper assessment that will be passed out to the associates. The second step uses web portal and has been designed to collect associates reactions to the class after a week to reflect on the training.

Level 2:

These evaluations will be conducted for 80% of the courses taught. These assessments will be delivered in the form of a pre and post class test. In order for the associates to receive course credits, they must pass the post-test with a score of 80% or higher. Comparison of pre and post test scores for modifications of test questions.

Level 3:

A two-step process for 60% of the courses. These evaluations will be developed by the assessment team in coordination with the SME's, designers and trainers of the courses. The first step will have the instructor send associates an e-mail 60-90 days following successful completion of the course. The second step attempts to validate the associate's behavior change by sending similar online survey to the associate's supervisor two weeks later.

Level 4:

These evaluations will be conducted for 3% of the courses. An email to the associates is sent 90-180 days following the course completion. Using the portal will make the data analysis more efficient and economical. The information derived from the analysis will be used to brief management on the course results and impact.

Case Study 2: Canada Revenue Agency

The program in this case study is referred to as the "JUMP START". It was evaluated at all the four levels of the Kirkpatrick Model. Canada Revenue Agency forms part of the federal public service of Canada, nationwide the agency has approximately 40,000 employees. This program is particularly focused on the agency's Pacific Region, which has roughly 4600 employees. The Jump Start was developed to provide new managers with the opportunity to learn what they need to perform effectively in their new roles. In-depth formal evaluation strategy is used to assess the effectiveness of the 3 day regional orientation session with the theme as "Balancing Management with Leadership". The session contained modules on manager development skills as well as a full-day hands-on exercise on managing performance and the opportunity to learn from a senior manager in an informal arm chair session. Four three day sessions were held between September 2003 & February 2004.

Level 1:
End of course evaluation in terms of a five point scale, where 5 is the highest and 1 is the lowest. Over 80% of the participants found the topics covered in the session were very relevant to their jobs and were satisfied with the workshop.
Level 2:

For the content sessions on Day 1& 3 participants were asked to complete content evaluation questionnaires. The hands on performance management simulation on day 2 was evaluated separately by narrative report. Participants reported that due to having taken part in the program, they felt better equipped to do their jobs.

Level 3:

In order to assess the transfer of learning, two focus groups were held with participants in April/May 2004, that is some time after they had attended jump start phase 2.

Level 4:

In an attempt to gain insight how Jump Start could possibly impact business results, focus group participants were asked to gauge the effect of implementing what they had learned in terms of: Morale, Teamwork, Turnover, and Production.

Case Study 3: Defense Acquisition University (DAU)

The Defense Acquisition University is a government corporate university for the department of defense, managed by the Office of the Undersecretary of Defense. DAU provides a full range certification training across 15 career fields and evaluates all its programs within an enterprise learning framework. They call it Performance Learning Model which includes evaluating all of its training courses, continuous learning module, and performance supports efforts totaling over

103 thousand graduates per year. The Performance Learning Model has four main thrusts: Certification Training, Continuous Learning Modules, Performance Support, and Knowledge Sharing Network. By developing this new strategy, DAU rapidly changed the traditional training paradigm to the one that provides the concept of anytime, anywhere learning. They reversed the trend related to data and analysis by spending 20% of the time on data collection and 80% on analysis. Each quarter a thorough review was done. DAU, using a data mart, can quickly evaluate mission performance and trends, comparing measures of efficiency and effectiveness mined from various tools. This web based learning evaluation capability allows DAU to quickly gauge how effective learning is and cost effectively measuring training impact on the individual, supervisors and organizational performance.

Level 1:

End of class surveys. Each focus area has multiple questions to provide for further drill down on data into categories.

Level 2:
For all the certification courses, pre-test and post-test evaluations are conducted. Students must achieve 80% end of course score that is required to graduate. For senior level courses that include case based scenarios, they are evaluated by one-on-one feedback.

Level 3:
Survey students 3 months after the course completion after they are back on the job.

Level 4:

They are interested in the Return On Investment data, but it is not the sole determinant at the DAU. Other factors influence the success like Hawthorne effect, recruiting and so on. Since 1998, the students increased from 30,000 to 90,000 per year. This translated a project savings of $50million and faculty savings up to $10 million, 2002 corporate university Best in class award.

Case Study 4: Duke Energy Corporation

This case study describes a thorough process of developing a form to evaluate the significant aspects of the program. Duke Energy is a world leader in the development, collection, distribution, and production of energy related services. The company employs 23,000 individuals worldwide. Evaluation processes took turns through the years at the duke energy corporation. This case tracks the history of electronic level 1 evaluation process for a more rigorous level 1& 3 evaluation.

Duke Energy had a strong focus on continuous improvement and quality performance measures. As a result, criteria for pursuing the Malcom Bridge Award were adopted as a

standard from which all the programs would be measured. The training function was asked to produce reports in four area of training outlined in the Malcom Baldrige Award (MBA) which turned out to be the four levels of the Kirkpatrick Model.

Initially, Smile sheets and spreadsheets were used to gauge the end of class reaction for years, but two weeks later into the project they found it was not capturing adequate data. So, a project was chartered to design a database to perform these duties. On January 1st 1996, the first electronic evaluations were formally used. After the first month, less than 200 level 1 reaction sheets were submitted. The volume grew by 1000 sheets/month, by the year end of 1996, there were 12000 evaluations on the reaction to training and by 1997, it grew to over 25000 participants. Analysis of data revealed that the level 1 is directly linked to the operation and business management of the training unit. Once the correlation between level 1 & level 3 was observed, Duke Energy started working on developing standardized questions for level 3.

Case Study 5: First Union National Bank

This case study is an example of a relatively simple approach for evaluating the four levels. The major goal of first union is to let their employees know the value of their contribution to the success and growth to the bank. CARE 1 (Communication, Awareness, Renewal, Empowerment) is a one day program that was developed to provide developmental opportunity for the non-exempt employees at the First Union National Bank. More than 10,000 employees have attended the training in 1991.

Level 1:

Standard end of course evaluation form were collected from the participants. Processing was done by corporate training and development department. It was separated into 3 categories: content, instruction & overall evaluation. They used a 5 pointer scale where 5 is the best (content-4.45, instruction-4.76, overall-4.69).

Level 2 & Level 3:

A questionnaire to a random sample was mailed to the participants at the end of each quarter. On this measure an average of 3.9 was received on a 5 pointer scale.

Level 4:

It was evaluated by having a look at the turnover. Comparison of control group and experimental group calculations were made to determine what a reduction in turnover. The difference in turnover was 14%, CARE group-4.2%, NON CARE group-18.2%. So, the total estimated savings were over $1,000,000 in 1991 and that was only for 1/3 of the CARE group.

Case Study 6: Caterpillar, Inc.

It was a leadership initiative in 2002 with a purpose of not only to develop more leaders, but to develop different leaders. Caterpillar won the overall Corporate University Best in Class (CUBIC) award in 2004. It also received CUBIC award for the evaluation technique and the CUX Xchange Best Measurement. It featured multisource feedback, a two day workshop and a follow up session to further drive application and business impact. A second one day session after 3 months. This intention was to reinforce and accelerate how participants applied what they learnt to their work environment.

Level 1:
Leadership development feedback through reaction data which was collected by End of course evaluations. The level 1 data suggested several enhancements and the reaction scores roared to over 95% favorable in all three areas.
Level 2:

Learning data was not formally collected as a part of the evaluation plan. It was collected as a part of the value narratives. Eight impact areas were listed and it was asked to mention examples on how the participants applied what they learnt from the training.

Level 3:

Quick wins score sheet about two months after the completion of the workshop and about 1week prior to the one day session. Examples were given by the leaders in the quick wins score sheet. Intangible benefits were also cited.

Level 4:

Business results data were collected 4 months after the one day follow up session Innovative value narrative process. Value narratives with a 25% sample of leaders from the two pilot groups, leaders were asked two additional questions. The first required leaders to attribute a % of the monetary benefit directly to their LD experience. Then they were asked to express as a % their confidence in this attribution. Improved strategic focus, improved performance management, increased accountability, increased insights, and higher employee engagement. In addition to these benefits, a total of $141,576 in qualified, annualized, monetary benefits were identified by a 25 percent sample of leaders included in the value narrative process.

Case Study 7: Cisco Systems, Inc.

Cisco Systems, a worldwide leader in the highly competitive networking industry, is a rapidly growing company with a critical goal to keep costs down and profits high. The case study

illustrates how an organization can evaluate at all four levels and was done jointly by an internal training professional and an outside consultant. The first step was to identify the desired business results and the training program was planned and implemented. One example of the challenge was the new Return-to-Vendor (RTV) process. The write offs were financial losses they incurred every quarter that cut into the profitability. Cost accounting drove this project with a goal to reduce the write-offs, eliminate at least one head count and increase the speed of returning boards and receiving the credit. Three weeks were given to train over 130 people for the new process.

In the past, new process training had been done by a series of department meeting demos and Q&A process which would take months, depending on the complexity of the procedure. 100% proficiency training method was used by ETS consulting firm, which is not a classroom training but a self-paced with a guided supervision by a trained facilitator. The core of this system is the check sheet, reference material is given, written by three SME's who designed the process (cost accountant, buyer, materials coordinator). SME's provided a train-the-trainer to a trainer from every department, during the training checkout the trainer verified that the student was fully proficient by watching the student perform the exact task. There was no pretest and the level 2 measure on the actual task to be performed on the job removed any mystery about level 3.

Level 1:

They conducted a survey three weeks after the training program via email. A focus group to evaluate the effectiveness of the new work process and related information.

Level 3:
Trainers observed students over a weeklong period after they signed off the check sheets.

Level 4:

Reduction in the dollar amount of the write off for untraceable RTV's. Decrease in queue and reduced aging of RTV's in the system. Reduction in the dollar value of RTV inventory in the plant at any given time waiting for the process to complete. Immediate increase in productivity in the CAD by eliminating the inspection, verification and resolution of the problems related to RTV's.

Case Study 8: GAP, Inc.

This case illustrates an organized approach to evaluating a leadership training program at all four levels. In 1994, the need for leadership training was identified for the store manager level for all the divisions of Gap Inc. The Leadership Training for Supervisors (LTS), a 3 day program was developed through a partnership between Blanchard Training and Development (BTD) and Gap Inc. Corporate Training Department. The main focus was on Situational

Leadership and various skills of leadership. In 1994, the program included general managers. In 1995, it was rolled out to store managers. The program continues today focusing on the new store managers. The evaluation strategy included measuring the program's effectiveness on four levels.

Level 1:

The participant reaction was evaluated both qualitatively and quantitatively using LTS Program Evaluation form. The LTS evaluation questionnaire was at the end of the program and was measured on a range from 1 to 5.

Level 2:
Participant learning was evaluated using LTS questionnaire (fill in the blanks) with 55 possible answers. A sample of 17% of participants completed the questionnaire. The average score for all the divisions was 87%.

Level 3:

Short Term behavior change was measured quantitatively by interviewing participants and their direct reports using LTS Post-Program Survey. A random sample of 17 percent of the total participants were selected from each division for the evaluation method. All the completed surveys were mailed to Gap Inc. Corporate Training Department. Long Term behavior change was measured using Leadership skills assessment questionnaire (% change between pre and post assessment).

Level 4:

Impact study on areas such as sales, employee turnover, shrinkage. Rating scales were used to interpret the results of the levels of evaluation. On four levels of evaluation, LTS was a success.

Store Managers:

Had a positive reaction to LTS program. Learned new skills and knowledge. Used those learnings to improve their performance as leaders on the job. Impacted their store business.

Case Study 9: Group Iberdrola

This practical case study describes a program of great interest to many types and sizes of organizations where "coaching" has become a critical component of training. With more than 100 years of experience, Iberdrola is one of the main private electricity supply industries of the world. In the year 2000, they did 400,000 hours of training, which make for an average of about 41 training hours per person per year. Initially only level 1 evaluation was being done,

later there was a need for an integral evaluation system. One of the events they applied the four level model for evaluation was the face-to-face course on coaching and counselling, administered at Iberdrola Engineering and Consultancy. Having been conducted in the previous years, they had criteria up to level 2 but criteria for level 3 and 4 were not available. In order to obtain this information, a workshop was conducted with the participant's supervisor.

Level 1:

The questionnaire usually used by the consulting firm responsible for teaching the course was employed. The participants completed the questionnaire at the end of the course.

Level 2:
One test for knowledge and another for skills (Pre and Post event). The firm designed a questionnaire and guidelines for observation to the role-playing activities.

Level 3:

A questionnaire was designed and the participants and supervisors completed the questionnaire before and 3 months after the training event. Only 3 of the supervisors responded to the questionnaire that was sent, so the study is was limited to the data provided.

Level 4:

The level 4 criterion that were selected were those that correspond to the strategic goals of the department. Index Rotation, Meeting deadlines, Profits, Internal Client Satisfaction Index. Control group methodology was used in the evaluation. Unfortunately, it was impossible to carry out the evaluation at this level.

Case Study 10: Toyota Motor Sales, U.S.A., Inc.

This impressive case study evaluates programs at all four levels plus Return on Investment (ROI). A large and respected automotive dealership group located on the East Coast identified the need to improve their service and financial performance. After an upfront analysis by the Measurement & Evaluation team (M & E) on the desired and current business results. A performance improvement solution was designed and presented to the dealer principal. The intent was to send all the service managers and assistant service managers from all 28 dealerships. The 5 week leader led immersion training program integrated process and job related improvements. The specific areas are Power of communication, ASM's in the service process, managing service workflow, consultative service selling.

Level 1:

The survey consisted of closed and open ended questions, administered by the instructor at the end of the course. A standard form was used to enable the surveys to be scanned and tabulated quickly. Students were asked to rate items using a forced-choice, six point Likert scale. Open-ended comments were compiled into a general report and analyzed for opportunities for program improvement.

Level 2:

Knowledge assessment was administered at the end of course by instructor. An Item Analysis Report was generated for each course to help monitor program effectiveness and continuous improvements.

Level 3 & Level 4:

Post training Interviews and observations. Telephone follow up with managers thirty days after training to determine if ASM's action items on their individual Action plans. Telephone interviews with each ASM 90 to 120 days after training. In-Dealership ASM observation follow up six months after training as well as in-dealership interviews with ASM's, service managers.

Level 5 - Return On Investment (ROI):

Completed by M&E team focused on improvement in labor sales pre and post study compared to the direct costs of the program. The ROI for the program was calculated to be 551.15 percent overall. Even after a 50% adjustment to allow for any external factors, the ROI for the program was 275.57 percent.

Case Study 11: Innovative Computer, Inc.

This is a case study describing the evaluation effort for a career development initiative. Evaluation results from the study showed a positive link between participants applied behaviors learned from training and desired business results. The Career Development Initiative began as a strategy to build organizational capacity and bench strength due to the ongoing challenge of retaining top management and technical talent. The evaluation purpose was to measure the business impact and cost benefit of the solution. In this case, preliminary planning was involved to define and link the business objectives through a data collection plan. With this approach, the training process had built in evaluation components. Another planning step involved examining the organizational targets set for every program to be evaluated at every level.

Level 1:

Data was collected at the end of the program and again during the Impact questionnaire. Project manager and management reaction was also collected. Overall satisfaction rating: 4.8/5. 92% reported intention to conduct development discussion with their manager within 30 days of the workshop.

Level 2:

Measured during the training through skill practices, role plays and training simulations. Skill assessments and learning exercises. Better understanding of performance priorities for the next 6-12 months: 4.48.

Level 3:
On the job behavior was measured through an Action plan. A 60 day impact questionnaire was also used to assess participant's application of the Development Discussion. 94% conducted a development discussion with their manager within 60 days. 76% apply critical skills from development discussion plan.

Level 4:

Data was collected with both Development Discussion Action Plan and the 60 day impact questionnaires. Increased productivity and increased labor efficiency. To ensure strong response, the questionnaire was administered during a 90 minute follow up session, scheduled two months after training.

Level 5 - Return On Investment (ROI):

Cost Benefit analysis and Impact questionnaire, estimates. 2 months after action plan completion and 3 months after the program. Monetary benefits from improved efficiencies and increased labor. Intangible benefits like improved relationships, confidence, adapt to change. The overall ROI calculated was 235%.

Table 3: Summary of Findings from the Kirkpatrick Model Case Studies

Kirkpatrick Model Case Studies	Levels of Evaluation				
	Level 1	Level 2	Level 3	Level 4	Level 5
Army & Air Force Exchange Services(AAFEs)	Multiple Surveys	Pre & Post Test	Online Surveys	Online Surveys	X
Canada Revenue Agency	End of Course Survey	Content Survey	Focus Groups	Focus Groups	X
Defense Acquisition University(DAU)	End of Course Survey	Pre & Post Test	Post Course Survey	ROI	ROI
Duke Energy Corporation	Reaction Sheets	X	Correlation	X	X
First Union National Bank	End of Course Survey	X	Questionnaires	Control Group	X
Caterpillar, Inc.	End of Course Survey	X	Quick Wins Score Sheet	Value Narration	X
Cisco Systems, Inc.	Survey(3 Months)	X	Observation	Factors Oriented	X
GAP, Inc.	Questionnaire	Questionnaire	Post survey	Impact Study	X
Group Iberdrola	Questionnaire	Pre & post test	Questionnaire	Control Group	X
Toyota Motor Sales, U.S.A., Inc.	Survey	Knowledge assessment	Interviews	Interviews & observations	Pre & post study of factors
Innovative Computer, Inc.	Questionnaire	Skills Assessment	Questionnaire	Questionnaire	Monetary, Intangible benefits

2.3. Review of case studies on transferring learning to behavior

The case studies presented in Section 2.2 provided us an overview of the best practices from the other industries on all levels of evaluations. In this section, we further reviewed 8 case studies on transferring learning to behavior. Focus was given to the implementation steps in transferring learning to behavior, as well as the evaluation measures and outcomes. Again, these information helped benchmark the current AJI-2 customer satisfaction process and provided reference in setting up the future state levels 4 and 5 processes for AJI-2 customer data collection, analysis and the related feedback mechanism.

Case Study 1: Toyota Quality Financial Management

The strategic challenge was that the customer satisfaction indexes in the mid 90's showed a very high dissatisfaction with the process of financial transactions. Toyota Financial Services (TFS) way of approach was from a performance improvement perspective rather than training solution perspective. They did preliminary background and research where a group of 4 associates spent 18 months researching top performance dealerships, interviews, observations, automobile Financing Corporation training facility visits.

In order for a 10-step plan to be completed and to assist the dealers, a Performance Development Manager position was established and out of the 10 steps, 4 steps are during the training intervention and 6 steps are during the transferring from learning to behavior phase.

<u>Training Intervention:</u>

1. Dealer Orientation meeting
2. Self-Assessment (the satisfactory score for the assessment is 90% for the training satisfaction)
3. Self-Study Modules
4. The University of Toyota conducted a 5 day class using state-of-the-art learning technologies, including Audience Response System (ARS)

<u>Transferring Learning to Behavior Steps:</u>

1. The Installation step involves the setup of the customer satisfaction process
2. Evaluation step- PDM observes the process, offers subsequent feedback and coaching to develop an Action Plan and prepares the Dealer Performance Report
3. Certification step where TQFM follows up with Financial Service Managers throughout
4. Advanced Seminars were conducted which are used as the continuous improvement process
5. In-Dealership Consulting (specific needs and customize strategies)
6. Performance Groups are conducted for 1 day, three times a year

<u>Measures & Outcomes:</u>

Dealer Performance Reports (which will have the information of productivity, profitability, customer satisfaction, employee retention). Evaluations by PDM following completion of each step. Reports were conducted 6 months before the installation step and continued for 12 months after the installation step. FSM monitored Customer Satisfaction Index reports are prepared on a monthly basis.

Case Study 2: Nextel Communications, Inc.

This case study outlines the strategic challenge of Nextel's evolution from numerous decentralized training teams into a results focused Human Resource Development (HRD) Department. By centralizing HRD, Nextel has realized efficiencies in the design and development process.

Training Intervention:
In 2001, Nextel's Training Council was designed to bring together training professionals to share the resources, ideas and best practices. HRD Performance Center, linking learning with the On-Job performance. To determine the effectiveness, the council undertook a robust evaluation form for use as a company standard replacing the existing smile sheets.

Transferring Learning to Behavior:
The survey collected data at all the learning levels was a paper based survey, valuable data. To make use of the data, participants post course predictions and estimations and compared them with tangible follow up results 60 days later.

Evaluation Metrics:
HRD can provide quantifiable metrics from participant's estimations that link learning to performance through the online evaluation system. Monthly balanced scorecard, courses require a job impact score of 80% or higher. With real-time evaluation data available, HRD can quickly react to an ineffective course and make immediate changes. The Level 1 evaluations are conducted monthly for measuring performance of the instructors, Instructional Systems Designers. Collaborative discussion was initiated from which they provide data collected from the post event and follow up surveys. The discussion structure includes Review evaluation forms and map course objectives of learning levels, Report review, Small group brainstorming. A plan to determine the possible barriers involved in transferring learning to behavior.

Case Study 3: Hewlett Packard

The strategic challenge is to achieve and maintain the highest levels of relevant skills and knowledge, HP services must employ a consistent, holistic worldwide approach to capability development and training. The strategic directive was to create and validate solution development capability, in order to capture emerging market for services focused on Microsoft.NET Architecture**.**

Training Intervention:
Considering lessons learned in conjunction with business parameters of the program, a live online training solution was defined. Learning sessions were held for 2 hours each day, 3 days each week for 10 weeks to address the material in 25 days of lecture lab training that was available from Microsoft. The learning solution consists of:

1. NET Advisor CD
2. Pre course & Post course knowledge assessments
3. Microsoft office curriculum
4. Online interactive lab exercises
5. Mentoring
6. Online technical publications
7. Practice exams for certification
8. Unlimited session playback capabilities

Transferring learning to behavior started with coaching, observation by the management where they used CERTrak- Certification Tracking Database on a monthly progress. Feedback was done at Level 1, revenue performance of the program, customer satisfaction. Knowledge Transfer was done through a live online exam in which 75% trainees are certified till date.

Outcomes:
Average hourly billable rate and utilization, Average travel, lodging and meal costs, tuition costs. Average class size, number of students and classes per year, inflation over a 2 year period. The online learning solution saved over $9000/student over traditional training. The training resulted in average 5% increase in billable time/week, the organization realized a payback on the investment in less than 5.5 weeks. Reduction in turnover.

Case Study 4: Ingersoll-Rand, Von Duprin Division

Executives at Von Duprin, recently decided that they would initiate Pathway to Excellence (PTE) that drives world class performance. The strategic challenge outlined here is to see how an individual trains, coaches, and leads her industrial associates to implement the PTE process. Minh used the PTE process concepts of “working with strength” and the training methodology of “Teaching, showing, coaching, monitoring and signing off”.

Training Intervention:
The goal was to change the Trim assembly process from batch manufacturing to a flow process. In 10 months, the Trim department quickly transformed its assembly process from 10 individually operated assembly cells to 3 mixed model flow lines. As a result of quick changes, the material and equipment became disorganized, there was definite need to improve the workplace organization (WPO). It was done through 5S methodology. The steps involved in this process where they used PTE issue boards, a tool structured to empower employees. WPO WAR (With All Resources) was declared wherein 100% involvement of people to solve the

task. On the first day of WPO WAR, communicated expectations, trained members on 5S process and taught them the tools they would use for creating and managing a formal action list. Associates assessed the production line with their own goals for improvement. Formal spreadsheet documents, in the Action list the initial step was to record the problems in the area (46 problems) and they captured them by Digital pictures. Minh supported the team by removing barriers, resolving concerns, resource availability. After the 5 day WPO WAR, the industrial associates continued to self-manage the action list.

Outcomes:
Required production floor space reduced by 1120 sq.ft (4355 to 3235 sq.ft). Production rate increased by 50/shift (800 to 850). Department staffing decreased by one (21 to 20).

Case Study 5: First Indiana Bank

The strategic challenge came from the objective to provide internal partners with accurate, timely and efficient service so that the sales associates can serve external customers.

Training Intervention:
Interview data was obtained from Dave and one of his team leads, Kelly Trips. Dave's first task was to assess how well his area measured and reported key data. Balanced scorecards were used monthly to assess the department by which most of the internal quality measures came in 99.9% satisfactory. Dave & Kelly knew that the accuracy in errors was there and turn-around times for returning phone calls to customers were not perfect. Dave started encouraging Kelly to take the Kirkpatrick's Balanced Scorecard classes. He expects each of the individuals to initiate self-development projects (SDP's). He became a coach on and off the job which helped the employees and the organization. Dave gave clear expectations of the outcomes to Kelly. There were weekly meetings with Kelly to discuss the project milestones. Dave allowed the team to be creative and let them run with new ideas. Constant follow up, Motivate and involve our entire team in planning was the main idea. Monthly balanced scorecard were discussed in their monthly meetings to demonstrate its importance in the process.

Outcomes:
Commercial Operations now has improved, more relevant customer Impact Errors on their scorecard. Pattern recognition and easy correction of the errors. Improved service led to a significant increase in Quarter 2-2004, customer loyalty and sales. Improved morale, stronger bench strength, and teamwork and relationships with internal partners. Skills development in presentation and project management.

Case Study 6: Indiana Public Defender Council

The strategic challenge was that IPDC has conducted more than 100 Continuing Legal Education credits (CLE) programs, specifically, 1 day seminars and 4 day workshops. After the training event, participants intend to apply all the principles they have learned, but day to day

demands cause them to lose the focus and momentum needed to sustain change. There were two critical factors for practical application where one was Knowledge gained deteriorates dramatically within a few days, the other being an environment that does not support new behaviors drives people back to old ways of working.

Training Intervention:
The mission of the IPDC is to improve the quality of indigent defense in Indiana. Since 1976, they have been working to improve lawyer competence. Two years ago, IPDC designed a professional development program for public defender with the objectives to increase the effectiveness and performance capability of public defenders, Encourage public defenders to be responsible for their professional development. It was a 16 week coaching program conducted by IPDC.

Why this approach?
It was an Experimental training in work environment with increased commitment to professional development when involved in the design of their learning experiences. The lawyer and the coach can identify performance barriers, customize developmental plans and apply new behaviors in cases. The personalized approach helps to integrate core knowledge, skills and abilities into the lawyer's individual style. There was periodic consultation and support.

Summary of program features:
The Sponsoring Agency for the program was IPDC approved CLE sponsor. Trainees were trained free of charge. The trainers for the program were Independent contractors, criminal defense lawyers with teaching experience. Adult Learning principles were taught 16 weeks requiring a minimum of 2 hours per week. There was a requirement to enroll. The evaluation process was done through focus groups with trainees, curriculum review with trainers, trainers prepare written progress reports, and OJT behavior was also assessed. Written materials were given as references, checklists to trainees on the progress.

Case Study 7: Nicco Internet Ventures Ltd

The strategic challenge was to hire the Consultants for search & selection(S&S) line of business, they were hired from small, medium and large firms over 3 years. Even with specialization in HR, they had no or little experience in negotiating with clients. The S&S industry, primarily proprietorship firms work within a narrow band of professional charges usually from 8.33-12.5%. The consultants were working in a stereotyped manner. This analysis indicated a knowledge skill attitude issue that could effectively remedied through training.

Training Intervention:
The major business problem was the falling margins owing to the inability of the consultants to get the clients to agree to rates. Negotiating objectives was the problem and they came up with the initiative to plan, prepare & execute a strategy for emerging gains and minor losses. For the

level 1, a summative evaluation was done, level 2 assessment was done through pre and post assessment tests. The training would be considered achieved only if the consultants were able to negotiate better deals from the clients.

Transferring Learning to Behavior:
Two basic mechanisms were used to ensure training translated into a sustained and consistent deployment of KSA (knowledge, attitude & skills) which was Reward reinforcement & Task reinforcement. Beyond level 2, the source of information in this case was debriefing sessions held with the consultants by their managers after a negotiating session. The key drivers to success were Strategic perspective, Alignment of priorities, Ownership & commitment, Strong line of sight, Management actions.

Case Study 8: ABN AMRO Bank

The strategic challenge was to build capability in the wholesale banking operations using business driven action learning. The main focus of this case study is how ABN AMRO is encouraging strategic innovation, value creation, market differentiation. It was achieved through a change management program called Building capability. The strategic imperative for the wholesale bank is to be in the top 5 wrt a chosen peer group when, measured against total shareholder return (TSR). Capitalize on an extensive global network of ABN staff in 60 countries to build leading edge business capability. In 2000, ABN adopted its own Value based management and the managing for value was introduced. MfV identifies the true drivers of profitability at all levels in the organization. After including the business driven action learning element, it took a form of business improvement project.

Training Intervention:
Building Capability 1 is related to MfV, competition and markets, creating value, strategy implementation. Building Capability-2 is related to MfV, global business, client orientation. The participants for the program are Vice-President's & Senior Vice-President's. The content summary of BC1 & BC2 is that a significant volume of material is delivered interactively through the workshops and case studies and linking the content to projects and case studies. The transferring learning to behavior was done through Business Improvement Projects, Messages to Management, Website, Sponsoring managers.

Outcomes:
Networking around projects and messages. The examples of Business Improvement Projects are focus on central Europe- global strategy, cross selling treasury products, linking service and products in China, improving market risk approval process for business in India. Examples of Messages to Management are the extended Brazilian operating model to other countries, management empowerment, creating client value, globalizing MIS.

2.4. Phone Interviews

Throughout the course of the study, we conducted numerous phone interviews with our technical monitor, Mr. Anthony Murray, to gather information, update progress, validate results and coordinate with other key stakeholders in the AJI-2 customer satisfaction process.

We also conducted a phone interview with AMA-20 manager, Mr. Valdrie Buford, on July 14, 2017 to gather information related to the current academy evaluation process. A list of interview questions was emailed to AMA-20 prior to the phone interview. These questions include the training course types, delivery methods, levels 1-5 data collection and analysis methods, metrics used for evaluation, how the Academy Evaluation System (AES) works, what is the trigger for actions in the evaluation process, etc.

A written response from AMA-20 to those questions was provided before the phone interview. During the phone interview, further explanations and clarifications on the written responses to the questions were provided. The list of interview questions are listed in Appendix I. Additionally, a list of questions about level 4 and level 5 evaluations, shown in Appendix II, was provided to our technical monitor, who provided feedbacks to us via our phone interviews.

2.5. On-site Interviews

As an outcome from the phone interview with AMA-20 manger, an on-site visit and interview with AMA-20 was made on August 24, 2017. A list of interview questions and requested information for the on-site interview was provided to AMA-20 prior to the visit. These on-site interview questions are listed in Appendix III. During the on-site interview, a demonstration of the AES on how it is used to collect and analyze level 1 and level 3 data, was made. A detailed walk-through of the EOC (level 1) and PC (level 3) surveys in terms of the survey questions, survey data review process, performance metric (favorability percentage), the feedback mechanism, and the corresponding AES workflows, was also provided. It was also agreed that AMA-20 would prepare and provide 3-year worth of AES data for us to explore the potential use of advanced analytical techniques in these data.

2.6. Academy Evaluation System (AES) Data Mining

A 3-year worth of historical data during the period of 2014-2017 was provided by AMA-20. The data were obtained from the AES for both EOC surveys and PC surveys, which include quantitative answers to the survey questions, and the individual surveyee's comments. The following Table 4 lists the survey questions. Specifically, questions 1-14 are for the EOC survey; questions 29, 30, 33, 35, 36 are for the PC survey's student portion, and questions 31, 32, 34, 37, 38, 39 are for the PC survey's supervisor portion.

The answers to each survey question is rated on a scale from 1 to 7. The detail is provided in Table 5. In addition to the quantitative data, qualitative data in form of comments are also

included in the data set. The comment categories are shown in Table 6. The analysis approaches and results of these data will be presented in Section 3.6.

Table 4: List of Questions in EOC and PC Surveys

QUESTION_ID	QUESTION	TYPE	SUBTYPE
1	The instructor(s) was knowledgeable about the subject.	EOC	RES
2	The instructor(s) presented the material in an understandable way.	EOC	RES
3	The instructor(s) was approachable and helpful.	EOC	RES
4	The objectives were clearly presented for each lesson.	EOC	RES
5	The course materials were up-to-date.	EOC	RES
6	The course materials were understandable.	EOC	RES
7	The learning environment was free from distractions.	EOC	RES
8	The course provided training in an area important to my job.	EOC	RES
9	The course was appropriately paced.	EOC	RES
10	The course was organized to support understanding and learning.	EOC	RES
11	The labs/workshops supported the lectures and increased my understanding and learning.	EOC	RES
12	The written assessments reflected the course material presented.	EOC	RES
13	The skill performance evaluation(s) assessed my proficiency level.	EOC	RES
14	Overall this training was highly effective.	EOC	RES
29	The course has improved my knowledge and skills needed to perform my job.	PC	Student
30	I am applying the knowledge and skills I learned in this course.	PC	Student
33	The training has improved my job performance.	PC	Student
35	The training was worth the time and energy I invested.	PC	Student
36	Overall, how satisfied were you with this course?	PC	Student
31	The course has improved the job-related knowledge and skills my employee needed.	PC	Supervisor
32	My employee is applying the knowledge and skills learned in this course.	PC	Supervisor
34	The training has improved my employee's job performance.	PC	Supervisor
37	The training was worth the time and energy that my employee invested.	PC	Supervisor
38	For my department, the training was worth the cost of employee leave time and tuition.	PC	Supervisor
39	Overall, how satisfied were you with this course?	PC	Supervisor

Table 5: Survey Question Rating Scales

ANSWER ID	ANSWER
1	Strongly Agree
2	Agree
3	Somewhat Agree
4	Somewhat Diagree
5	Diagree
6	Strongly Diagree
7	Not Applicable

Table 6: Survey Comment Categories

COMMENT_CATEGORY	LABEL
Additional	Additional Comments. (Please categorize your comment)
Complaint	
Compliment	
Disagreement	Comment on negative choices
General	General comment
Instructor	Effectiveness of Instructors: Please describe effectiveness and impact instructor(s) made toward your learning experience.
NoNeedtoTrain	Please explain why you/your employee didn't need this training for the present job.
Other	
OverallCourse	Please provide comments relating to the overall content, material organization, labs etc.
Statement	Comment on a question/statement
Suggestion	
Training	List any training you feel should be added to/deleted from this course

3. Study Findings

3.1. AJI-2 Current State Customer Satisfaction Process Mapping

Based on the information obtained through literature review, phone interviews, and on-site interviews, an overview current state AJI-2 customer satisfaction process map is constructed. Figure 3 below depicts the current workflows across multiple functional units.

The technical training process starts with AJI-2 approving and releasing funding to national and FAA Academy-delivered training courses. Once the training requirements and curriculum are identified by AJI-2, FAA Academy develops the course schedule as well as staffing plan, collaboratively with AJI-2. AJI-2 also oversees the identification for national level training for the fields. FAA academy delivers the training through its Technical Operations Division (AMA-400) and Air Traffic Division (AMA-500). If a trainee fails the evaluation/testing, training is terminated. Otherwise, the EOC survey is distributed through Academy Evaluation System (AES) immediately after the training course is completed. 3 months after the training, PC survey is distributed through AES to the trainees and their supervisors.

AMA-20 is the centralized unit overseeing the evaluation process for academy delivered training courses. For EOC survey (level 1 evaluation) and PC survey (level 3 evaluation), there are certain timeframes established for the review process. We will discuss in detail about the levels of evaluation in the coming subsections. As the evaluation and review process is done, if the favorability percentage for a training course is more than 95% the course is satisfactory. If the course favorability percentage is less than 95% and/or there are negative comments, it triggers actions for continuous improvement.

The Academy currently does not have a process in place for collecting and analyzing Levels 2, 4 and 5 data. Details will be discussed in the upcoming subsections.

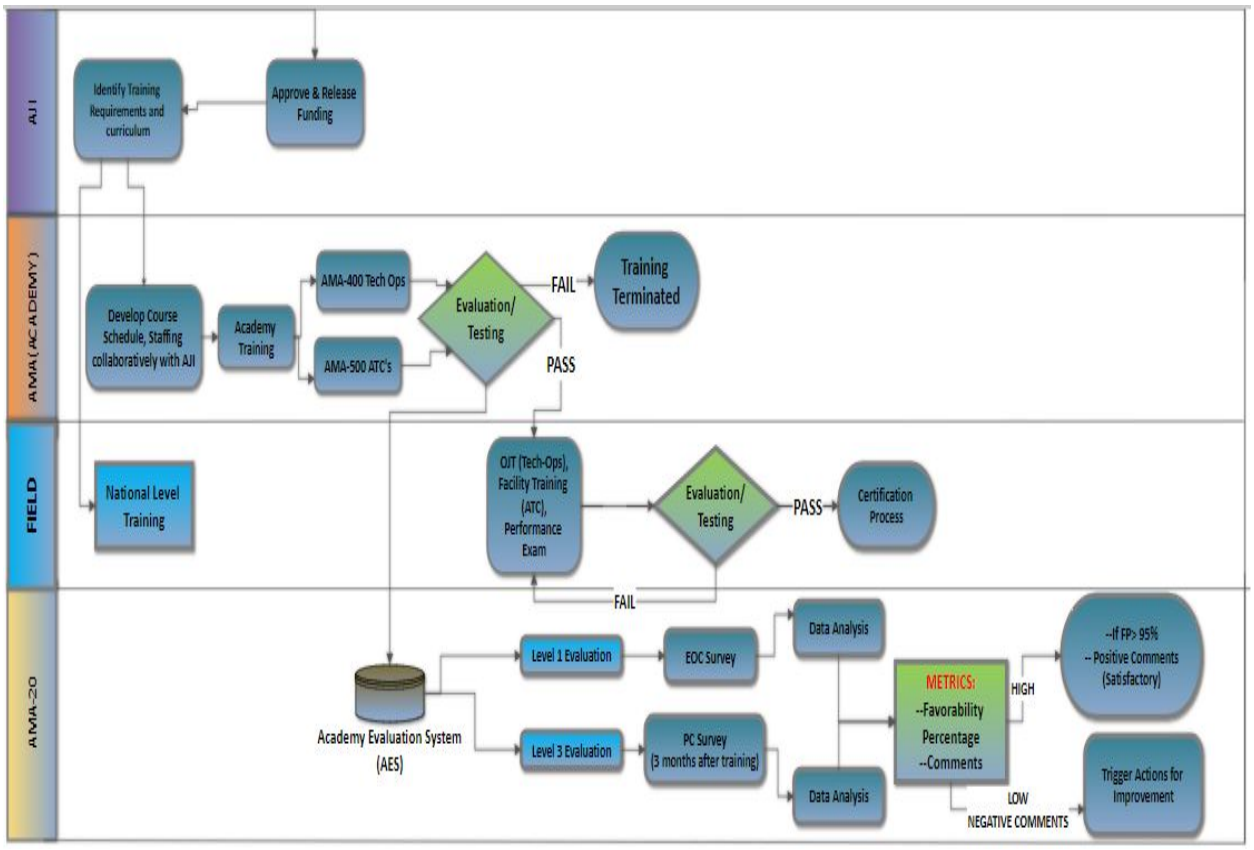


Figure 3: AJI-2 Current State Customer Satisfaction Process Map – Overview

3.1.1. Level 1 Evaluation Process

The Level 1 evaluation at the Academy is conducted after the training is completed at the end of the course for the instructor led training. It is administered online and it is a standard survey consisting of 14 questions and evaluates various categories of the training and the survey is sent out to the trainees through the Academy Evaluation System (AES), which is the academy's self - developed system for training evaluation.

After the survey is completed, the favorability percentage is calculated by AES and used primarily to determine the overall success of the course offering. Individual EOC critiques are reviewed manually by the review team. The course coordinators/instructors has 14 days to review and comment the survey critiques, and then AMA managers have 30 days to review and comment the results. If the favorability percentage is less than 95%, it triggers actions for further investigation and interventions if necessary. Figure 4 illustrates the Level 1 evaluation process map.

Overall, the Level 1 evaluation through the EOC survey via AES is a well-established and efficient process. The use of a standard survey for all instructor led training courses plus the

option for individual comments provide both quantitative and qualitative evaluations of the customer (trainee)'s satisfaction.

For non-instructor led courses, such as self paced online delivered courses via eLMS/eLearning, different level 1 evaluation survey is used and may not be integrated to AES.

It was also observed that review timelines (14 days for course coordinators/instructors and 30 days for AMA managers) are available for completing evaluations and are automatically tracked by AES, however, the actual compliance is not tracked and enforced.

Currently, favorability percentage is the sole quantitative performance metric for assessment. A detailed study on the favorability percentage is presented in section 3.1.6.

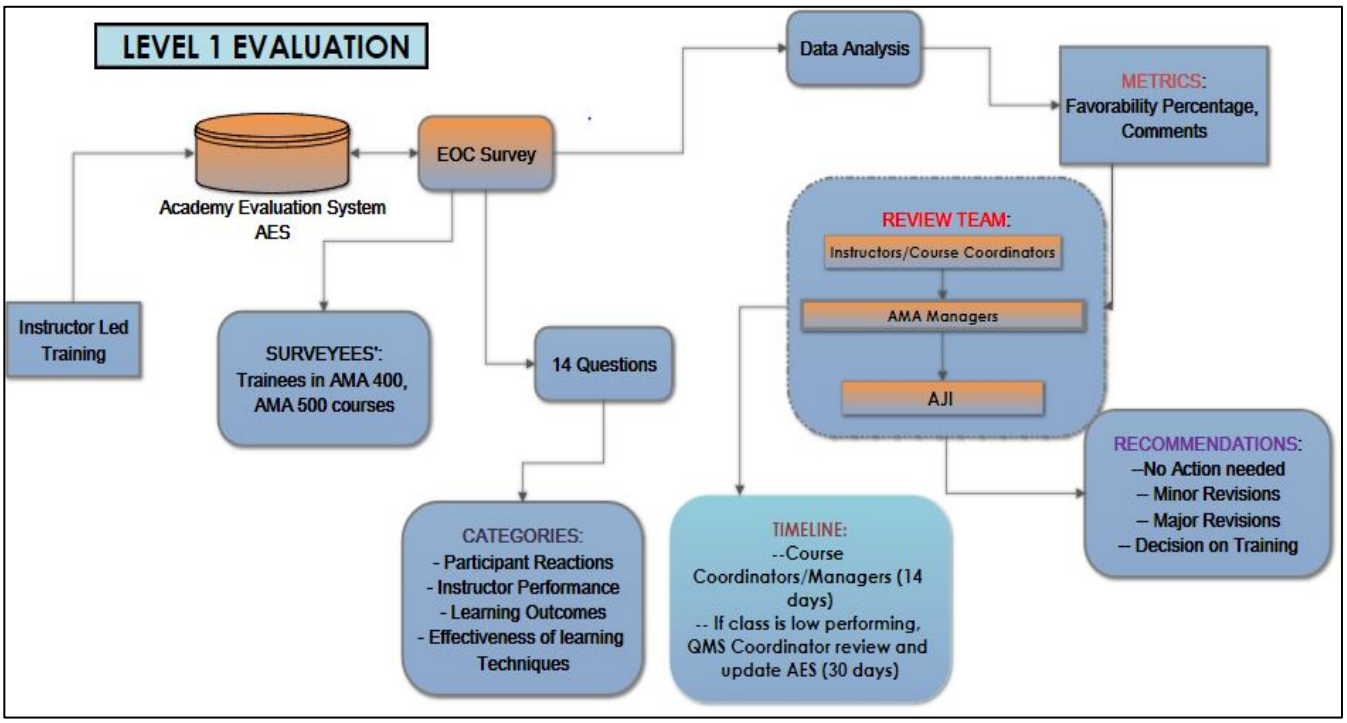


Figure 4: Level 1 Evaluation Process Map

3.1.2. Level 2 Evaluation Process

Currently, the Academy does not have a process for collecting and analyzing Level 2 data. The divisions within the Academy use objectives and develop tests/activities to determine if learning occurred in course offerings, but there is no centralized process to collect and analyze Level 2 data.

3.1.3. Level 3 Evaluation Process

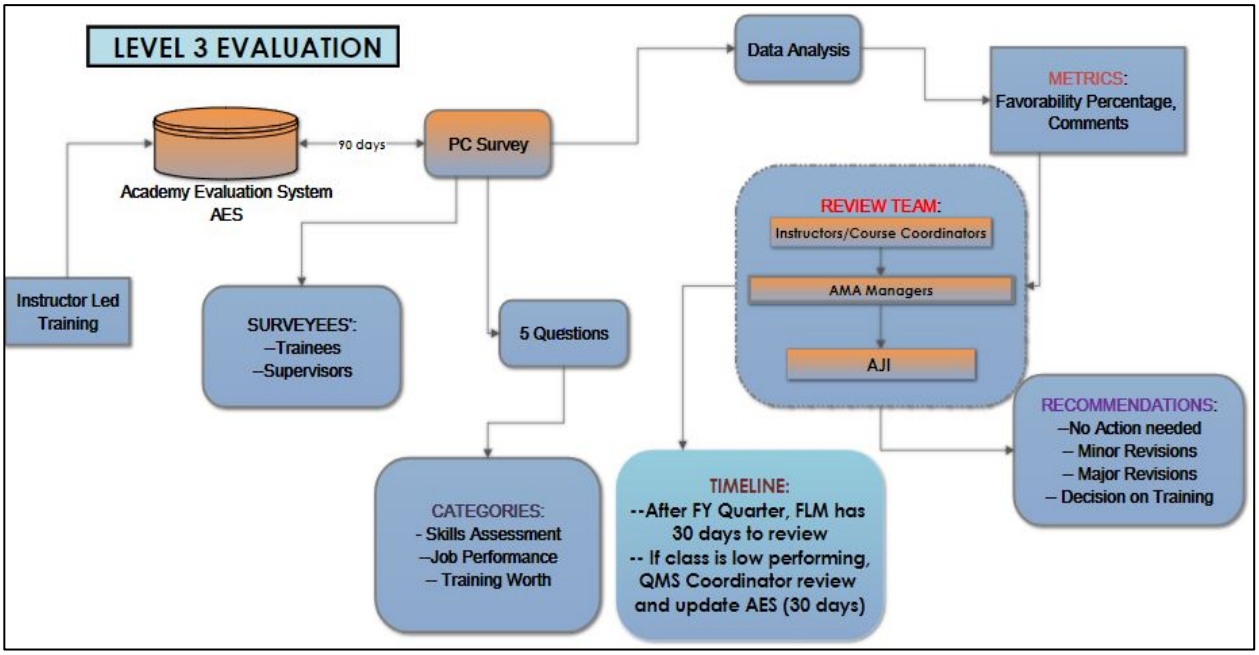


Figure 5: Level 3 Evaluation Process Map

The Level 3 evaluation at the academy are conducted after the training is completed 90 days after the course for the instructor led training. It is administered online and it is a standard survey consisting of 5 questions for the student survey, 6 questions for the supervisor survey and evaluates various categories of the training, job performance. The survey is sent out to the trainees and their immediate supervisors through the Academy Evaluation System (AES) which is the academy's self - developed system for training evaluation.

After the survey is completed, the favorability percentage is calculated by AES and used primarily to determine the overall success of the course offering. Individual PC critiques are reviewed manually by the review team. The course coordinators/instructors has 30 days to review and comment the survey critiques, and then AMA managers have 30 days to review and comment the results. If the favorability percentage is less than 95%, it triggers actions for further investigation and interventions if necessary. Figure 5 illustrates the Level 3 evaluation process map.

Overall, the Level 3 evaluation through the PC survey via AES is a well-established and efficient process. The use of a standard survey for all instructor led training courses plus the option for individual comments provide both quantitative and qualitative evaluations of the trainee and trainee's supervisor satisfaction.

For non-instructor led courses, such as self paced online delivered courses via eLMS/eLearning, level 3 PC survey is not distributed via AES.

It was also observed that review timelines (30 days for course coordinators/instructors and 30 days for AMA managers) are available for completing evaluations and are automatically tracked by AES, however, the actual compliance is not tracked and enforced.

Currently, favorability percentage is the sole quantitative performance metric for assessment. A detailed study on the favorability percentage is presented in section 3.1.6.

3.1.4. Level 4 Evaluation Process

Currently, the Academy does not have a process in place to provide Level 4 evaluation.

3.1.5. Level 5 Evaluation Process

Currently, the Academy does not have a process in place to provide Level 5 evaluation.

3.2. AES Data Analytical Results

In this section, we presented our data analytical results to investigate the feasibility of using an alternative metric instead of the favorability percentage and using advanced analytics to interpret the Level 1 and Level 3 survey data.

3.2.1. Alternative Metric to Favorability Percentage

The Favorability Percentage is the sole quantitative metric used for evaluating the overall performance of the training courses. The formula for Favorability Percentage calculation is shown below. The Not Applicable answer category was not included in the formula.

$$\left(\frac{(\text{Somewhat Agree} + \text{Agree} + \text{Strongly Agree})}{\left(\begin{array}{l}\text{Somewhat Agree}\\ + \text{Agree}\\ + \text{Strongly Agree}\\ + (\text{Somewhat Disagree} + \text{Disagree} + \text{Strongly Disagree})\end{array}\right)}\right) \cdot 100$$

Based on this formula, if a surveyee is “Somewhat Agree”, “Agree” or “Strongly Agree”, they are all treated as “Favorable” answers. Mathematically, there is no different among these

answers, as they contribute to the overall Favorability Percentage with equal weight. Likewise, if a surveyee is “Somewhat Disagree”, “Disagree” or “Strongly Disagree”, they are all treated as “Unfavorable” answers and contribute equally to the overall Favorability Percentage. In summary, Favorability Percentage lacks the ability to differentiate the degrees of surveyee’s satisfaction levels.

As an alternative metric, the Average Weighted Score (AWS) is widely used in survey analysis. Average Weighted Score (AWS) is calculated using the following formula. The Not Applicable answer category was not included in the formula.

$$\frac{\left(\begin{array}{l}\text{Col Stored Value}(\textit{Strongly Disagree}) * 1 \\ + \text{Col Stored Value}(\textit{Disagree}) * 2 \\ + \text{Col Stored Value}(\textit{Somewhat Disagree}) * 3 \\ + \text{Col Stored Value}(\textit{Somewhat Agree}) * 4 \\ + \text{Col Stored Value}(\textit{Agree}) * 5 \\ + \text{Col Stored Value}(\textit{Strongly Agree}) * 6\end{array}\right)}{\textit{TOTAL RATINGS}}$$

We compared the performance of using Favorability Percentage and Average Weighted Score on the AES data that was provided by AMA-20. First, we chose course 50046, class 92018, to compare the Favorability Percentage and Average Weighted Score on each EOC question. As we can see, question 1, 2, 4, and 6 all have 100% Favorability Percentage, however, their Average Weighted Score ranges from 5.5-5.8 (with 6 being the highest possible score). It is because the distribution of the counts in different ratings.

	CLASS NBR	QUESTIONS	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	Not Applicable	TOTAL RATINGS	FAVORABILITY PERCENTAGE	Average Weighte...
1	92018	QUESTION 1	14	3	0	0	0	0	0	17	100	5.8
2	92018	QUESTION 2	11	6	1	0	0	0	0	18	100	5.6
3	92018	QUESTION 3	13	3	1	1	0	0	0	18	94.44	5.6
4	92018	QUESTION 4	12	5	1	0	0	0	0	18	100	5.6
5	92018	QUESTION 5	9	6	1	0	1	1	0	18	88.89	5.1
6	92018	QUESTION 6	10	7	1	0	0	0	0	18	100	5.5
7	92018	QUESTION 7	6	3	5	1	3	0	0	18	77.78	4.4
8	92018	QUESTION 8	12	4	1	1	0	0	0	18	94.44	5.5
9	92018	QUESTION 9	6	1	5	2	1	3	0	18	66.67	4
10	92018	QUESTION 10	7	8	2	1	0	0	0	18	94.44	5.2
11	92018	QUESTION 11	8	7	1	0	1	0	0	17	94.12	5.2
12	92018	QUESTION 12	7	7	1	0	1	0	2	18	93.75	4.6
13	92018	QUESTION 13	7	5	3	1	0	1	1	18	88.24	4.6
14	92018	QUESTION 14	7	7	3	1	0	0	0	18	94.44	5.1

Figure 6: Comparison of Favorability Percentage and Average Weighted Score on course 50046, class 92018 EOC data

We also compared the top 10 classes for EOC survey during the period of 2014-2017 in terms of Favorability Percentage and Average Weighted Score respectively in Figure 7 and Figure 8. As a result, the ranking of the top 10 classes is different using these two approaches.

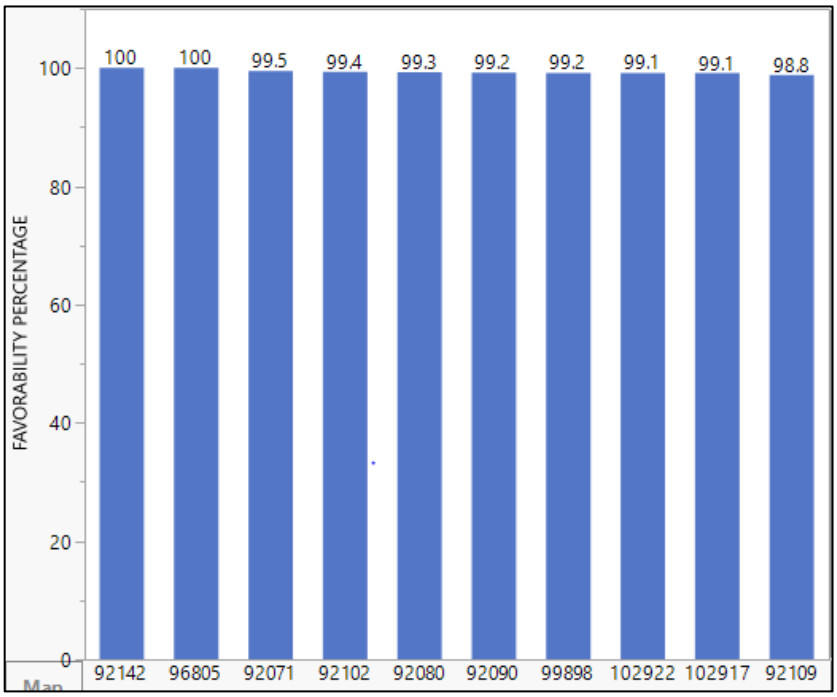


Figure 7: Top 10 Classes by Favorability Percentage (for EOC survey)

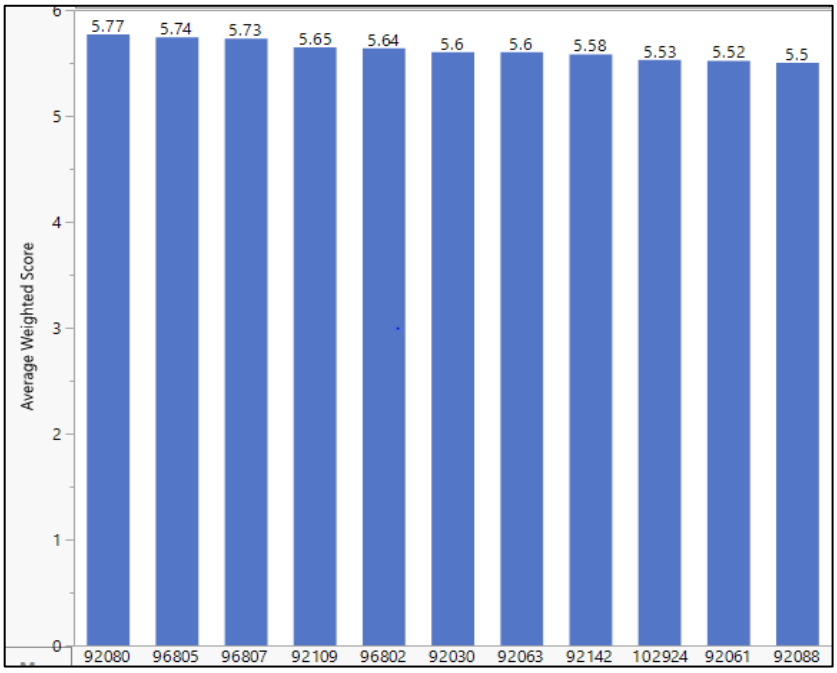


Figure 8: Top 10 Classes by Average Weighted Score (for EOC survey)

Furthermore, we compared the Favorability Percentages and Average Weighted Scores for selected courses in year 2016 (for EOC evaluations). The result is shown below in Figure 9: class 99898 has an Favorability Percentage of 99.2 but has an Average Weighted Score of 5.2, but the classes with lower Favorability Percentage has higher Average Weighted Scores than class 99898.

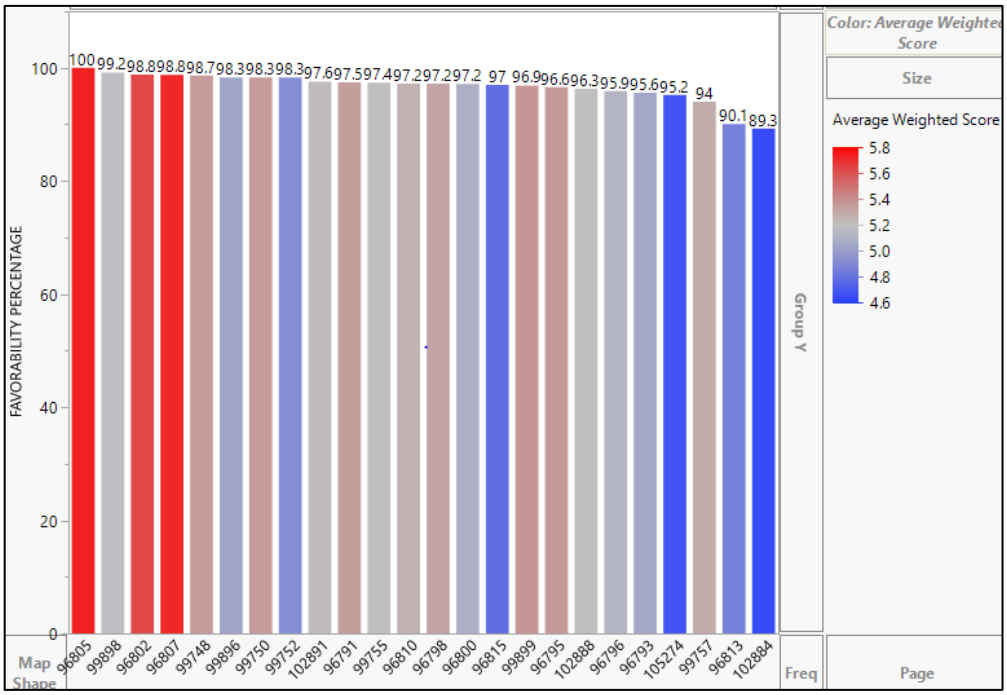


Figure 9: Comparison of Favorability Percentage and Average Weighted Score on selected courses in 2016 (for EOC survey)

Based on the these comparisons, we can see that the alternative metric "Average Weighted Score" is able to differentiate the degree of surveyee's satisfaction level on the survey questions, and consequently is able to provide more insightful information on the course evaluations and customer satisfaction.

3.2.2. Advanced Analytical Results

In this section, we present our advanced analytical results, including Correlation Analysis, Contingency Analysis, Logistic Regression Model, Clustering Analysis, on the End of Course survey (EOC) data (level 1) and Post Course (PC) survey data (level 3) as well as the sentiment analysis result using text mining approach on the survey comments.

3.2.2.1. Correlation Analysis

Correlation Analysis is used to check the correlation between two variables. In our case, we conducted correlation analysis between the individual questions (Questions 1-13) with Question 14 (the overall satisfaction "Overall this training was highly effective") in the EOC survey. This analysis helps us understand the relationship between each aspect of the surveyed questions (for example, the knowledge of the instructor on the subject, the learning environment, the pace of the course, etc.) with the overall satisfaction of the trainees. The results could shed lights on the direction of continuous improvement efforts.

As an example, the following Figure 10 shows the scatterplot and fitted correlation model for Question 14 /Variable Y versus Question 1/Variable X (The instructor(s) was knowledgeable about the subject). The regression equation is Y = 1.68+ 0.5723*X, R-Square= 0.097, this explains that for every increase in 1 unit of X there is an increase of 0.5723 in Y and the value of 0.097 represents that 9.7 percent variations of Y are explained with this linear fit.

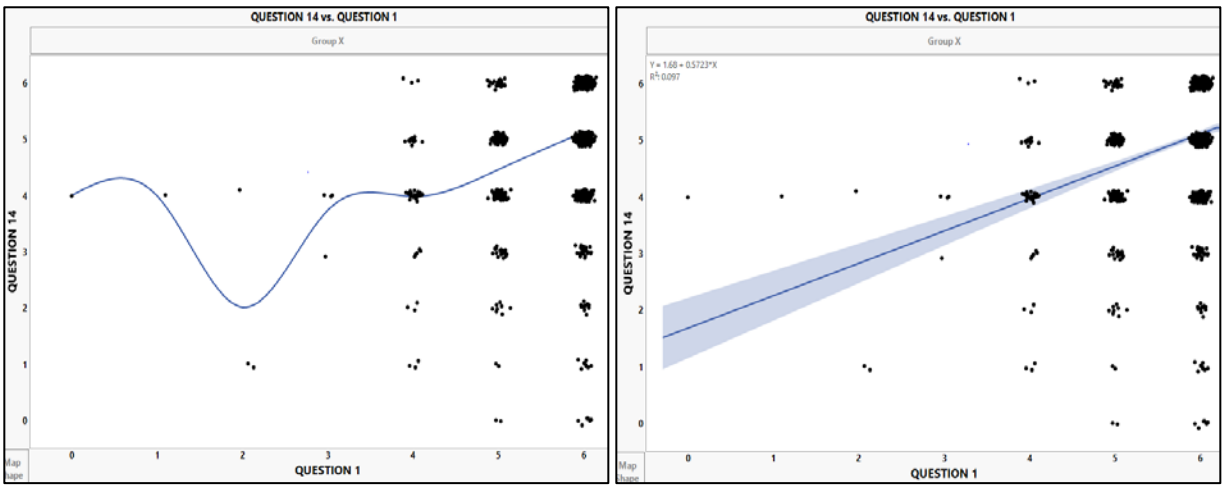


Figure 10: Correlation Analysis between Question 14 and Question 1

The rest of the correlation scatterplots and correlation models for EOC survey are included in Appendix IV. Table 7 below is a summary of the correlation analysis results. Neither questions 1-13 has a high R-square value, indicating there is no strong linear correlation between the overall satisfaction (question 14) and a single question. This result does not mean there exists no strong correlation between question 14 and questions 1-13 as the overall satisfaction is likely the outcome of joint effects from multiple questions. The slope does tell us the relative correlation level of each question with question 14. Question 8 has the highest slope value of 0.745, question 6 with 0.7077 and question 10 with 0.6894.

Table 7: Summary of the Correlation Analysis (Question 14 versus the other questions 1-13)

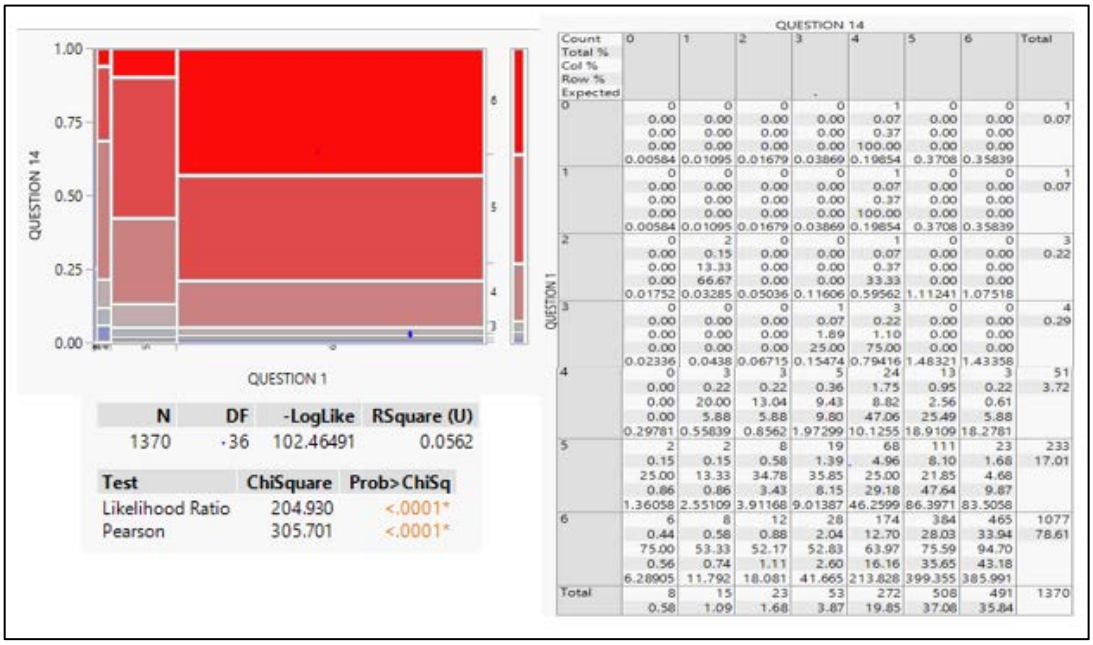
Question ID	R-Square Value	Slope
1	0.097	0.5723
2	0.111	0.4601
3	0.089	0.4339
4	0.171	0.5472
5	0.184	0.453
6	0.272	0.7077
7	0.146	0.3965
8	0.305	0.745
9	0.267	0.424
10	0.344	0.6894
11	0.299	0.6029
12	0.077	0.1696
13	0.246	0.4055

3.2.2.2. Contingency Analysis

Contingency Analysis is a type of association analysis which is used to understand the distribution of one variable to another variable. In our case, we conducted Contingency Analysis to analyze the responses the trainees are choosing for every question compared to the overall satisfaction of the course. This helps us understand a trend between the response trainees tend to choose for each question (questions 1-13 in the EOC survey) and what is the prediction of response the trainees might choose for the overall satisfaction (question 14 in the EOC survey).

As an example, the following Figure 11 shows the contingency analysis result between question 14 and question 1. The null hypothesis is that the variables (Questions 1 & 14) are independent. The test compares the observed data to a model that distributes the data according to the expectation that the variables are independent. Wherever the observed data doesn't fit the model, the likelihood that the variables are dependent becomes stronger, thus proving the null hypothesis incorrect and explains that the variables (Questions 1 & 14) are dependent.

The rest of the contingency analysis results for EOC survey are included in Appendix V. Table 8 below is a summary of the contingency analysis results. We can observe in the analysis that questions 8, 9, 10, 11, 13 have higher likelihood ratios and it explains that they have stronger association with question 14. In other words, when a trainee is satisfied with questions 8, 9, 10, 11, 13, he or she is predicted also to be satisfied with question 14.



N	DF	-LogLike	RSquare (U)
1370	36	102.46491	0.0562

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	204.930	<.0001*
Pearson	305.701	<.0001*

QUESTION 1 \ QUESTION 14 (Count / Total % / Col % / Row % / Expected)	0	1	2	3	4	5	6	Total
0	0 0.00 0.00 0.00 0.00584	0 0.00 0.00 0.00 0.01095	0 0.00 0.00 0.00 0.01679	0 0.00 0.00 0.00 0.03869	1 0.07 0.37 100.00 0.19854	0 0.00 0.00 0.00 0.3708	0 0.00 0.00 0.00 0.35839	1 0.07
1	0 0.00 0.00 0.00 0.00584	0 0.00 0.00 0.00 0.01095	0 0.00 0.00 0.00 0.01679	0 0.00 0.00 0.00 0.03869	1 0.07 0.37 100.00 0.19854	0 0.00 0.00 0.00 0.3708	0 0.00 0.00 0.00 0.35839	1 0.07
2	0 0.00 0.00 0.00 0.01752	2 0.15 13.33 66.67 0.03285	0 0.00 0.00 0.00 0.05036	0 0.00 0.00 0.00 0.11606	1 0.07 0.37 33.33 0.59562	0 0.00 0.00 0.00 1.11241	0 0.00 0.00 0.00 1.07518	3 0.22
3	0 0.00 0.00 0.00 0.02336	0 0.00 0.00 0.00 0.0438	0 0.00 0.00 0.00 0.06715	1 0.07 1.89 25.00 0.15474	3 0.22 1.10 75.00 0.79416	0 0.00 0.00 0.00 1.48321	0 0.00 0.00 0.00 1.43358	4 0.29
4	0 0.00 0.00 0.00 0.29781	3 0.22 20.00 5.88 0.55839	3 0.22 13.04 5.88 0.8562	5 0.36 9.43 9.80 1.97299	24 1.75 8.82 47.06 10.1255	13 0.95 2.56 25.49 18.9109	3 0.22 0.61 5.88 18.2781	51 3.72
5	2 0.15 25.00 0.86 1.36058	2 0.15 13.33 0.86 2.55109	8 0.58 34.78 3.43 3.91168	19 1.39 35.85 8.15 9.01387	68 4.96 25.00 29.18 46.2599	111 8.10 21.85 47.64 86.3971	23 1.68 4.68 9.87 83.5058	233 17.01
6	6 0.44 75.00 0.56 6.28905	8 0.58 53.33 0.74 11.792	12 0.88 52.17 1.11 18.081	28 2.04 52.83 2.60 41.665	174 12.70 63.97 16.16 213.828	384 28.03 75.59 35.65 399.355	465 33.94 94.70 43.18 385.991	1077 78.61
Total	8 0.58	15 1.09	23 1.68	53 3.87	272 19.85	508 37.08	491 35.84	1370

Figure 11: Question 14 vs Question 1 Contingency Analysis

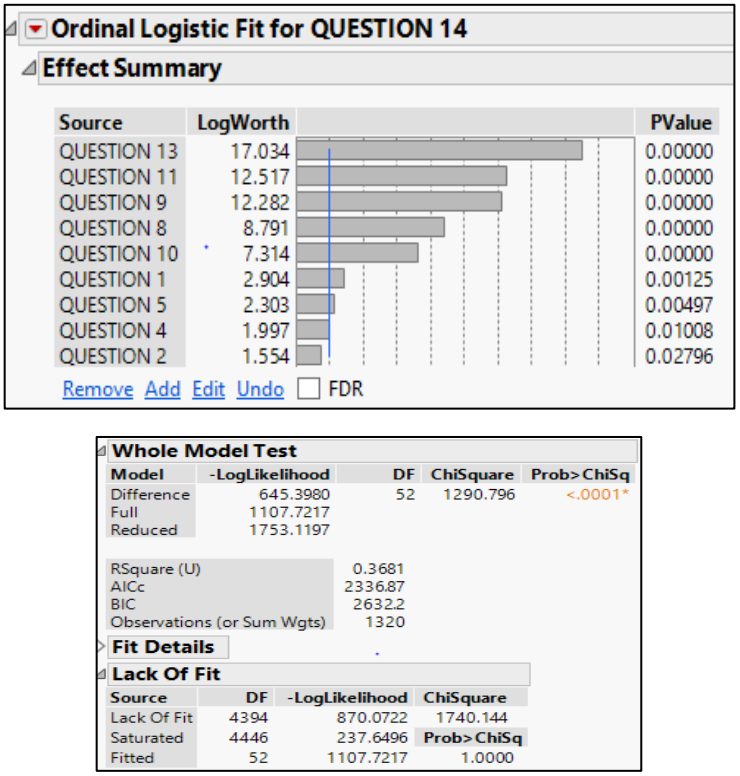
Table 8: Summary of the Contingency Analysis (Question 14 versus the other questions 1-13)

Question ID	R-Square Value	Likelihood Ratio
1	0.0562	204.930
2	0.0930	339.518
3	0.0693	252.866
4	0.1082	394.227
5	0.1129	411.115
6	0.1657	599.232
7	0.1268	459.029
8	0.1709	618.362
9	0.2028	734.029
10	0.2300	831.590
11	0.2119	768.182
12	0.1561	567.412
13	0.2165	788.060

3.2.2.3. Logistic Regression Model

Logistic regression is a predictive analysis. It is used to describe data and to explain the relationship between one dependent categorical variable and other independent variables. In our case, we developed a logistic regression model to predict how the questions 1-13 contribute to the trainee's overall satisfaction (question 14). Specifically, questions 8, 9,10,11,13 are most significant in prediction of the responses of the overall satisfaction question 14, as shown in the following Figure 12. Once the model is run, we can see that the questions 3, 6, 7, 12 are not significant in relation with the question 14. This model could help us test various scenarios as

we improve the various aspects of the surveyed questions, how much overall satisfaction score can be changed.



Ordinal Logistic Fit for QUESTION 14

Effect Summary

Source	LogWorth	PValue
QUESTION 13	17.034	0.00000
QUESTION 11	12.517	0.00000
QUESTION 9	12.282	0.00000
QUESTION 8	8.791	0.00000
QUESTION 10	7.314	0.00000
QUESTION 1	2.904	0.00125
QUESTION 5	2.303	0.00497
QUESTION 4	1.997	0.01008
QUESTION 2	1.554	0.02796

Remove Add Edit Undo FDR

Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	645.3980	52	1290.796	<.0001*
Full	1107.7217			
Reduced	1753.1197			

RSquare (U)	0.3681
AICc	2336.87
BIC	2632.2
Observations (or Sum Wgts)	1320

Fit Details

Lack Of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack Of Fit	4394	870.0722	1740.144
Saturated	4446	237.6496	Prob>ChiSq
Fitted	52	1107.7217	1.0000

Figure 12: Logistic Regression Model for EOC Survey in Predicting the Overall Satisfaction

The Model is significant as we can see that the p value is less than 0.001 indicating the model is good for prediction of question 14 with the other independent variables. The R-square value of 0.3681 indicates that 36.81 percentage of the variations in question 14 are explained by this model. A lack of fit test is conducted to see if there are errors in the prediction model. As the *P*-value is larger than the significance level α for the Lack of fit test, we fail to reject the null hypothesis. We conclude that there is not enough evidence at the α level to conclude that there is lack of fit in the regression model. The likelihood ratios in Figure 13 indicate the maximum dependency of question 14 on which questions and the confusion matrix in Figure 13 helps us understand the predicted outcomes from the actual outcomes and to describe the performance of the model. The distribution shows the actual responses of question 14 to the predicted responses by the Logistic Regression Model.

Effect Likelihood Ratio Tests

Source	Nparm	DF	L-R ChiSquare	Prob>ChiSq
QUESTION 1	5	4	17.975435	0.0012*
QUESTION 2	6	5	12.5523004	0.0280*
QUESTION 4	6	6	16.7919869	0.0101*
QUESTION 5	6	6	18.5610633	0.0050*
QUESTION 8	6	6	52.3071432	<.0001*
QUESTION 9	6	6	69.4795253	<.0001*
QUESTION 10	5	5	42.4135469	<.0001*
QUESTION 11	6	6	70.6290898	<.0001*
QUESTION 13	6	6	92.4819754	<.0001*

Confusion Matrix

Training

Actual QUESTION 14	Predicted Count 0	1	2	3	4	5	6
0	1	0	0	0	3	4	0
1	2	3	2	2	3	0	1
2	0	1	3	7	10	2	0
3	0	0	3	4	30	13	2
4	1	1	1	1	134	102	16
5	0	0	0	0	64	363	67
6	0	0	0	0	3	76	395

Figure 13: Logistic Regression Model Likelihood Ratio Test and Confusion Matrix

3.2.2.4. Clustering Analysis

Clustering is the technique of grouping variables together that share similar values. It is an exploratory technique to help us understand the clumping structure of the data. In our case, with regard to each question 1-14, we clustered the courses into different groups as they share certain commonalities.

The following example in Figure 14 shows the clustering analysis for the overall satisfaction question (question 14). Six clusters are identified. The specific grouping information is listed below. It helps understand which courses share similarities with regard to the trainee's overall satisfaction, so that targeted continuous improvement strategies could be implemented for different clusters.

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

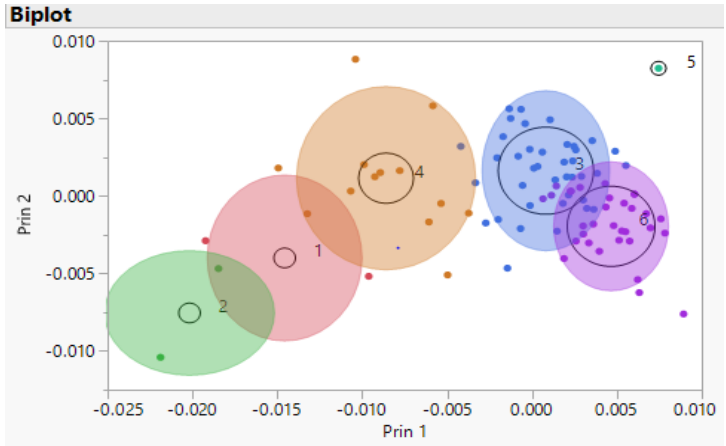
Cluster	Count	Step	Criterion
1	2	5	0
2	2		
3	39		
4	13		
5	1		
6	33		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	1.45426733	3.51524422	4.06097689	1.51524422	1.03048845	2	67.4577295	3.8305153
2	0.99996599	0	5.49994899	0.99996599	4	0.500017	52.2219577	3.18887491
3	4.22242489	6.6404172	3.44566114	0.31017095	0.15388276	0.09973346	96.3887207	4.88841968
4	1.9900652	3.71063263	4.52373892	2.0976846	0.38064415	0.3824851	77.019	4.2305592
5	12	18	6	0	0	0	100	5.16666667
6	8.60821215	5.36997316	1.71300807	0.28098351	0.06207814	0.02931869	97.8333802	5.38296482

Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	1.500697	0.50023233	2.00092933	0.50023233	1.00046466	0	5.11601249	0.3410675
2	1	0	1.5	1	4.4409e-16	0.5	7.77777778	0.41111111
3	1.60867673	2.50770713	1.808764	0.46154512	0.42598071	0.30340191	3.86476469	0.22620765
4	1.6172456	1.53857067	2.40641874	0.91687934	0.48652046	0.48650892	7.80045336	0.30789302
5	1.7764e-15	0	8.8818e-16	0	0	0	1.4211e-14	8.8818e-16
6	2.47336687	2.04226322	1.33686863	0.50894139	0.23861084	0.17142265	3.1340737	0.20251909



Iterative Clustering QUESTIONS=QUESTION 14

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	260.997	
K-Means Clustering	4	278.287	
K-Means Clustering	5	292.214	
K-Means Clustering	6	305.172	Optimal CCC

Figure 14: Clustering Analysis for Question14:

Cluster 1 (2 Classes): 96183, 102902

Cluster 2 (2 Classes): 102918, 102925

Cluster 3 (39 Classes): 92018, 92022, 92025, 92026, 92031, 92059, 92073, 92082, 92085, 92097, 92102, 92103, 92113, 92116, 92120, 96782, 96788, 96793, 96796, 96800, 96815, 99750, 99752, 99755, 99757, 99898, 102888, 102893, 102897, 102904, 102909, 102911, 102915, 102917, 102922, 102929, 102931, 102935, 105282

Cluster 4 (13 Classes): 92065, 92091, 102884, 102895, 102899, 102900, 102906, 102913, 102920, 102927, 105274, 105276, 105278

Cluster 5 (1 Class): 96810

Cluster 6 (33 Classes): 92021, 92028, 92029, 92030, 92061, 92063, 92067, 92069, 92071, 92076, 92078, 92080, 92088, 92090, 92093, 92109, 92118, 92122, 92142, 96786, 96791, 96795, 96798, 96802, 96805, 96807, 99748, 99896, 99899, 102891, 102924, 102933, 105280

The rest of the clustering analysis results for EOC survey questions 1-13 are shown in Appendix VI.

We also conducted the advanced analytics for PC survey, on both student data and supervisor data. The results are shown in Appendix VII.

3.2.2.5. Text Mining – Sentiment Analysis

Introduction

The individual comments/critiques in EOC and PC are a useful metric to gauge customer opinion. However, processing such responses can be time intensive and require immense manpower. Using automated sentiment analysis, it is possible to determine which comments need attention, allowing the surveyors to focus on only processing responses that require action. For example, if a comment is determined to be positive, an evaluator of the course can most likely ignore that response. If the comment is negative, it will most likely need attention. Further determining where the negativity is focused can allow the evaluator to focus on an excerpt rather than the entire passage. Especially with long passages, this can decrease the time required to understand the writer's complaint and ultimately improve the process.

There is popular open source tool for sentiment research named VADER, which stands for Valence Aware Dictionary and Sentiment Reasoner. According to the researchers who developed it, it is specifically attuned to comments written on social media websites such as Twitter, which are termed microblogs. VADER leverages a "lexicon" which is dictionary of words ranked with their sentiment as validated independently by humans. Using this lexicon, and a python implementation of a rule-based system, VADER calculates the positivity, negativity and neutrality of a comment as floating point values. These three features should approximate to one when combined. It also generates a compound score. The researcher's state that a compound score at or below -0.5 is negative, a score at or above 0.5 is positive and a score in between those bounds is neutral.

The tool created for this evaluation leverages the popular python packages NLTK, natural language toolkit, and scikit-learn. Both of these packages contain utilities for working with natural language algorithms. This tool was constructed using the NLTK implementation of a Naïve Bayes classifier and later replaced with the scikit-learn implementation of a Multinomial Bayes classifier. These classifiers are named for their use of the Bayes algorithm, which is defined by the "naïve" assumption that all of the features in the given input are independent of each other. Despite this shortcoming, it performs well with classification of objects with discrete features. In this case, the text is transformed into a distinct feature set using a term frequency-inverse document frequency (TF-IDF) vectorizer, which converts the text input into a matrix of TF-IDF features. These features essentially quantify the number of times a term appears in a data set, scaled down by the number of documents in which it appears. The goal of

this is to separate high information terms, such as “love” and “hate” from low information ones, such as “a” and “the” which most likely appear in every document. The terms or features used for this study were the set of all unigrams and bigrams for an input text. Using this scoring on features allows the model to predict the positivity and negativity of similar features.

Analysis Approach

The FAA gathered the comments used from surveys they conducted of trainees and course instructors. The majority of the comments, 187 in total, were negative; there was a much smaller group of 60 comments, which were positive, and 11 total comments, which were ambiguous. The VADER tool is written in python as in the tool used for comparison. The survey data was read in as text strings and run through both tools. The VADER distribution from the python package manager named pip comes pre-trained with the VADER lexicon and the rule based system. The data for training the tool includes a set of movie reviews from the NLTK movie review corpus of 2,000 reviews, 500 YouTube comments that were manually classified and an open source database of 3,000,000 Amazon reviews on various products. The tool was trained twice using different portions of this aggregate dataset. The first two datasets label the class of their texts as negative or positive, and do not require any preprocessing to be used with the tool. The Amazon review data uses a numerical 5-point scale, which had to be converted to class labels based on the score. For this a score of 3 was considered neutral with positive as all scores above 3 and negative as all scores below 3. At first, it was only trained using the movie review and YouTube comment data, later the Amazon dataset was added in an attempt to increase the accuracy. After each training, the tool and VADER were run over the set of survey comments. The results are output into a csv file, which is then compared with the correct output to determine accuracy. After these tests, 5-fold cross validation was applied to the tool using the survey data. This means a portion of the comments were used to train the tool and then it was tested on the remaining comments. This was done to gauge its accuracy on the dataset with no other training data.

Results

The VADER tool proved to be worse than a random guess when analyzing the survey results. It consistently achieved a total accuracy of 43.7% on this dataset after multiple runs. The score would be worse using the suggested rating system in the VADER proposal paper. By that metric, many of the comments were classified as “neutral”, for having a composite score between 0.5 and – 0.5, which reduced the accuracy to 23.6%. This study gave a more lenient scoring, as a majority of the comments lean one way or the other. As such, the rating was considered positive or negative based on if the compound score was a positive or negative floating-point value with zero being neutral. The tool developed using python and scikit-learn returns labels as positive, negative or neutral and is therefore much less ambiguous. This tool

achieved 53% percent accuracy when trained using only the set of YouTube comments and movie reviews. During the study, the tool was extended using a dataset of Amazon reviews, which increased the accuracy of the classifier to 66%. The classifier when trained using a subset of the survey results and then tested on the remaining ones scored accuracy of 73.7%.

4. Recommendations

4.1. Level 1 Evaluation Process

As discussed in section 3.1.1, the Level 1 evaluation through the EOC survey via AES is a well-established and efficient process. Minor process improvement opportunities are identified are follows:

(1) Expand the use of standardized EOC survey via AES to non instructor-led training courses.
(2) Actively track and enforce the review timelines (14 days for course coordinators/instructors and 30 days for AMA managers) to identify potential risks and take necessary actions in a timely manner.
(3) Use Average Weighted Score instead of Favorability Percentage as the performance metric for survey data analysis. This could be easily done using the existing AES, as the survey data are already in the required format. This change of performance metric will lead to the redesign of trigger point(s) for the feedback mechanism. Based on the other industry's practice, different training courses may use different trigger point(s) that is/are most suitable for the specific courses. Once the trigger points are decided, they can be coded in AES to enable automatic triggers.
(4) Use advanced analytics (correlation analysis, contingency analysis, logistic regression model, and cluster analysis) to analyze the survey data. This could lead to insightful discoveries, which can be used to drive continuous improvement efforts. This can be done either offline periodically (easy approach) or automated in the AES (challenging approach).
(5) The use of text mining for automating the analysis of individual comments/critiques is currently immature, because the accuracy level is not high enough. It is still recommended for the review team to manually read the comments/critiques.

4.2. Level 2 Evaluation Process

Currently, the Academy does not have a process for collecting and analyzing Level 2 data. The divisions within the Academy use objectives and develop tests/activities to determine if learning occurred in course offerings, but there is no centralized process to collect and analyze Level 2 data.

Kirkpatrick model's Level 2 measures the participants understanding to the course content by testing the knowledge and skills learnt in the training program through a Performance exam at the end of course. There are several data collection methodologies for the evaluation model. The most widely used data collections methods used in best practices in other industries are the pre and post-test assessments, interview before and after the training (which is a very time consuming process). Based on our interviews with AJI-2 customer satisfaction process stakeholders and the industry best practices, we recommend that the pre and post-test assessments is the best option considering the Academy's organizational structure and the number of students that attend the training. It would be difficult in selecting a sample of students and interviewing them to collect Level 2 data.

In Figure 15, we proposed a future state process map for the Level 2 evaluation at the Academy. Both pre-training assessment and post-training assessment need to be conducted. For the pre-training assessment, as each training course has its own training requirements and objectives, it is difficult to use a standardized instrument for pre-training assessment. It is recommended each course instructor conducts his/her pre-training assessment. This could be done using an actual assessment exam or an assessment survey that asks the trainees to answer a series of questions with ratings on their proficient levels on the relevant training tasks. In either case, the pre-training assessment results should be standardized and documented as pre-training assessment scores.

For the post-training assessment, it is recommended that the final course scores be used as the post-training assessment scores. Then, the comparison of the pre-training and post-training assessment scores should be documented as Level 2 data. Each training course could set up its own trigger point for the review process.

It is recommended to use a centralized system, such as AES, to document and track these Level 2 data.

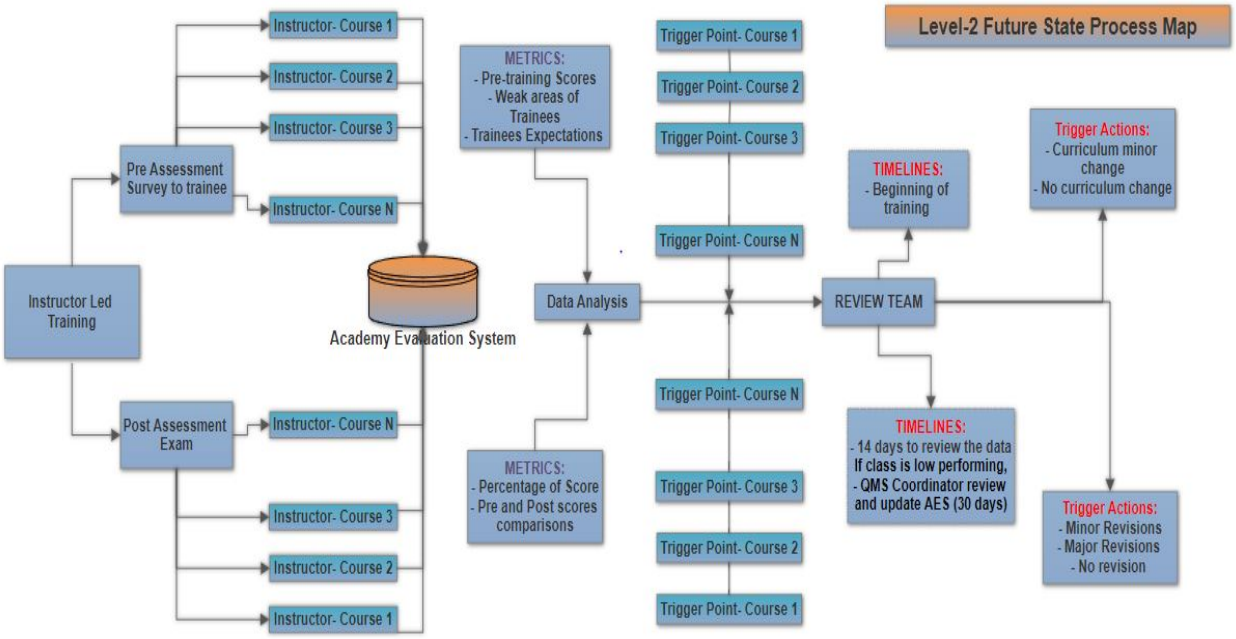


Figure 15: Future State Level 2 Evaluation Process Map

4.3. Level 3 Evaluation Process

As discussed in section 3.1.3, the Level 3 evaluation through the EOC survey via AES is a well-established and efficient process. Minor process improvement opportunities are identified are follows:

(1) Expand the use of standardized EOC survey via AES to non instructor-led training courses.
(2) Actively track and enforce the review timelines (30 days for course coordinators/instructors and 30 days for AMA managers) to identify potential risks and take necessary actions in a timely manner.
(3) Use Average Weighted Score instead of Favorability Percentage as the performance metric for survey data analysis. This could be easily done using the existing AES, as the survey data are already in the required format. This change of performance metric will lead to the redesign of trigger point(s) for the feedback mechanism. Based on the other industry's practice, different training courses may use different trigger point(s) that is/are most suitable for the specific courses. Once the trigger points are decided, they can be coded in AES to enable automatic triggers.
(4) Use advanced analytics (correlation analysis, contingency analysis, logistic regression model, and cluster analysis) to analyze the survey data. This could lead to insightful discoveries, which can be used to drive continuous improvement efforts. This can be done either offline periodically (easy approach) or automated in the AES (challenging approach).

(5) The use of text mining for automating the analysis of individual comments/critiques is currently immature, because the accuracy level is not high enough. It is still recommended for the review team to manually read the comments/critiques.

4.4. Level 4 and Level 5 Evaluation Process

Currently, the AJI-2 and the Academy does not have a process in place to provide Level 4 and Level 5 evaluations. Kirkpatrick model's Level 4 evaluates the business results of the organization on which the training program was conducted. This level of evaluation involves deep understanding of the data obtained from Levels 1-3 and different data analytics have to be performed to obtain the results. Philip's Level 5 Return on Investment (ROI) is the ultimate level of evaluation. It compares the monetary benefits from the program with the program costs. Although the ROI can be expressed in several ways. The Phillips' model evolves from, and can be distinguished from, the earlier Kirkpatrick model by the adoption of return on investment to yield additional, critical insight. ROI allows decision makers to compare the ultimate value of a training investment with other potential investment opportunities.

From the best practices from the other industries, the data collection methodologies for level 4 and level 5 are largely based on online survey, focus group, ROI, value narration, tangible and intangible benefits. In Figure 16, we proposed a future state process map for the Level 4 and Level 5 evaluation process.

To measure the business results (level 4) and ROI (level 5), we propose to use both direct measures and indirect measures. Specifically, at the Academy, the direct measures include trainee turnover rates, division budgets, cost to train new hires, as well as the number of instructors and the associated budgets. The indirect measures can be obtained by sending out a survey to the "alumni" who successfully completed academy training and worked in the field. In the "alumni" survey, proposed questions are designed to gather information about employee work to turnover contribution, organizational structure, team work, morale, improved customer satisfaction and sustainability. Based on other industries' best practices, it is recommended the survey to be conducted every 2 years.

In the field, when the OJT, facility training, performance exam assessments are conducted, these performance assessment results can be used as Level 4 direct measures. Data analysis on these assessment results can be conducted to obtain metrics such as the assessment score summary statistics (mean, median, standard deviation, etc.), and the first pass yield. Another source of direct measures from the filed could be the documented performance deficiencies (if available). The challenge is that in the field, currently, there is not a centralized unit similar to the AMA-20 in the Academy to coordinate the data collection, analysis and review process. It is recommended further studies to be conducted to investigate the best ways to collect data from the field and establish an effective data sharing and information sharing mechanism among AJI-2, the Academy, and the field.

Furthermore, it is recommended to form a review team consisting of members from different backgrounds to review and analyze the data obtained from direct measures and indirect measures both from the Academy and the field, identify specific trigger points (such as, when employee turnover is more than 10%, or the ROI is less than 1:2, etc.), to take actions. The review cycle is recommended to be every one year.

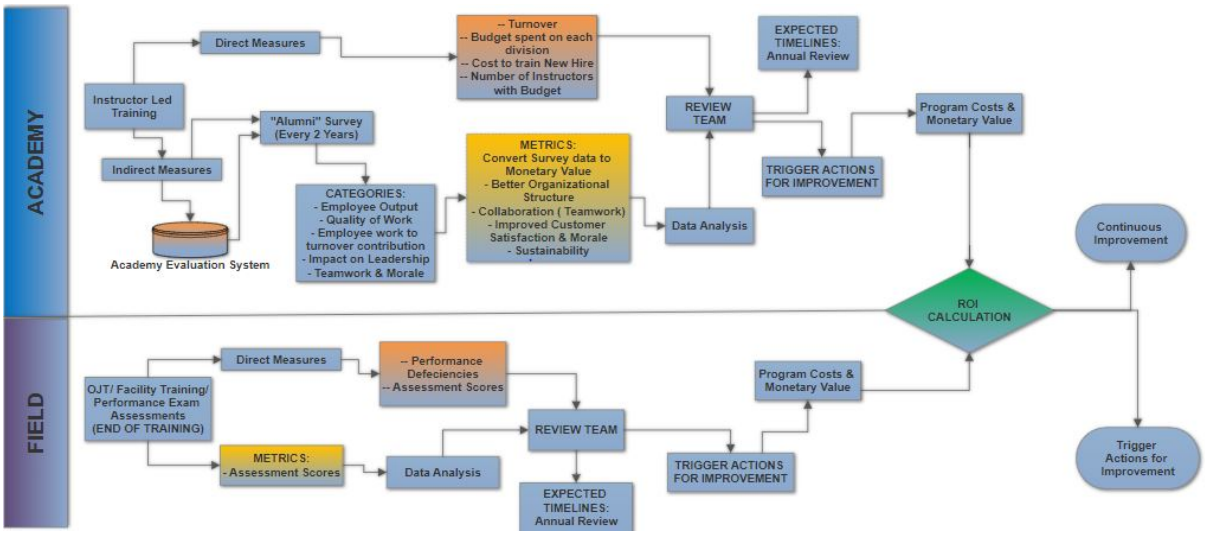


Figure 16: Future State Level 4 and Level 5 Evaluation Process Map

4.5.Evaluation Data Analytical Strategies

Based on the data analysis results presented in Section 3.2, we recommend the following data analytics strategies for the survey data analysis.

(1) Use Average Weighted Score instead of Favorability Percentage as the performance metric for survey data analysis. This could be easily done using the existing AES, as the survey data are already in the required format. This change of performance metric will lead to the redesign of trigger point(s) for the feedback mechanism. Based on the other industry's practice, different training courses may use different trigger point(s) that is/are most suitable for the specific courses. Once the trigger points are decided, they can be coded in AES to enable automatic triggers.

(2) Use advanced analytics (correlation analysis, contingency analysis, logistic regression model, and cluster analysis) to analyze the survey data. This could lead to insightful discoveries, which can be used to drive continuous improvement efforts. This can be done either offline periodically (easy approach) or automated in the AES (challenging approach).

Specifically, Logistic regression analysis was used to check the relation of the questions with the overall satisfaction rating as every question will play a major role in the trainee's perspective and we will be able to quantify which questions are adding more values to the overall satisfaction score. The outcomes from the logistic regression analysis are that we are able to identify the questions which are most significant and least significant in improving the overall satisfaction rating. The questions with least significant effect on question 14 are Q3, Q6, Q7 and Q12. The countermeasures for these outcomes are to look into the category of the question and determine the root cause for why there is less significance when compared with the overall satisfaction.

Over the three years period when the data was given, for the overall favorability percentages of all the questions, the lowest favorability percentage was 81.2% for Question 9. The improvement in the values of this question will have an impact on the overall satisfaction score, as it is one of the most significant questions in the prediction of the Question 14 responses. And this will in return improve the satisfaction score which can be converted into the tangible benefits as well as intangible benefits which can help calculate the Return-On-Investment (ROI).

The clustering analysis will help FAA in understanding which classroom falls into which cluster with specific cluster means for each of them. By looking at that it can be easily identified over the three year period which classes had fallen into a cluster with low means and high means, which will be resourceful to check what went wrong in those similar types of classes based on the responses, favorability percentage and the average weighted score.

(3) The use of text mining for automating the analysis of individual comments/critiques is currently immature, because the accuracy level is not high enough. It is still recommended for the review team to manually read the comments/critiques.

The text mining technique was most accurate when trained using survey results. The best method for improving its accuracy would be to acquire as many survey results as possible and continually use them to improve the classifier. The confusion matrix showing the results from that training shows that the classifier falsely identifies most of the comments as being negative. This is largely a result of how skewed the dataset is towards negative comments. While acquiring more survey data generally will improve accuracy, increasing the representation of positive and neutral comments will help improve this accuracy.
There are other versions of text classifiers, such as random forests, which may perform better, even with the current data but more evaluation is required to determine their viability. In addition, a more rigorous feature extraction process can improve the accuracy of this tool; however, the computation time increases dramatically as the number of features extracted increases.

Another way to improve the accuracy would be to setup the tool as a semi supervised learning system. The system would be allowed to sort out positive comments, and the persons reviewing the negative comments would mark the wrongly classified positive and neutral comments. The system preferentially identifies comments as negative and, consequently, the system is not likely to wrongly classify something as neutral or positive. After the system sorts through the input text, it would be retrained on the updated classifications of all the results it has seen. This allows the system to be utilized now and become more useful overtime.

References

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FAA Order 3000.57 (Air Traffic Organization Technical Operations Training and Personnel Certification)
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Evaluating Training Programs: The Four Levels (3rd Edition) by Donald Kirkpatrick

The Focus Group Kit: Transferring from Learning to Behavior by David L. Morgan

FAA Academy Self-Assessment Report NCA CASI Institution Accreditation

Employ Standard Metrics for Evaluation- AES eLMS Questions Scales Recommendations v5

AMC Quality Management System- AMAWI-00012 Work Instruction (WI)

Appendix I: Draft Questions for FAA Academy Quality Assurance (AMA-20)

(1) What is the organizational structure of AMA-20? What is the number of employees in AMA-20?
(2) Who are the customers of AJI? In addition to Air Traffic Controllers, Technicians, and Engineers, are there any other direct customers?
(3) How many Air Traffic Controllers, Technicians, and Engineers are trained at the Academy per year?
(4) In the Academy, how many mangers and course coordinators? And how many courses does each manger and course coordinator mange?
(5) How many courses are available at the Academy? What are they? What are the different delivery methods?
(6) Based on Kirkpatrick model, what levels of assessment data are currently collected, analyzed, and used for continuous improvement? Specifically, what do you currently do for Level 1, Level 2, Level 3, Level 4, and Level 5 evaluations?
(7) How is evaluation data collected? Where is it stored? Who receives (or has access to) course evaluation data? Do you share feedback with instructors? Do you report out/communicate course evaluation data outside of the Academy? To whom? Is it required?
(8) For Level 1 evaluation:
    a. Is it based on end of course survey? Are there any other evaluation methods, such as focus group? If yes, how often are they conducted?
    b. For the end of course survey, is it administrated online or by paper?
    c. Is it mandatory for the trainee to fill out the survey?
    d. Is it a standard survey used by all courses? Do all courses conduct the end of course survey?
    e. Once the survey data is collected, how is it analyzed? Is it an automated process in AES? What statistics are reported (such as mean, median, standard deviation for each survey question)? Is advanced analytics (such as regression analysis, time series analysis, cluster analysis, data mining, etc.) used for analyzing the survey data?
    f. For the qualitative data from the survey, i.e. individual comments, what is the process of analyzing it and taking actions?
    g. Can we have samples of the end of course survey raw data, including the individual response to each survey question and the individual comments? We would like to have the raw data for 10 different courses, if possible.
    h. Are there defined timelines for the evaluation process? For example, the survey data needs to be analyzed x days after the survey is conducted; the managers and the course coordinators need to complete the evaluation and take actions within y days. If yes, what percent of courses' evaluations are in compliance with the timelines?

i. Is the evaluation process and result documented? Is there a standardized format for documentation? If yes, what percent of courses document the evaluation process and result? And can we have some sample reports?
j. Are there defined trigger points to take actions? For example, if 80% of the trainees' final course score is below 85/100, actions need to take to investigate the root causes. If yes, are these trigger points standardized for all courses, or varies from course to course?

(9) For Level 2 evaluation:

a. What is the current process of collecting, analyzing level 2 data and its feedback mechanism?
b. What percent of courses have Level 2 evaluation?
c. Can we have some sample reports?

(10) For Level 3 evaluation:

a. Is it based on post course evaluation survey? Are there any other evaluation methods, such as focus group? If yes, how often are they conducted?
b. For the post course evaluation survey, is it administrated online or by paper? Is it sent to the trainees or their supervisors or both?
c. Is it mandatory for the trainee and/or their supervisors to fill out the survey? If no, what are the response rates?
d. Is it a standard survey used by all courses? Do all courses conduct the post course evaluation survey?
e. Once the survey data is collected, how is it analyzed? Is it an automated process in AES? What statistics are reported (such as mean, median, standard deviation for each survey question)? Is advanced analytics (such as regression analysis, time series analysis, cluster analysis, data mining, etc.) used for analyzing the survey data?
f. For the qualitative data from the survey, i.e. individual comments, what is the process of analyzing it and taking actions?
g. Can we have samples of the end of course survey raw data, including the individual response to each survey question and the individual comments? We would like to have the raw data for 10 different courses, if possible.
h. Are there defined timelines for the evaluation process? For example, the survey data needs to be analyzed x days after the survey is conducted; the managers and the course coordinators need to complete the evaluation and take actions within y days. If yes, what percent of courses' evaluations are in compliance with the timelines?
i. Is the evaluation process and result documented? Is there a standardized format for documentation? If yes, what percent of courses document the evaluation process and result? And can we have some sample reports?
j. Are there defined trigger points to take actions? If yes, are these trigger points standardized for all courses, or varies from course to course?

(11) For Level 4 evaluation:

a. What is the current process of collecting, analyzing level 4 data and its feedback mechanism?
b. Can we have some sample reports?

(12) For Level 5 evaluation:

a. What is the current process of collecting, analyzing level 4 data and its feedback mechanism?
b. Can we have some sample reports?

(13) For Academy courses taught by contracted instructors, what is the current process of collecting, analyzing Levels 1-5 data and its feedback mechanism? Can we have some sample reports?

(14) For On Job Training (OJT), what is the current process of collecting, analyzing Levels 1-5 data and its feedback mechanism? Can we have some sample reports?

(15) Are the processes for collecting, analyzing evaluation data and the feedback mechanisms the same for training courses on different personnel (Air Traffic Controllers, Technicians, and Engineers)?

(16) Are the processes for collecting, analyzing evaluation data and the feedback mechanisms the same for training courses with different delivery methods (instructor-led course, web-based training, blended, etc.)

(17) About AES:

a. Who developed AES? When was it developed? Was it developed in house or by a vendor? If by a vendor, who is the vendor? Does the vendor still provide technical support?
b. Can you provide a detailed demonstration of the AES interfaces and functions, through teleconference or during our on-site visit?

(18) If possible, can we have the recent FAA Academy accreditation “self-study” report?

(19) We read a report titled “Review and Evaluation of Air Traffic Controller Training at the FAA Academy” published in January 2013. Was there a similar study done recently for the Air Traffic Controller Training? Were there similar reports on Tech Training and Engineer Training? If yes, can we have the reports?

Appendix II: Questions on Level 4 & Level 5 Evaluations:

1. Can we have the data on the number of courses taught each fiscal year from 2013 to 2017, by divisions (ATC, Tech Ops, and Field) and by delivery methods?

Fiscal Year	Number of Courses - ATC				
	Instructor Led Classroom (Traditional)	Instructor Led – Virtual Classroom (Instructor Remote)	Instructor Led Online Delivered (Instructor Guided)	Self Paced Online Delivered	Correspondence Study
2013					
2014					
2015					
2016					
2017					
Fiscal Year	Number of Courses - Tech Ops				
	Instructor Led Classroom (Traditional)	Instructor Led – Virtual Classroom (Instructor Remote)	Instructor Led Online Delivered (Instructor Guided)	Self Paced Online Delivered	Correspondence Study
2013					
2014					
2015					
2016					
2017					
Fiscal Year	Number of Courses - Field				
	Instructor Led Classroom (Traditional)	Instructor Led – Virtual Classroom (Instructor Remote)	Instructor Led Online Delivered (Instructor Guided)	Self Paced Online Delivered	Correspondence Study
2013					
2014					
2015					
2016					
2017					

2. Can we have the data on the number of trainings initiated and the number of training completions each fiscal year from 2013 to 2017, by divisions (ATC, Tech Ops, and Field) and by delivery methods?

Fiscal Year	Number of trainings initiated/Number of training completions - ATC				
	Instructor Led Classroom (Traditional)	Instructor Led – Virtual Classroom (Instructor Remote)	Instructor Led Online Delivered (Instructor Guided)	Self Paced Online Delivered	Correspondence Study
2013	/	/	/	/	/
2014	/	/	/	/	/
2015	/	/	/	/	/
2016	/	/	/	/	/
2017	/	/	/	/	/
Fiscal Year	Number of trainings initiated/Number of training completions - Tech Ops				
	Instructor Led Classroom (Traditional)	Instructor Led – Virtual Classroom (Instructor Remote)	Instructor Led Online Delivered (Instructor Guided)	Self Paced Online Delivered	Correspondence Study
2013	/	/	/	/	/
2014	/	/	/	/	/
2015	/	/	/	/	/
2016	/	/	/	/	/
2017	/	/	/	/	/
Fiscal Year	Number of trainings initiated/Number of training completions - Field				
	Instructor Led Classroom (Traditional)	Instructor Led – Virtual Classroom (Instructor Remote)	Instructor Led Online Delivered (Instructor Guided)	Self Paced Online Delivered	Correspondence Study
2013	/	/	/	/	/
2014	/	/	/	/	/
2015	/	/	/	/	/
2016	/	/	/	/	/
2017	/	/	/	/	/

3. Can we have the data on the number of FAA academy instructors and the number of contracted instructors each fiscal year from 2013 to 2017, by divisions (ATC, Tech Ops, and Field)? Are there any instructors who taught courses across divisions (ATC, Tech Ops, and Field)? If yes, how many such instructors and how many courses were taught by such instructors?

Fiscal Year	ATC		Tech Ops		Field	
	Number of FAA Academy Instructors	Number of Contracted Instructors	Number of FAA Academy Instructors	Number of Contracted Instructors	Number of FAA Academy Instructors	Number of Contracted Instructors
2013						
2014						
2015						
2016						
2017						

4. Can we have the budgeted amounts from AJI-2 to each division (ATC, Tech Ops, and Field) each fiscal year from 2013 to 2017? What does the total budget include? Is the trainees' travel expenses included in the budgets?

Fiscal Year	ATC		Tech Ops		Field	
	Total budget from AJI-2	Total spending on trainees' travels from AJI-2	Total budget from AJI-2	Total spending on trainees' travels from AJI-2	Total budget from AJI-2	Total spending on trainees' travels from AJI-2
2013						
2014						
2015						
2016						
2017						

5. What is the timeframe for a new hire trainee to complete trainings from the Academy and become a full-time employee, by job series (ATC, engineers, Technicians, ATSS)? What is the approximate cost to train a new hire (ATC, engineers, Technicians, ATSS) to become a full-time employee?
   Based by disciplines? Environmental disciplines – subparts

6. What is the current process to evaluate the On-the-Job Training (OJT), Facility training and Enhanced-Hands-On-Training (EHOT) for each division (ATC, Tech Ops, and Field)? What are the metrics used for evaluations? Are performance exam data available? Can we have some sample reports?

7. Are data on individual's documented performance deficiencies and decertification available? If yes, can you provide the information listed in the following Table? If it is not easy to collect data for the entire divisions, can you provide data from some representative locations?

Fiscal Year	ATC			
	Number of documented deficiencies	Number of termination of employment due to training failure	Number of the individuals who have been decertified as a result of performance deficiencies/ The average employment years with FAA for those individuals	Number of Remedial Training Initiated/ Number of Remedial Training Successfully Passed
2013			/	
2014			/	
2015			/	
2016			/	
2017			/	
Fiscal Year	Tech Ops			
	Number of documented deficiencies	Number of termination of employment due to training failure	Number of the individuals who have been decertified as a result of performance deficiencies/ The average employment years with FAA for those individuals	Number of Remedial Training Initiated/ Number of Remedial Training Successfully Passed
2013			/	
2014			/	
2015			/	
2016			/	
2017			/	
Fiscal Year	Field			
	Number of documented deficiencies	Number of termination of employment due to training failure	Number of the individuals who have been decertified as a result of performance deficiencies/ The average employment years with FAA for those individuals	Number of Remedial Training Initiated/ Number of Remedial Training Successfully Passed
2013			/	
2014			/	
2015			/	
2016			/	
2017			/	

8. Are data on the employee voluntary turnovers available? If yes, can you provide the information listed in the following Table? If it is not easy to collect data for the entire divisions, can you provide data from some representative locations?

Fiscal Year	ATC		
	Number of employee voluntary turnovers	The average employment years with FAA for those individuals	List of voluntary turnover reasons
2013			
2014			
2015			
2016			
2017			
Fiscal Year	Tech Ops		
	Number of employee voluntary turnovers	The average employment years with FAA for those individuals	List of voluntary turnover reasons
2013			
2014			
2015			
2016			
2017			
Fiscal Year	Field		
	Number of employee voluntary turnovers	The average employment years with FAA for those individuals	List of voluntary turnover reasons
2013			
2014			
2015			
2016			
2017			

9. Were there any employee satisfaction surveys conducted for the ATC, Tech Ops, and Field divisions? If yes, can we have access to the surveys and survey results?

10. Were there any return of investment studies or cost benefit analyses conducted for AJI? If yes, can we have access to the reports?

11. Is there a current process to measure the intangible benefits of AJI tech training, such as Morale, Teamwork, etc.? If yes, can you provide the details?

12. Were there any organizational changes in the divisions in the AJI in the past five years? If yes, can you provide the details?

13. How is the Comprehensive Management Resource Information System (CMRIS) used to collect and store trainee's performance evaluation data? If possible, can you show us the CMRIS via a teleconference call or on-site visit?

Appendix III: List of On-Site Interview Questions for FAA Academy

We would like to see a detailed demonstration of the Academy Evaluation System (AES), inquire about sample Level 1 and Level 3 survey data and course evaluation reports, and interview with AMA-20 personnel. The specific questions are listed below.

(1) Demonstration of the Academy Evaluation System (AES):

- Can you demonstrate the interfaces, functions, and capabilities of AES?
- Can you demonstrate the process of collecting, analyzing survey data, and taking actions based on the trigger points?
- How does ASE collect and differentiate the evaluation data from the courses with different delivery methods (Instructor Led Classroom, Instructor Led – Virtual Classroom, Instructor Led Online Delivered, Self-Paced Online Delivered, and Correspondence Study)?
- Is the survey data collection process the same for different divisions (ATC, Tech Op, and Field)?
- For the quantitative survey data analysis:
    - What statistics (mean, median, standard deviation, etc.) are used?
    - What charts are generated in AES?
    - Is advanced analytics (such as regression analysis, time series analysis, cluster analysis, data mining, etc.) used for analyzing the survey data?
    - Does ASE has the capability to incorporate some of the advanced analytics?
- For the qualitative data analysis:
    - What methods are used for the end-of-course (EOC) critiques and the Post Course Critique (POC)?
    - How the results are documented and stored in AES?
- What is the relationship between AES and eLMS? Any interface between the two systems?
- Does AES track the timelines for completing evaluations?
- How the AES system updates and revisions are handled? Were there any recent updates and revisions?

(2) Sample Level 1 and Level 3 survey data and course evaluation reports

- Can we have some sample data and reports?
    - Level 3 survey questions (we do have Level 1 survey questions)
    - Can we have samples of Level 1 the end of course survey raw data, including the individual response to each survey question and the individual comments? We would like to have the raw data for 10 different courses, if possible.
    - Can we have samples of Level 3 the post course survey raw data, including the individual response to each survey question and the

individual comments? We would like to have the raw data for 10 different courses, if possible.

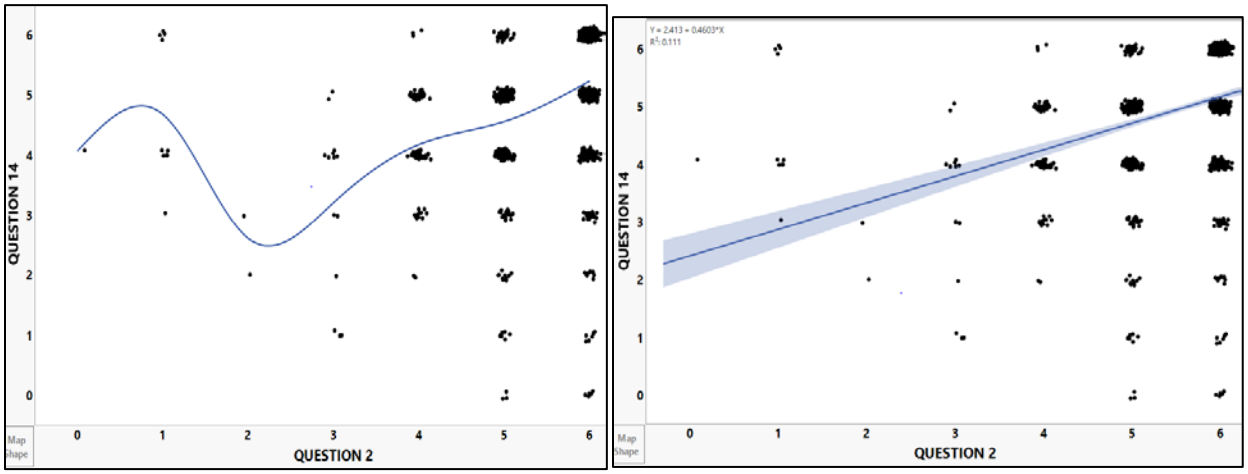
- Can we have some sample course evaluation reports? If possible, we would like to have 2-3 sample reports from each combination of divisions (ATC, Tech Ops, and Field) and course delivery methods (Instructor Led Classroom, Instructor Led – Virtual Classroom, Instructor Led Online Delivered, Self-Paced Online Delivered, and Correspondence Study)?

(3) Other interview questions

- Were any continuous improvement initiatives conducted in recent years to improve AJI-2 customer satisfaction?
- Can we have a copy of the recent FAA Academy accreditation "Self-Assessment" report?
- When the final report on the review and evaluation of Tech Training and Engineer Training at the FAA Academy becomes available, can we have a copy?
- Do you have access to the Comprehensive Management Resource Information System (CMRIS)? If yes, can you show us how the CMRIS works to collect and store trainee's performance evaluation data?
- Can you help answer or guide us to the right persons to answer the questions for Level 4 and Level 5 evaluations (please see the attached pdf file "Questions on Level 4 and Level 5 Evaluations")?

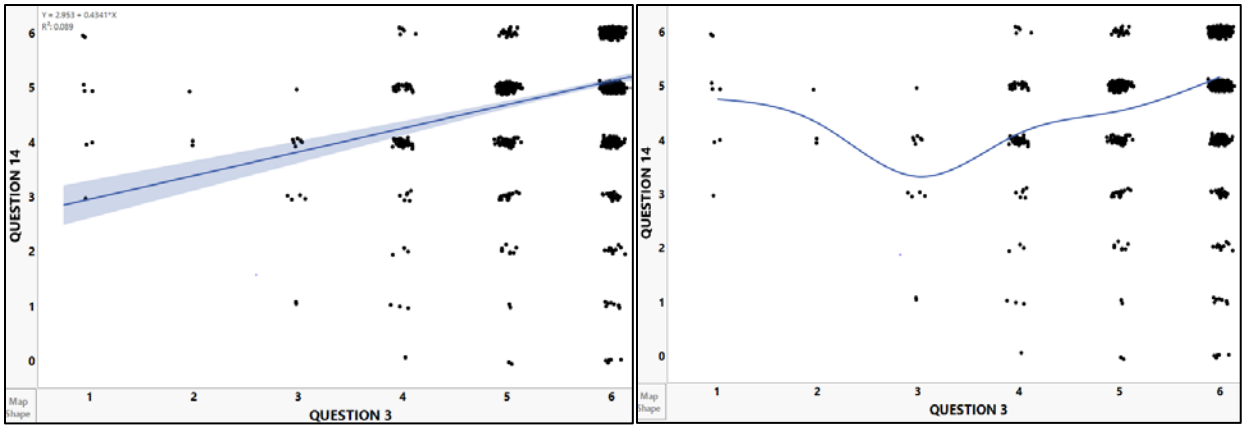
Appendix IV: Correlation Scatterplots and Correlation Models for EOC survey

Question 14 vs Question 2:



The regression equation is Y = 2.414 + 0.4601*X, R-Square= 0.111, this explains that for every increase in 1 unit of X there is an increase of 0.4601 in Y and the value of 0.111 represents that 11.1 percent variations of Y are explained with this linear fit.

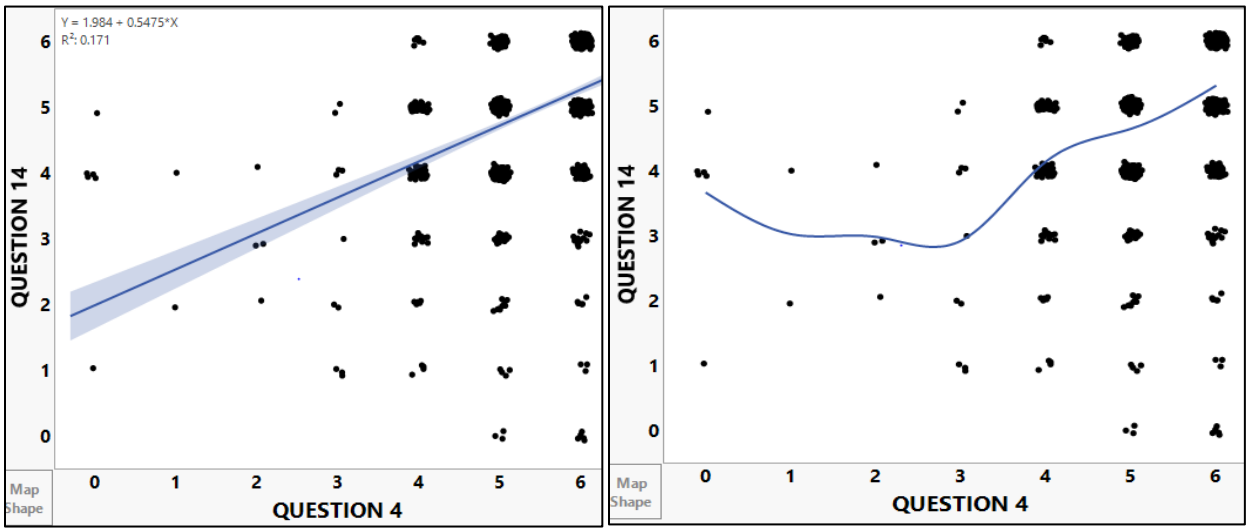
Question 14 vs Question 3:



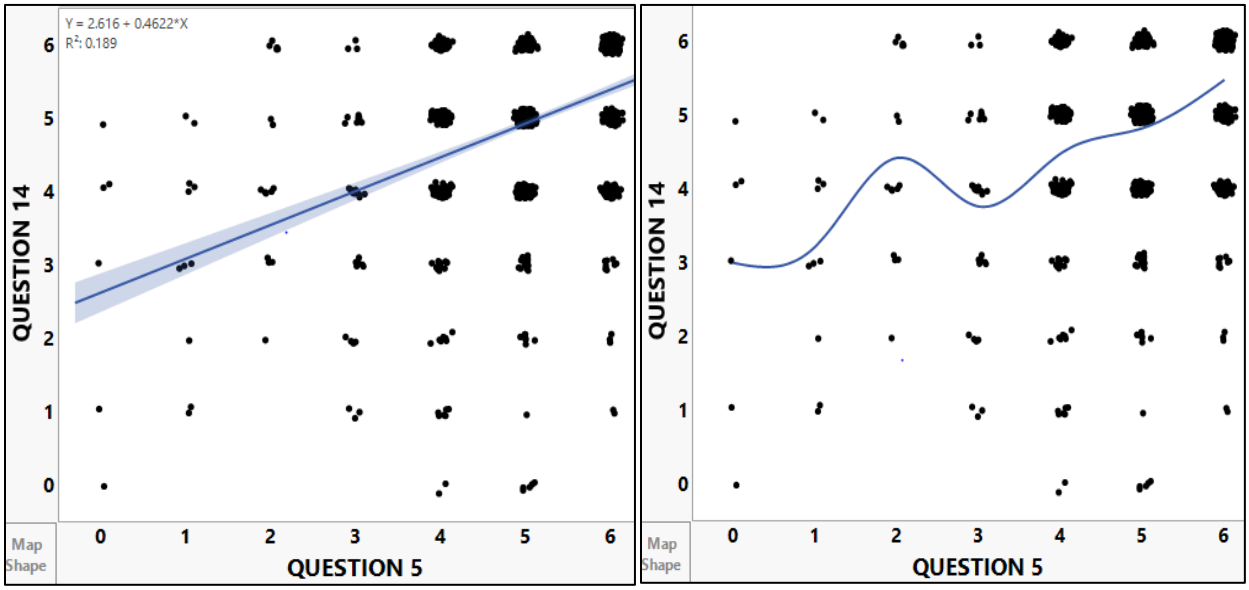
The regression equation is Y = 2.954 + 0.4339*X, R-Square= 0.089, this explains that for every increase in 1 unit of X there is an increase of 0.4339 in Y and the value of 0.089 represents that 8.9 percent variations of Y are explained with this linear fit.

Question 14 vs Question 4:

The regression equation is Y = 1.985 + 0.5472*X, R-Square= 0.171, this explains that for every increase in 1 unit of X there is an increase of 0.5472 in Y and the value of 0.171 represents that 17.1 percent variations of Y are explained with this linear fit.



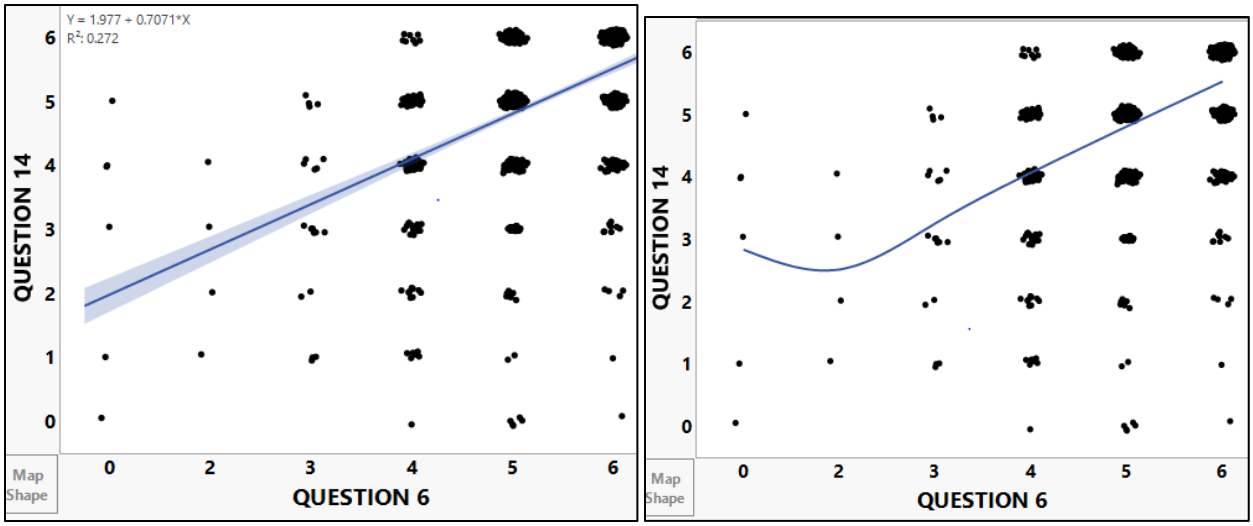
Question 14 vs Question 5:



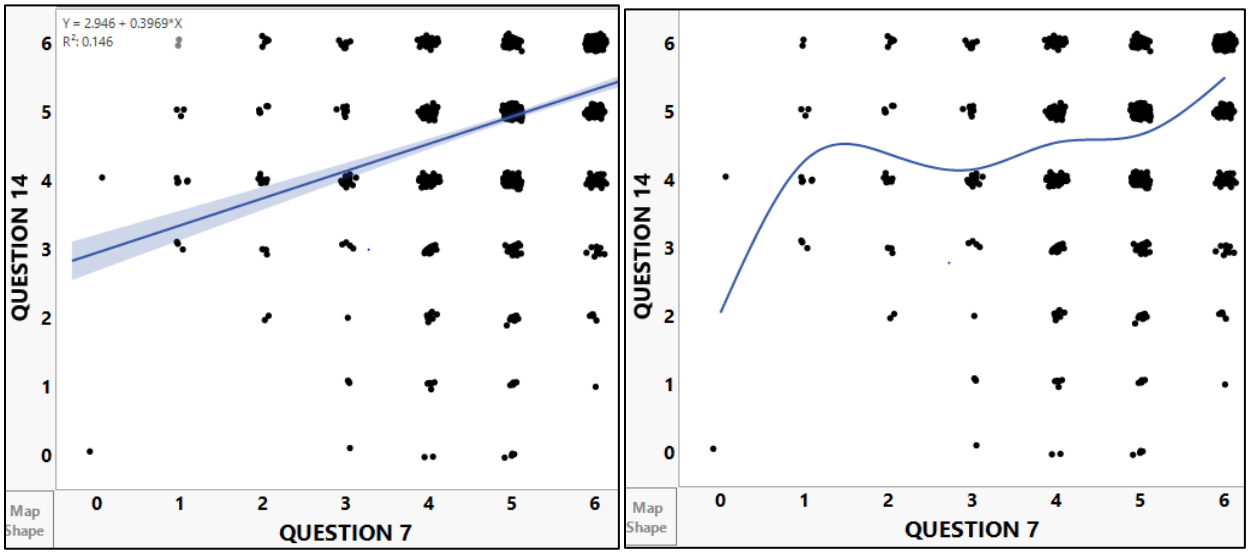
The regression equation is Y = 2.665 + 0.453*X, R-Square= 0.184, this explains that for every increase in 1 unit of X there is a increase of 0.453 in Y and the value of 0.184 represents that 18.4 percent variations of Y are explained with this linear fit.

Question 14 vs Question 6:

The regression equation is Y = 1.975 + 0.7077*X, R-Square= 0.272, this explains that for every increase in 1 unit of X there is a increase of 0.7077 in Y and the value of 0.272 represents that 27.2 percent variations of Y are explained with this linear fit.



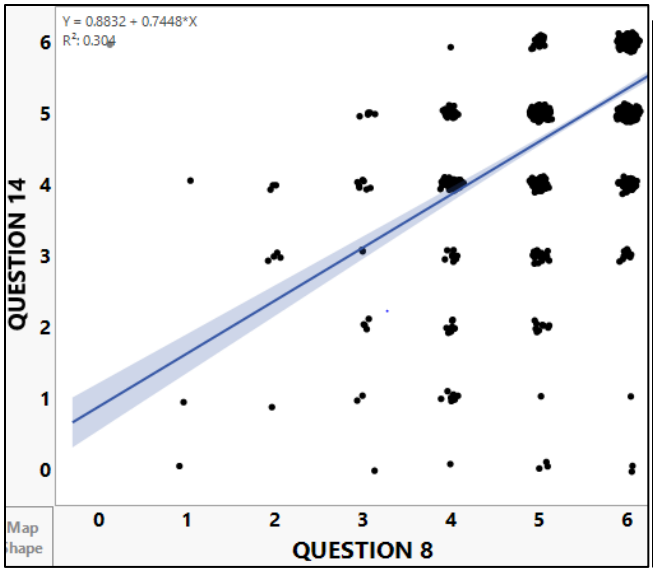
Question 14 vs Question 7:

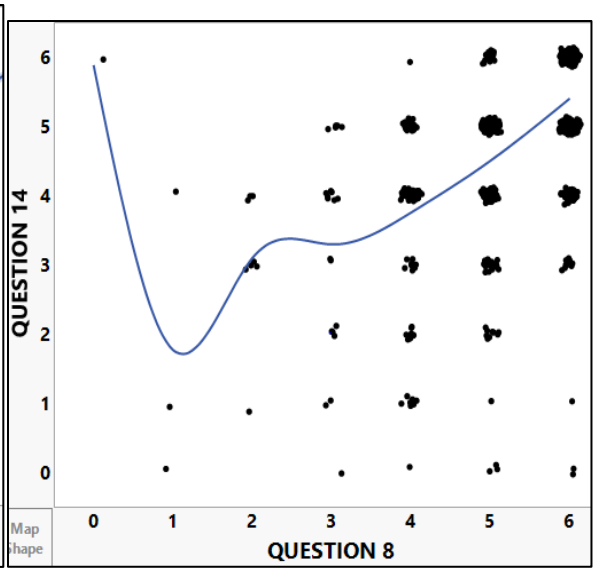


The regression equation is Y = 2.948 + 0.3965*X, R-Square= 0.146, this explains that for every increase in 1 unit of X there is a increase of 0.3965 in Y and the value of 0.146 represents that 14.6 percent variations of Y are explained with this linear fit.

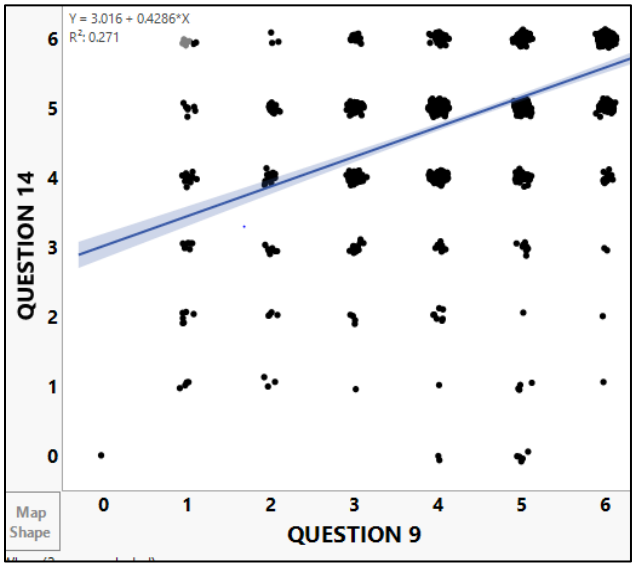
Question 14 vs Question 8:

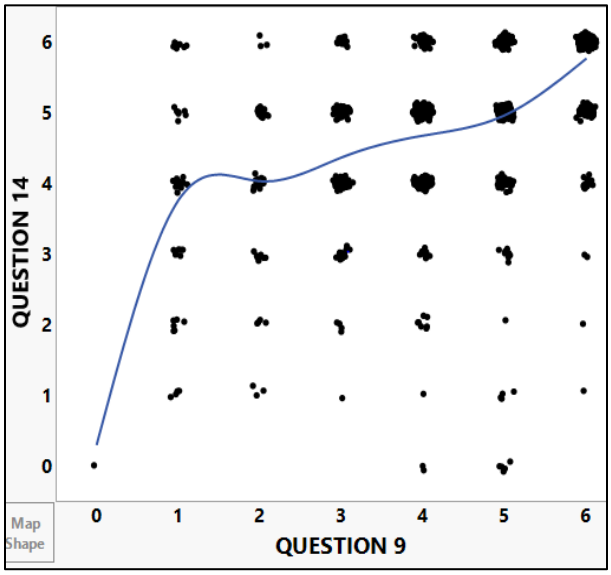
The regression equation is Y = 0.8829 + 0.745*X, R-Square= 0.305, this explains that for every increase in 1 unit of X there is a increase of 0.745 in Y and the value of 0.305 represents that 30.5 percent variations of Y are explained with this linear fit.





Question 14 vs Question 9:

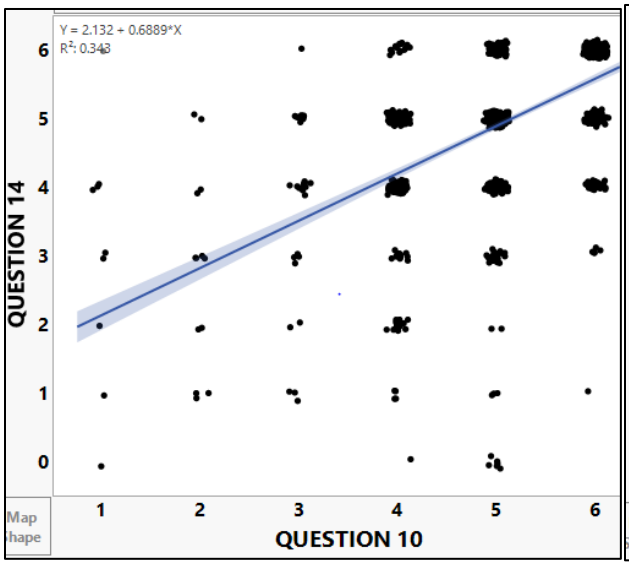


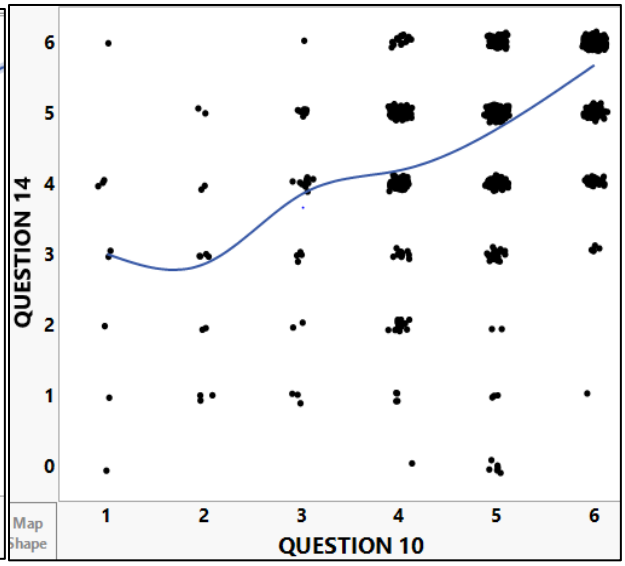


The regression equation is Y = 3.039 + 0.424*X, R-Square= 0.267, this explains that for every increase in 1 unit of X there is a increase of 0.424 in Y and the value of 0.267 represents that 26.7 percent variations of Y are explained with this linear fit.

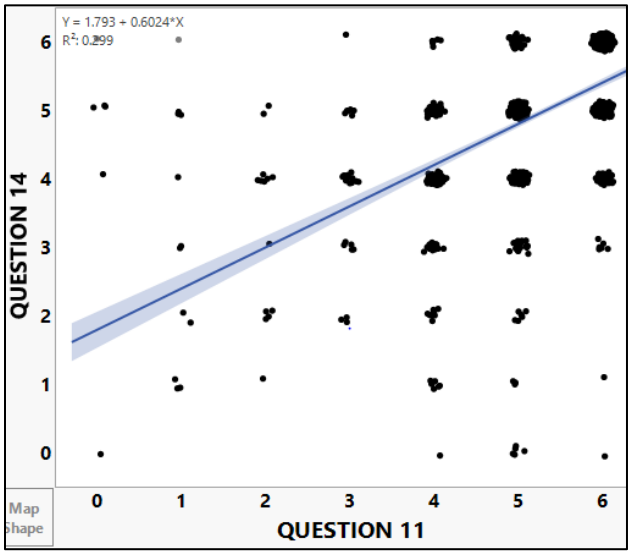
Question 14 vs Question 10:

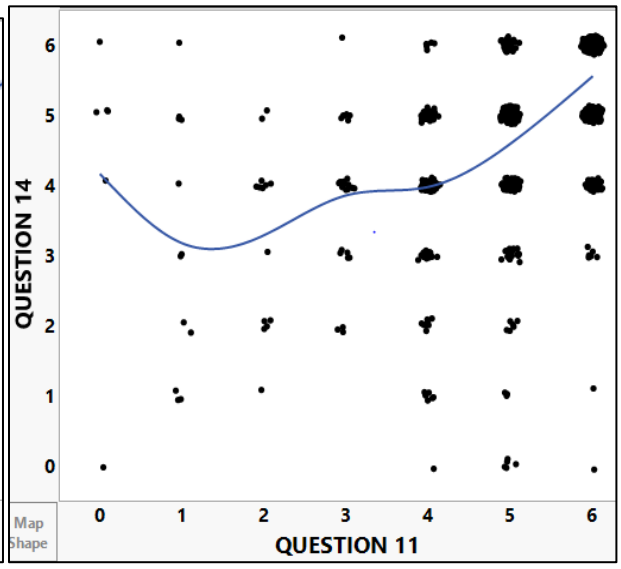
The regression equation is Y = 2.131 + 0.6894*X, R-Square= 0.344, this explains that for every increase in 1 unit of X there is a increase of 0.689 in Y and the value of 0.344 represents that 34.4 percent variations of Y are explained with this linear fit.





Question 14 vs Question 11:

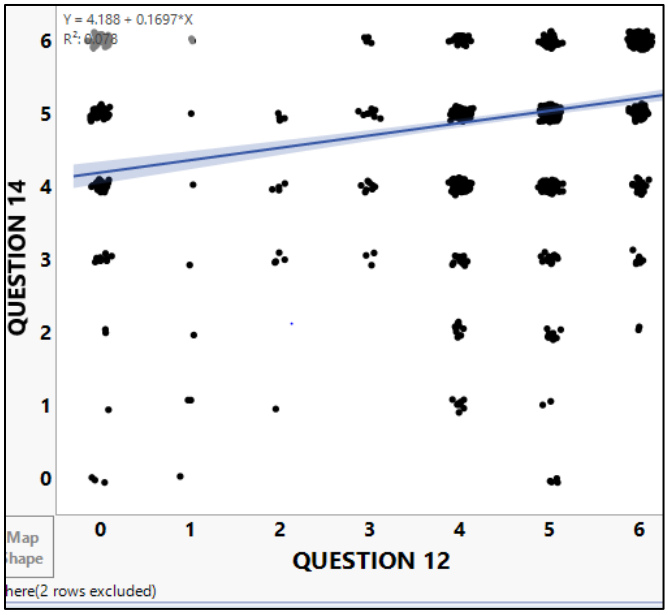


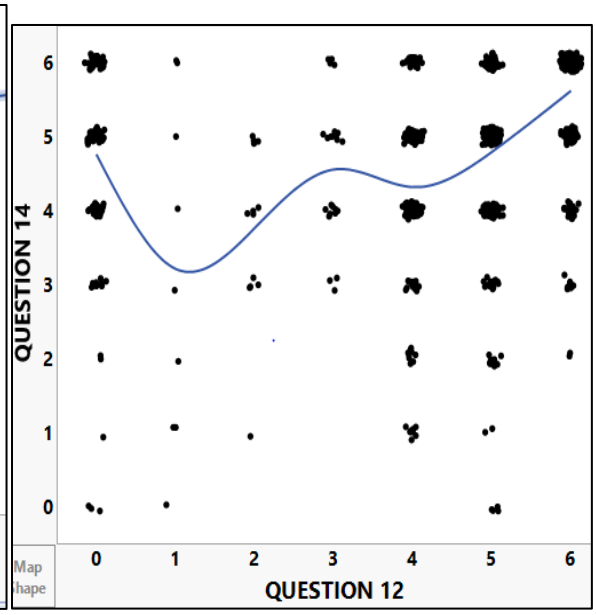


The regression equation is Y = 1.79 + 0.6029*X, R-Square= 0.299, this explains that for every increase in 1 unit of X there is a increase of 0.6029 in Y and the value of 0.299 represents that 29.9 percent variations of Y are explained with this linear fit.

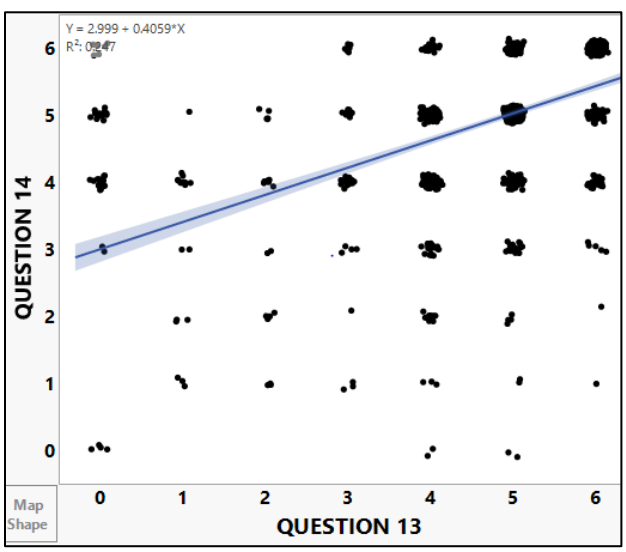
Question 14 vs Question 12:

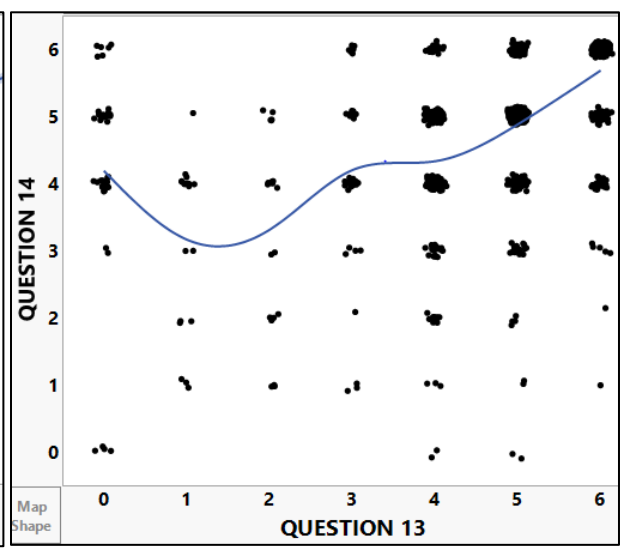
The regression equation is Y = 4.188 + 0.1696*X, R-Square= 0.077, this explains that for every increase in 1 unit of X there is a increase of 0.6029 in Y and the value of 0.077 represents that 7.7 percent variations of Y are explained with this linear fit.





Question 14 vs Question 13:

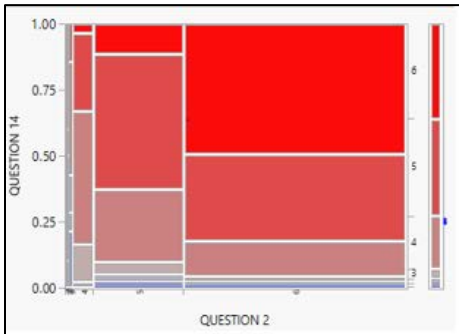




The regression equation is Y = 3 + 0.4055*X, R-Square= 0.246, this explains that for every increase in 1 unit of X there is a increase of 0.4055 in Y and the value of 0.246 represents that 24.6 percent variations of Y are explained with this linear fit.

Appendix V: Contingency Analysis Results for EOC Survey

Question 14 vs Question 2 Contingency Analysis

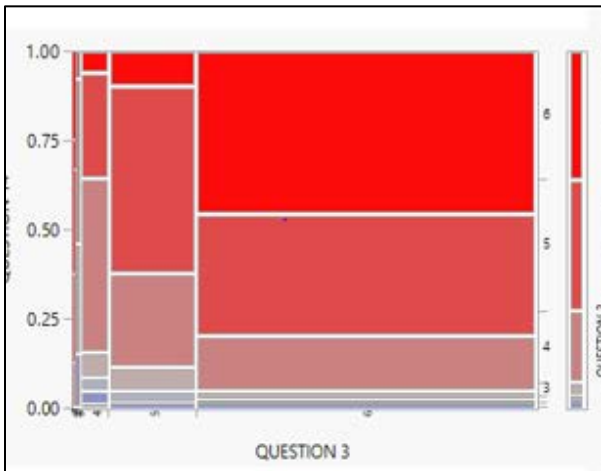


N	DF	-LogLike	RSquare (U)
1372	36	169.75919	0.0930

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	339.518	<.0001*
Pearson	391.631	<.0001*

QUESTION 2	QUESTION 14							
Count Total % Col % Row % Expected	0	1	2	3	4	5	6	Total
0	0 0.00 0.00 0.00 0.00583	0 0.00 0.00 0.00 0.01093	0 0.00 0.00 0.00 0.01676	0 0.00 0.00 0.00 0.03863	1 0.07 0.37 100.00 0.19898	0 0.00 0.00 0.00 0.37026	0 0.00 0.00 0.00 0.3586	1 0.07
1	0 0.00 0.00 0.00 0.05831	0 0.00 0.00 0.00 0.10933	0 0.00 0.00 0.00 0.16764	1 0.07 1.89 10.00 0.3863	5 0.36 1.83 50.00 1.9898	0 0.00 0.00 0.00 3.70262	4 0.29 0.81 40.00 3.58601	10 0.73
2	0 0.00 0.00 0.00 0.01166	0 0.00 0.00 0.00 0.02187	1 0.07 4.35 50.00 0.03353	1 0.07 1.89 50.00 0.07726	0 0.00 0.00 0.00 0.39796	0 0.00 0.00 0.00 0.74052	0 0.00 0.00 0.00 0.7172	2 0.15
3	0 0.00 0.00 0.00 0.08163	3 0.22 20.00 21.43 0.15306	1 0.07 4.35 7.14 0.23469	2 0.15 3.77 14.29 0.54082	6 0.44 2.20 42.86 2.78571	2 0.15 0.39 14.29 5.18367	0 0.00 0.00 0.00 5.02041	14 1.02
4	0 0.00 0.00 0.00 0.49563	0 0.00 0.00 0.00 0.9293	2 0.15 8.70 2.35 1.42493	12 0.87 22.64 14.12 3.28353	43 3.13 15.75 50.59 16.9133	25 1.82 4.92 29.41 31.4723	3 0.22 0.61 3.53 30.481	85 6.20
5	3 0.22 37.50 0.82 2.12828	6 0.44 40.00 1.64 3.99052	10 0.73 43.48 2.74 6.1188	17 1.24 32.08 4.66 14.0999	100 7.29 36.63 27.40 72.6276	187 13.63 36.81 51.23 135.146	42 3.06 8.54 11.51 130.889	365 26.60
6	5 0.36 62.50 0.56 5.21866	6 0.44 40.00 0.67 9.78499	9 0.66 39.13 1.01 15.0036	20 1.46 37.74 2.23 34.5736	118 8.60 43.22 13.18 178.087	294 21.43 57.87 32.85 331.385	443 32.29 90.04 49.50 320.948	895 65.23
Total	8 0.58	15 1.09	23 1.68	53 3.86	273 19.90	508 37.03	492 35.86	1372

Question 14 vs Question 3 Contingency Analysis:

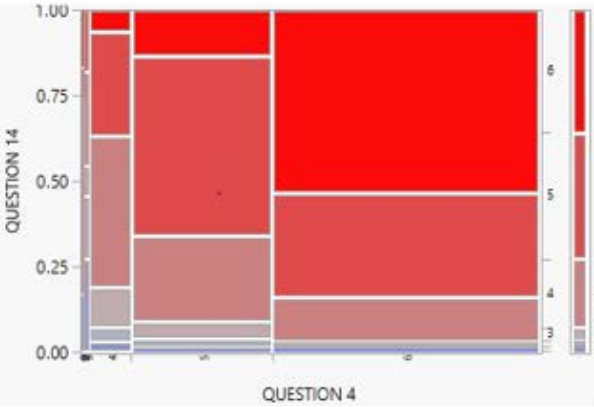


N	DF	-LogLike	RSquare (U)
1372	30	126.43302	0.0693

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	252.866	<.0001*
Pearson	265.514	<.0001*

QUESTION 3	QUESTION 14							
Count Total % Col % Row % Expected	0	1	2	3	4	5	6	Total
1	0 0.00 0.00 0.00 0.04665	0 0.00 0.00 0.00 0.08746	0 0.00 0.00 0.00 0.13411	1 0.07 1.89 12.50 0.30904	2 0.15 0.73 25.00 1.59184	3 0.22 0.59 37.50 2.9621	2 0.15 0.41 25.00 2.8688	8 0.58
2	0 0.00 0.00 0.00 0.01749	0 0.00 0.00 0.00 0.0328	0 0.00 0.00 0.00 0.05029	0 0.00 0.00 0.00 0.11589	2 0.15 0.73 66.67 0.59694	1 0.07 0.20 33.33 1.11079	0 0.00 0.00 0.00 1.0758	3 0.22
3	0 0.00 0.00 0.00 0.0758	2 0.15 13.33 15.38 0.14213	0 0.00 0.00 0.00 0.21793	4 0.29 7.55 30.77 0.50219	6 0.44 2.20 46.15 2.58673	1 0.07 0.20 7.69 4.81341	0 0.00 0.00 0.00 4.66181	13 0.95
4	1 0.07 12.50 1.19 0.4898	3 0.22 20.00 3.57 0.91837	3 0.22 13.04 3.57 1.40816	6 0.44 11.32 7.14 3.2449	41 2.99 15.02 48.81 16.7143	25 1.82 4.92 29.76 31.102	5 0.36 1.02 5.95 30.1224	84 6.12
5	2 0.15 25.00 0.77 1.51603	2 0.15 13.33 0.77 2.84257	8 0.58 34.78 3.08 4.3586	18 1.31 33.96 6.92 10.0437	68 4.96 24.91 26.15 51.7347	137 9.99 26.97 52.69 96.2682	25 1.82 5.08 9.62 93.2362	260 18.95
6	5 0.36 62.50 0.50 5.85423	8 0.58 53.33 0.80 10.9767	12 0.87 52.17 1.20 16.8309	24 1.75 45.28 2.39 38.7843	154 11.22 56.41 15.34 199.776	341 24.85 67.13 33.96 371.743	460 33.53 93.50 45.82 360.035	1004 73.18
Total	8 0.58	15 1.09	23 1.68	53 3.86	273 19.90	508 37.03	492 35.86	1372

Question 14 vs Question 4 Contingency Analysis:

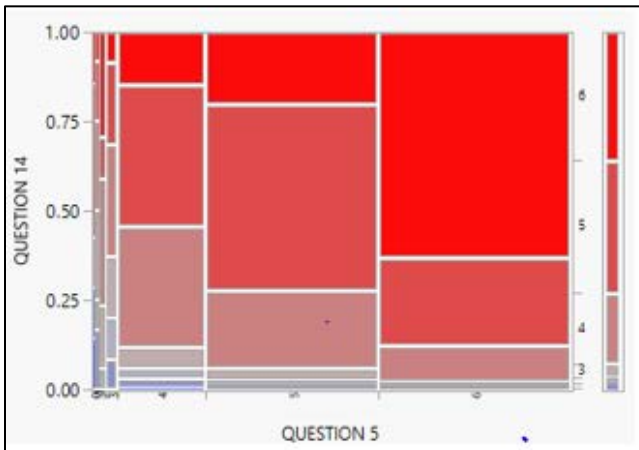


N	DF	-LogLike	RSquare (U)
1369	36	197.11349	0.1082

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	394.227	<.0001*
Pearson	498.141	<.0001*

QUESTION 4 \ QUESTION 14	0	1	2	3	4	5	6	Total
Count Total % Col % Row % Expected								
0	0 0.00 0.00 0.00 0.03506	1 0.07 6.67 16.67 0.06574	0 0.00 0.00 0.00 0.1008	0 0.00 0.00 0.00 0.23229	4 0.29 1.47 66.67 1.19211	1 0.07 0.20 16.67 2.21768	0 0.00 0.00 0.00 2.15632	6 0.44
1	0 0.00 0.00 0.00 0.01169	0 0.00 0.00 0.00 0.02191	1 0.07 4.35 50.00 0.0336	0 0.00 0.00 0.00 0.07743	1 0.07 0.37 50.00 0.39737	0 0.00 0.00 0.00 0.73923	0 0.00 0.00 0.00 0.71877	2 0.15
2	0 0.00 0.00 0.00 0.02337	0 0.00 0.00 0.00 0.04383	1 0.07 4.35 25.00 0.0672	2 0.15 3.77 50.00 0.15486	1 0.07 0.37 25.00 0.79474	0 0.00 0.00 0.00 1.47845	0 0.00 0.00 0.00 1.43755	4 0.29
3	0 0.00 0.00 0.00 0.06428	3 0.22 20.00 27.27 0.12053	2 0.15 8.70 18.18 0.18481	1 0.07 1.89 9.09 0.42586	3 0.22 1.10 27.27 2.18554	2 0.15 0.40 18.18 4.06574	0 0.00 0.00 0.00 3.95325	11 0.80
4	0 0.00 0.00 0.00 0.74215	4 0.29 26.67 3.15 1.39153	5 0.37 21.74 3.94 2.13367	15 1.10 28.30 11.81 4.91673	56 4.09 20.59 44.09 25.233	39 2.85 7.71 30.71 46.9408	8 0.58 1.63 6.30 45.6421	127 9.28
5	3 0.22 37.50 0.71 2.47188	4 0.29 26.67 0.95 4.63477	9 0.66 39.13 2.13 7.10665	22 1.61 41.51 5.20 16.3762	105 7.67 38.60 24.82 84.0438	223 16.29 44.07 52.72 156.346	57 4.16 11.59 13.48 152.02	423 30.90
6	5 0.37 62.50 0.63 4.65157	3 0.22 20.00 0.38 8.72169	5 0.37 21.74 0.63 13.3733	13 0.95 24.53 1.63 30.8167	102 7.45 37.50 12.81 158.153	241 17.60 47.63 30.28 294.212	427 31.19 86.79 53.64 286.072	796 58.14
Total	8 0.58	15 1.10	23 1.68	53 3.87	272 19.87	506 36.96	492 35.94	1369

Question 14 vs Question 5 Contingency Analysis:

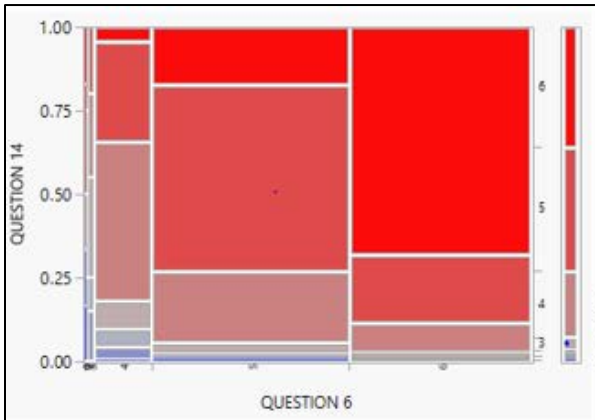


N	DF	-LogLike	RSquare (U)
1368	36	205.55734	0.1129

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	411.115	<.0001*
Pearson	487.516	<.0001*

QUESTION 5 \ QUESTION 14	0	1	2	3	4	5	6	Total
Count Total % Col % Row % Expected								
0	1 0.07 12.50 14.29 0.04094	1 0.07 6.67 14.29 0.07675	0 0.00 0.00 0.00 0.11769	1 0.07 1.89 14.29 0.2712	3 0.22 1.11 42.86 1.3867	1 0.07 0.20 14.29 2.58918	0 0.00 0.00 0.00 2.51754	7 0.51
1	0 0.00 0.00 0.00 0.07018	2 0.15 13.33 16.67 0.13158	1 0.07 4.35 8.33 0.20175	3 0.22 5.66 25.00 0.46491	3 0.22 1.11 25.00 2.37719	2 0.15 0.40 16.67 4.4386	1 0.07 0.20 8.33 4.31579	12 0.88
2	0 0.00 0.00 0.00 0.09942	0 0.00 0.00 0.00 0.1864	1 0.07 4.35 5.88 0.28582	3 0.22 5.66 17.65 0.65863	6 0.44 2.21 35.29 3.36769	2 0.15 0.40 11.76 6.28801	5 0.37 1.02 29.41 6.11404	17 1.24
3	0 0.00 0.00 0.00 0.20468	3 0.22 20.00 8.57 0.38377	4 0.29 17.39 11.43 0.58845	6 0.44 11.32 17.14 1.35599	11 0.80 4.06 31.43 6.93348	8 0.58 1.58 22.86 12.9459	3 0.22 0.61 8.57 12.5877	35 2.56
4	2 0.15 25.00 0.79 1.47368	6 0.44 40.00 2.38 2.76316	7 0.51 30.43 2.78 4.23684	15 1.10 28.30 5.95 9.76316	85 6.21 31.37 33.73 49.9211	100 7.31 19.76 39.68 93.2105	37 2.70 7.52 14.68 90.6316	252 18.42
5	5 0.37 62.50 1.01 2.90643	1 0.07 6.67 0.20 5.44956	7 0.51 30.43 1.41 8.35599	17 1,24 32.08 3.42 19.2551	108 7.89 39.85 21.73 98.4554	259 18.93 51.19 52.11 183.832	100 7.31 20.33 20.12 178.746	497 36.33
6	0 0.00 0.00 0.00 3.20468	2 0.15 13.33 0.36 6.00877	3 0.22 13.04 0.55 9.21345	8 0.58 15.09 1.46 21.231	55 4.02 20.30 10.04 108.558	134 9.80 26.48 24.45 202.696	346 25.29 70.33 63.14 197.088	548 40.06
Total	8 0.58	15 1.10	23 1.68	53 3.87	271 19.81	506 36.99	492 35.96	1368

Question 14 vs Question 6 Contingency Analysis



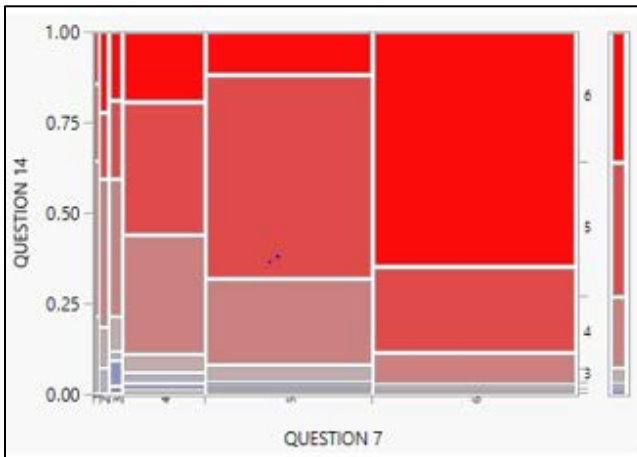
N	DF	-LogLike	RSquare (U)
1360	30	299.61592	0.1657

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	599.232	<.0001*
Pearson	703.588	<.0001*

QUESTION 14

QUESTION 6	Count / Total % / Col % / Row % / Expected	0	1	2	3	4	5	6	Total
0		1	1	0	1	2	1	0	6
		0.07	0.07	0.00	0.07	0.15	0.07	0.00	0.44
		12.50	6.67	0.00	1.92	0.75	0.20	0.00	
		16.67	16.67	0.00	16.67	33.33	16.67	0.00	
		0.03529	0.06618	0.10147	0.22941	1.18235	2.22794	2.15735	
2		0	1	1	1	1	0	0	4
		0.00	0.07	0.07	0.07	0.07	0.00	0.00	0.29
		0.00	6.67	4.35	1.92	0.37	0.00	0.00	
		0.00	25.00	25.00	25.00	25.00	0.00	0.00	
		0.02353	0.04412	0.06765	0.15294	0.78824	1.48529	1.43824	
3		0	3	2	6	5	4	0	20
		0.00	0.22	0.15	0.44	0.37	0.29	0.00	1.47
		0.00	20.00	8.70	11.54	1.87	0.79	0.00	
		0.00	15.00	10.00	30.00	25.00	20.00	0.00	
		0.11765	0.22059	0.33824	0.76471	3.94118	7.42647	7.19118	
4		1	7	9	15	84	53	8	177
		0.07	0.51	0.66	1.10	6.18	3.90	0.59	13.01
		12.50	46.67	39.13	28.85	31.34	10.50	1.64	
		0.56	3.95	5.08	8.47	47.46	29.94	4.52	
		1.04118	1.95221	2.99338	6.76765	34.8794	65.7243	63.6419	
5		5	2	7	21	126	336	104	601
		0.37	0.15	0.51	1.54	9.26	24.71	7.65	44.19
		62.50	13.33	30.43	40.38	47.01	66.53	21.27	
		0.83	0.33	1.16	3.49	20.97	55.91	17.30	
		3.53529	6.62868	10.164	22.9794	118.432	223.165	216.095	
6		1	1	4	8	50	111	377	552
		0.07	0.07	0.29	0.59	3.68	8.16	27.72	40.59
		12.50	6.67	17.39	15.38	18.66	21.98	77.10	
		0.18	0.18	0.72	1.45	9.06	20.11	68.30	
		3.24706	6.08824	9.33529	21.1059	108.776	204.971	198.476	
Total		8	15	23	52	268	505	489	1360
		0.59	1.10	1.69	3.82	19.71	37.13	35.96	

Question 14 vs Question 7 Contingency Analysis:



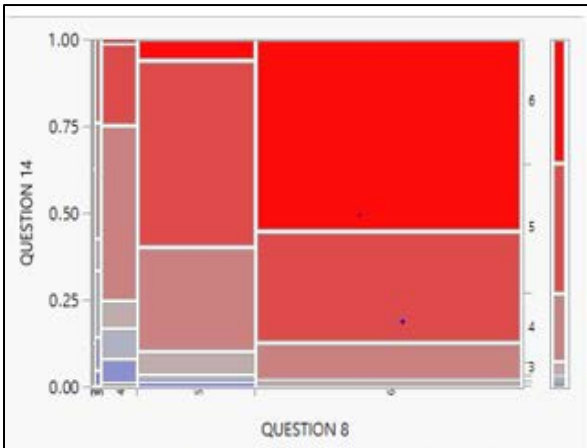
N	DF	-LogLike	RSquare (U)
1363	36	229.51435	0.1268

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	459.029	<.0001*
Pearson	540.240	<.0001*

QUESTION 14

QUESTION 7	Count / Total % / Col % / Row % / Expected	0	1	2	3	4	5	6	Total
0		1	0	0	0	1	0	0	2
		0.07	0.00	0.00	0.00	0.07	0.00	0.00	0.15
		12.50	0.00	0.00	0.00	0.37	0.00	0.00	
		50.00	0.00	0.00	0.00	50.00	0.00	0.00	
		0.01174	0.02054	0.03375	0.0763	0.39912	0.74101	0.71753	
1		0	0	0	3	6	3	2	14
		0.00	0.00	0.00	0.22	0.44	0.22	0.15	1.03
		0.00	0.00	0.00	5.77	2.21	0.59	0.41	
		0.00	0.00	0.00	21.43	42.86	21.43	14.29	
		0.08217	0.1438	0.23624	0.53412	2.79384	5.18709	5.02274	
2		0	0	2	3	11	5	6	27
		0.00	0.00	0.15	0.22	0.81	0.37	0.44	1.98
		0.00	0.00	8.70	5.77	4.04	0.99	1.23	
		0.00	0.00	7.41	11.11	40.74	18.52	22.22	
		0.15847	0.27733	0.45561	1.03008	5.38811	10.0037	9.68672	
3		1	3	1	4	16	9	8	42
		0.07	0.22	0.07	0.29	1.17	0.66	0.59	3.08
		12.50	21.43	4.35	7.69	5.88	1.78	1.64	
		2.38	7.14	2.38	9.52	38.10	21.43	19.05	
		0.24652	0.4314	0.70873	1.60235	8.38151	15.5613	15.0682	
4		2	5	7	12	76	85	45	232
		0.15	0.37	0.51	0.88	5.58	6.24	3.30	17.02
		25.00	35.71	30.43	23.08	27.94	16.83	9.20	
		0.86	2.16	3.02	5.17	32.76	36.64	19.40	
		1.3617	2.38298	3.91489	8.85106	46.2979	85.9574	83.234	
5		4	5	8	21	112	266	57	473
		0.29	0.37	0.59	1.54	8.22	19.52	4.18	34.70
		50.00	35.71	34.78	40.38	41.18	52.67	11.66	
		0.85	1.06	1.69	4.44	23.68	56.24	12.05	
		2.77623	4.8584	7.98166	18.0455	94.3918	175.249	169.697	
6		0	1	5	9	50	137	371	573
		0.00	0.07	0.37	0.66	3.67	10.05	27.22	42.04
		0.00	7.14	21.74	17.31	18.38	27.13	75.87	
		0.00	0.17	0.87	1.57	8.73	23.91	64.75	
		3.36317	5.88555	9.66911	21.8606	114.348	212.3	205.574	
Total		8	14	23	52	272	505	489	1363
		0.59	1.03	1.69	3.82	19.96	37.05	35.88	

Question 14 vs Question 8 Contingency Analysis:

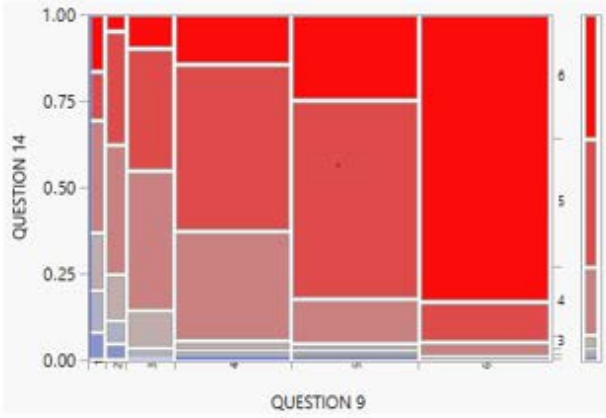


N	DF	-LogLike	RSquare (U)
1361	36	309.18103	0.1709

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	618.362	<.0001*
Pearson	715.320	<.0001*

QUESTION 8 \ QUESTION 14	0	1	2	3	4	5	6	Total
Count Total % Col % Row % Expected								
0	0 0.00 0.00 0.00 0.00588	0 0.00 0.00 0.00 0.01029	0 0.00 0.00 0.00 0.0169	0 0.00 0.00 0.00 0.03894	0 0.00 0.00 0.00 0.19838	0 0.00 0.00 0.00 0.37179	1 0.07 0.21 100.00 0.35783	1 0.07
1	1 0.07 12.50 33.33 0.01763	1 0.07 7.14 33.33 0.03086	0 0.00 0.00 0.00 0.0507	0 0.00 0.00 0.00 0.11683	1 0.07 0.37 33.33 0.59515	0 0.00 0.00 0.00 1.11536	0 0.00 0.00 0.00 1.07348	3 0.22
2	0 0.00 0.00 0.00 0.04702	1 0.07 7.14 12.50 0.08229	0 0.00 0.00 0.00 0.13519	4 0.29 7.55 50.00 0.31154	3 0.22 1.11 37.50 1.58707	0 0.00 0.00 0.00 2.97428	0 0.00 0.00 0.00 2.8626	8 0.59
3	1 0.07 12.50 4.76 0.12344	2 0.15 14.29 9.52 0.21602	4 0.29 17.39 19.05 0.35489	2 0.15 3.77 9.52 0.81778	7 0.51 2.59 33.33 4.16605	5 0.37 0.99 23.81 7.80749	0 0.00 0.00 0.00 7.51433	21 1.54
4	1 0.07 12.50 0.88 0.66422	8 0.59 57.14 7.08 1.16238	10 0.73 43.48 8.85 1.90963	9 0.66 16.98 7.96 4.40044	57 4.19 21.11 50.44 22.4173	27 1.98 5.34 23.89 42.0118	1 0.07 0.21 0.88 40.4342	113 8.30
5	3 0.22 37.50 0.80 2.20426	1 0.07 7.14 0.27 3.85746	9 0.66 39.13 2.40 6.33725	26 1.91 49.06 6.93 14.6032	112 8.23 41.48 29.87 74.3938	202 14.84 39.92 53.87 139.42	22 1.62 4.52 5.87 134.184	375 27.55
6	2 0.15 25.00 0.24 4.93755	1 0.07 7.14 0.12 8.64071	0 0.00 0.00 0.00 14.1954	12 0.88 22.64 1.43 32.7112	90 6.61 33.33 10.71 166.642	272 19.99 53.75 32.38 312.3	463 34.02 95.07 55.12 300.573	840 61.72
Total	8 0.59	14 1.03	23 1.69	53 3.89	270 19.84	506 37.18	487 35.78	1361

Question 14 vs Question 9 Contingency Analysis:

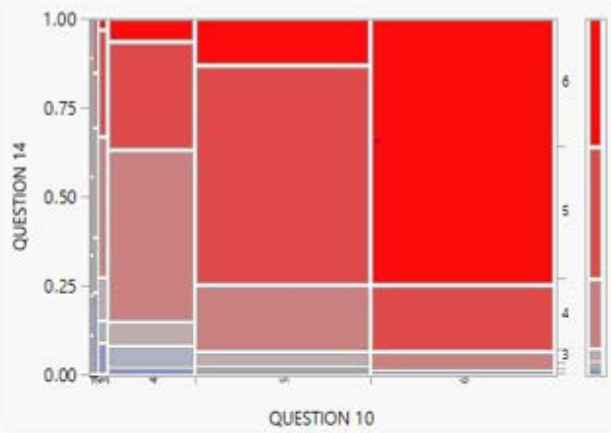


N	DF	-LogLike	RSquare (U)
1364	36	367.01455	0.2028

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	734.029	<.0001*
Pearson	937.488	<.0001*

QUESTION 9 \ QUESTION 14	0	1	2	3	4	5	6	Total
Count Total % Col % Row % Expected								
0	1 0.07 12.50 100.00 0.00587	0 0.00 0.00 0.00 0.01026	0 0.00 0.00 0.00 0.01686	0 0.00 0.00 0.00 0.03812	0 0.00 0.00 0.00 0.19795	0 0.00 0.00 0.00 0.37243	0 0.00 0.00 0.00 0.3585	1 0.07
1	0 0.00 0.00 0.00 0.28739	4 0.29 28.57 8.16 0.50293	6 0.44 26.09 12.24 0.82625	8 0.59 15.38 16.33 1.86804	16 1.17 5.93 32.65 9.69941	7 0.51 1.38 14.29 18.2493	8 0.59 1.64 16.33 17.5667	49 3.59
2	0 0.00 0.00 0.00 0.35777	3 0.22 21.43 4.92 0.6261	4 0.29 17.39 6.56 1.02859	8 0.59 15.38 13.11 2.32551	23 1.69 8.52 37.70 12.0748	20 1.47 3.94 32.79 22.7185	3 0.22 0.61 4.92 21.8688	61 4.47
3	0 0.00 0.00 0.00	1 0.07 7.14 0.69	4 0.29 17.39 2.78	16 1.17 30.77 11.11	58 4.25 21.48 40.28	51 3.74 10.04 35.42	14 1.03 2.86 9.72	144 10.56
4	2 0.15 25.00 0.58 2.02346	1 0.07 7.14 0.29 3.54106	7 0.51 30.43 2.03 5.81745	10 0.73 19.23 2.90 13.1525	108 7.92 40.00 31.30 68.2918	168 12.32 33.07 48.70 128.49	49 3.59 10.02 14.20 123.684	345 25.29
5	5 0.37 62.50 1.33 2.21114	4 0.29 28.57 1.06 3.8695	1 0.07 4.35 0.27 6.35704	8 0.59 15.38 2.12 14.3724	49 3.59 18.15 13.00 74.6261	217 15.91 42.72 57.56 140.408	93 6.82 19.02 24.67 135.156	377 27.64
6	0 0.00 0.00 0.00 2.26979	1 0.07 7.14 0.26 3.97214	1 0.07 4.35 0.26 6.52566	2 0.15 3.85 0.52 14.7537	16 1.17 5.93 4.13 76.6056	45 3.30 8.86 11.63 144.132	322 23.61 65.85 83.20 138.741	387 28.37
Total	8 0.59	14 1.03	23 1.69	52 3.81	270 19.79	508 37.24	489 35.85	1364

Question 14 vs Question 10 Contingency Analysis

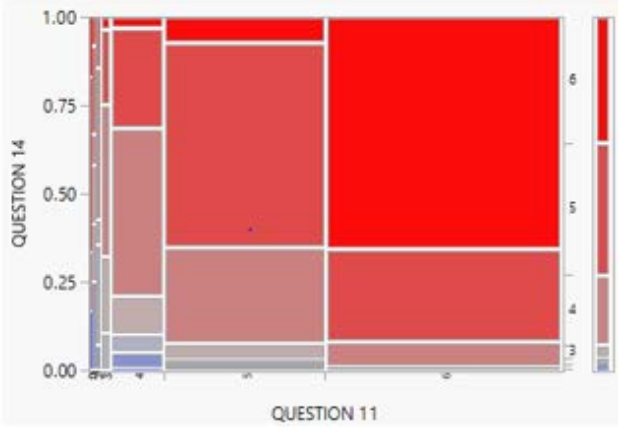


N	DF	-LogLike	RSquare (U)
1358	30	415.79485	0.2300

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	831.590	<.0001*
Pearson	927.053	<.0001*

QUESTION 10	QUESTION 14							
Count Total % Col % Row % Expected	0	1	2	3	4	5	6	Total
1	1 0.07 12.50 11.11 0.05302	1 0.07 6.67 11.11 0.09941	1 0.07 4.35 11.11 0.15243	2 0.15 3.77 22.22 0.35125	3 0.22 1.12 33.33 1.76951	0 0.00 0.00 0.00 3.34021	1 0.07 0.20 11.11 3.23417	9 0.66
2	0 0.00 0.00 0.00 0.07658	3 0.22 20.00 23.08 0.14359	2 0.15 8.70 15.38 0.22018	4 0.29 7.55 30.77 0.50736	2 0.15 0.75 15.38 2.55596	2 0.15 0.40 15.38 4.82474	0 0.00 0.00 0.00 4.67158	13 0.96
3	0 0.00 0.00 0.00 0.1944	3 0.22 20.00 9.09 0.36451	2 0.15 8.70 6.06 0.55891	4 0.29 7.55 12.12 1.28792	13 0.96 4.87 39.39 6.48822	10 0.74 1.98 30.30 12.2474	1 0.07 0.20 3.03 11.8586	33 2.43
4	1 0.07 12.50 0.40 1.49043	4 0.29 26.67 1.58 2.79455	16 1.18 69.57 6.32 4.28498	16 1.18 30.19 6.32 9.87408	123 9.06 46.07 48.62 49.743	77 5.67 15.28 30.43 93.8969	16 1.18 3.28 6.32 90.9161	253 18.63
5	6 0.44 75.00 1.17 3.02798	3 0.22 20.00 0.58 5.67747	2 0.15 8.70 0.39 8.70545	22 1.62 41.51 4.28 20.0604	97 7.14 36.33 18.87 101.059	316 23.27 62.70 61.48 190.763	68 5.01 13.93 13.23 184.707	514 37.85
6	0 0.00 0.00 0.00 3.15758	1 0.07 6.67 0.19 5.92047	0 0.00 0.00 0.00 9.07806	5 0.37 9.43 0.93 20.919	29 2.14 10.86 5.41 105.384	99 7.29 19.64 18.47 198.928	402 29.60 82.38 75.00 192.613	536 39.47
Total	8 0.59	15 1.10	23 1.69	53 3.90	267 19.66	504 37.11	488 35.94	1358

Question 14 vs Question 11 Contingency Analysis:

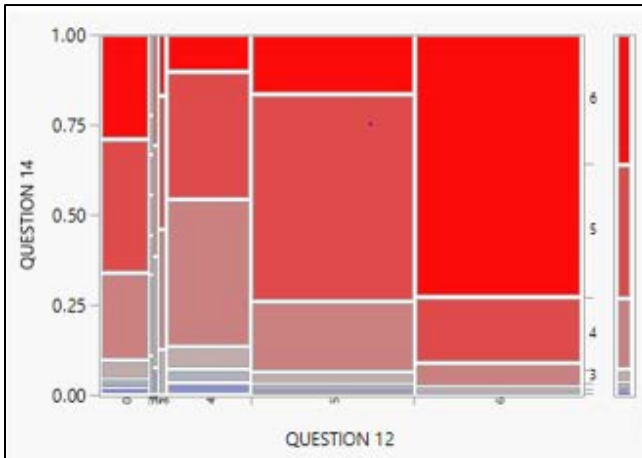


N	DF	-LogLike	RSquare (U)
1362	36	384.09083	0.2119

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	768.182	<.0001*
Pearson	857.400	<.0001*

QUESTION 11	QUESTION 14							
Count Total % Col % Row % Expected	0	1	2	3	4	5	6	Total
0	1 0.07 12.50 16.67 0.03524	0 0.00 0.00 0.00 0.06608	0 0.00 0.00 0.00 0.10132	0 0.00 0.00 0.00 0.23348	1 0.07 0.37 16.67 1.18502	3 0.22 0.59 50.00 2.22907	1 0.07 0.20 16.67 2.14978	6 0.44
1	0 0.00 0.00 0.00 0.07048	3 0.22 20.00 25.00 0.13216	2 0.15 8.70 16.67 0.20264	2 0.15 3.77 16.67 0.46696	1 0.07 0.37 8.33 2.37004	3 0.22 0.59 25.00 4.45815	1 0.07 0.20 8.33 4.29956	12 0.88
2	0 0.00 0.00 0.00 0.08223	1 0.07 6.67 7.14 0.15419	4 0.29 17.39 28.57 0.23642	1 0.07 1.89 7.14 0.54479	6 0.44 2.23 42.86 2.76505	2 0.15 0.40 14.29 5.20117	0 0.00 0.00 0.00 5.01615	14 1.03
3	0 0.00 0.00 0.00	0 0.00 0.00 0.00	3 0.22 13.04 10.71	6 0.44 11.32 21.43	12 0.88 4.46 42.86	6 0.44 1.19 21.43	1 0.07 0.20 3.57	28 2.06
4	1 0.07 12.50 0.64 0.9163	7 0.51 46.67 4.49 1.71806	8 0.59 34.78 5.13 2.63436	17 1.25 32.08 10.90 6.07048	74 5.43 27.51 47.44 30.8106	44 3.23 8.70 28.21 57.9559	5 0.37 1.02 3.21 55.8943	156 11.45
5	5 0.37 62.50 1.08 2.73128	3 0.22 20.00 0.65 5.12115	6 0.44 26.09 1.29 7.85242	21 1.54 39.62 4.52 18.0947	127 9.32 47.21 27.31 91.8392	269 19.75 53.16 57.85 172.753	34 2.50 6.97 7.31 166.608	465 34.14
6	1 0.07 12.50 0.15 4	1 0.07 6.67 0.15 7.5	0 0.00 0.00 0.00 11.5	6 0.44 11.32 0.88 26.5	48 3.52 17.84 7.05 134.5	179 13.14 35.38 26.28 253	446 32.75 91.39 65.49 244	681 50.00
Total	8 0.59	15 1.10	23 1.69	53 3.89	269 19.75	506 37.15	488 35.83	1362

Question 14 vs Question 12 Contingency Analysis:



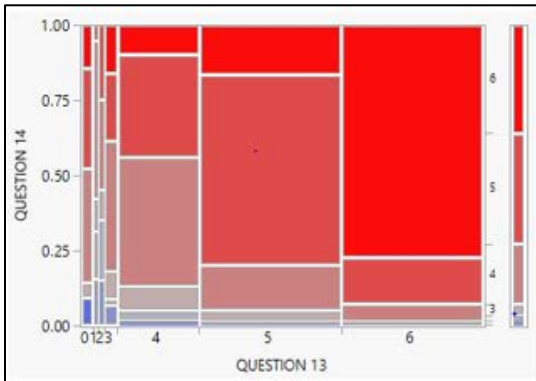
N	DF	-LogLike	RSquare (U)
1366	36	283.70599	0.1561

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	567.412	<.0001*
Pearson	629.304	<.0001*

QUESTION 14

QUESTION 12 / Count / Total % / Col % / Row % / Expected	0	1	2	3	4	5	6	Total
0	3	1	2	8	34	53	41	142
	0.22	0.07	0.15	0.59	2.49	3.88	3.00	10.40
	37.50	6.67	8.70	15.09	12.64	10.45	8.35	
	2.11	0.70	1.41	5.63	23.94	37.32	28.87	
	0.83163	1.5593	2.39092	5.50952	27.9634	52.7042	51.041	
1	1	2	1	1	1	1	2	9
	0.07	0.15	0.07	0.07	0.07	0.07	0.15	0.66
	12.50	13.33	4.35	1.89	0.37	0.20	0.41	
	11.11	22.22	11.11	11.11	11.11	11.11	22.22	
	0.05271	0.09683	0.15154	0.34919	1.77233	3.34041	3.23499	
2	0	1	0	4	4	4	0	13
	0.00	0.07	0.00	0.29	0.29	0.29	0.00	0.95
	0.00	6.67	0.00	7.55	1.49	0.79	0.00	
	0.00	7.69	0.00	30.77	30.77	30.77	0.00	
	0.07613	0.14275	0.21889	0.50439	2.56003	4.82504	4.67277	
3	0	0	0	3	8	9	4	24
	0.00	0.00	0.00	0.22	0.59	0.66	0.29	1.76
	0.00	0.00	0.00	5.66	2.97	1.78	0.81	
	0.00	0.00	0.00	12.50	33.33	37.50	16.67	
	0.14056	0.26354	0.4041	0.93119	4.72621	8.90776	8.62665	
4	0	9	9	15	99	85	25	242
	0.00	0.66	0.66	1.10	7.25	6.22	1.83	17.72
	0.00	60.00	39.13	28.30	36.80	16.77	5.09	
	0.00	3.72	3.72	6.20	40.91	35.12	10.33	
	1.41728	2.65739	4.07467	9.38946	47.6559	89.8199	86.9854	
5	4	2	9	14	91	268	76	464
	0.29	0.15	0.66	1.02	6.66	19.62	5.56	33.97
	50.00	13.33	39.13	26.42	33.83	52.86	15.48	
	0.86	0.43	1.94	3.02	19.61	57.76	16.38	
	2.71742	5.09517	7.81259	18.0029	91.3734	172.217	166.782	
6	0	0	2	8	32	87	343	472
	0.00	0.00	0.15	0.59	2.34	6.37	25.11	34.55
	0.00	0.00	8.70	15.09	11.90	17.16	69.86	
	0.00	0.00	0.42	1.69	6.78	18.43	72.67	
	2.76428	5.18302	7.94729	18.3133	92.9488	175.186	169.657	
Total	8	15	23	53	269	507	491	1366
	0.59	1.10	1.68	3.88	19.69	37.12	35.94	

Question 14 vs Question 13 Contingency Analysis:



N	DF	-LogLike	RSquare (U)
1367	36	394.03016	0.2165

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	788.060	<.0001*
Pearson	930.634	<.0001*

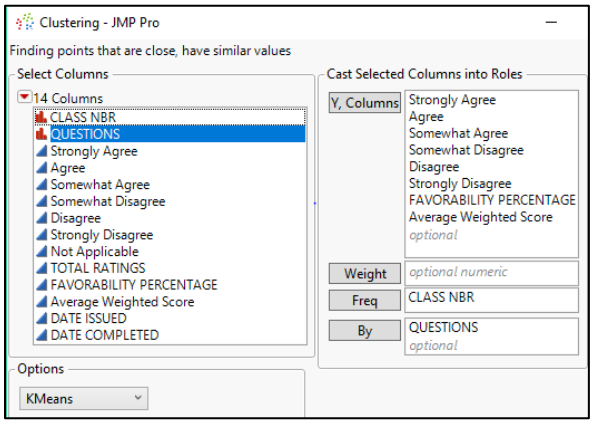
QUESTION 14

QUESTION 13 / Count / Total % / Col % / Row % / Expected	0	1	2	3	4	5	6	Total
0	4	0	0	2	16	14	6	42
	0.29	0.00	0.00	0.15	1.17	1.02	0.44	3.07
	50.00	0.00	0.00	3.77	5.88	2.77	1.22	
	9.52	0.00	0.00	4.76	38.10	33.33	14.29	
	0.24579	0.46086	0.70666	1.62838	8.35699	15.5157	15.0856	
1	0	3	3	2	10	1	0	19
	0.00	0.22	0.22	0.15	0.73	0.07	0.00	1.39
	0.00	20.00	13.04	3.77	3.68	0.20	0.00	
	0.00	15.79	15.79	10.53	52.63	5.26	0.00	
	0.11119	0.20849	0.31968	0.73665	3.78054	7.01902	6.82443	
2	0	3	4	2	6	5	0	20
	0.00	0.22	0.29	0.15	0.44	0.37	0.00	1.46
	0.00	20.00	17.39	3.77	2.21	0.99	0.00	
	0.00	15.00	20.00	10.00	30.00	25.00	0.00	
	0.11704	0.21946	0.3365	0.77542	3.97952	7.38844	7.18361	
3	0	3	1	4	19	10	7	44
	0.00	0.22	0.07	0.29	1.39	0.73	0.51	3.22
	0.00	20.00	4.35	7.55	6.99	1.98	1.43	
	0.00	6.82	2.27	9.09	43.18	22.73	15.91	
	0.2575	0.48281	0.74031	1.70593	8.75494	16.2546	15.804	
4	2	3	10	21	119	95	27	277
	0.15	0.22	0.73	1.54	8.71	6.95	1.98	20.26
	25.00	20.00	43.48	39.62	43.75	18.81	5.50	
	0.72	1.08	3.61	7.58	42.96	34.30	9.75	
	1.62107	3.0395	4.66057	10.7396	55.1163	102.33	99.4931	
5	2	2	4	17	74	306	80	485
	0.15	0.15	0.29	1.24	5.41	22.38	5.85	35.48
	25.00	13.33	17.39	32.08	27.21	60.59	16.29	
	0.41	0.41	0.82	3.51	15.26	63.09	16.49	
	2.83833	5.32187	8.1602	18.804	96.5033	179.17	174.203	
6	0	1	1	5	28	74	371	480
	0.00	0.07	0.07	0.37	2.05	5.41	27.14	35.11
	0.00	6.67	4.35	9.43	10.29	14.65	75.56	
	0.00	0.21	0.21	1.04	5.83	15.42	77.29	
	2.80907	5.26701	8.07608	18.6101	95.5084	177.323	172.407	
Total	8	15	23	53	272	505	491	1367
	0.59	1.10	1.68	3.88	19.90	36.94	35.92	

Appendix VI: Clustering Analysis Results for EOC Survey

Clustering Analysis Question-1:

- The clustering analysis is launched with 3 clusters and the range was given as 5 clusters and we can observe that the cluster cubic criterion (CCC) is more for 5 clusters and that is the optimal number of clusters for question 1



Iterative Clustering QUESTIONS=QUESTION 1

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	284.337	
K-Means Clustering	4	293.353	
K-Means Clustering	5	312.552	Optimal CCC

K Means NCluster=5

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	4	4	0
2	58		
3	25		
4	2		
5	1		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	12.2425427	2.01150422	0.99439885	1	0	0	93.7920174	5.54650645
2	13.592115	1.75521995	0.22586033	0	0	0	100	5.86039769
3	8.91039131	4.76761493	1.25306649	0	0	0	100	5.50409838
4	8.72073172	2.52792683	2.05585366	0	1	0	92.5780365	5.16627618
5	7	1	0	0	1	1	80	5

- In the above image it is seen in the cluster summary that how many classes are distributed in each of the 5 clusters based on their similar properties of the responses as well as the FP and AWS

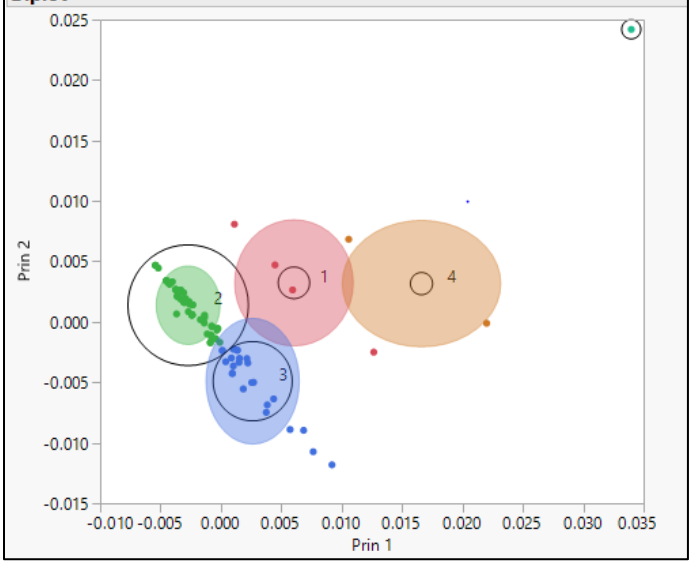
- The cluster means gives us the means of the each variable in that cluster for the responses, FP and AWS for Question-1.

- With the cluster analysis we can understand which classes have similar properties and how we can the factors be used to increase the overall satisfaction by continuous improvement

Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	3.69966966	1.58118068	1.22475768	0	0	0	0.59318033	0.25276916
2	3.77850315	1.2534903	0.45649298	0	0	0	0	0.0965544
3	2.63698546	1.83914599	1.33512948	0	0	0	0	0.15183098
4	5.007793	0.5007793	1.0015586	0	0	0	1.77043187	0.3692615
5	0	0	0	0	0	0	0	0

Biplot



Clustering Analysis Question-2:

K Means NCluster=5

Columns Scaled Individually

Cluster Summary

Cluster	Count
1	67
2	1
3	9
4	11
5	2

Step	Criterion
4	0

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	10.3720225	3.93616448	0.907559	0	0	0	100	5.61439332
2	26	9	1	0	0	0	100	5.69444444
3	7.90442981	4.94842761	1.10725315	1.11572184	0	0	92.3152459	5.2911307
4	8.87702894	3.53452466	0.79269881	0.17416944	0	1	90.9647815	5.21090786
5	5	6.5171198	2.9885868	1	1	0	87.8718431	4.81693176

Cluster Standard Deviations

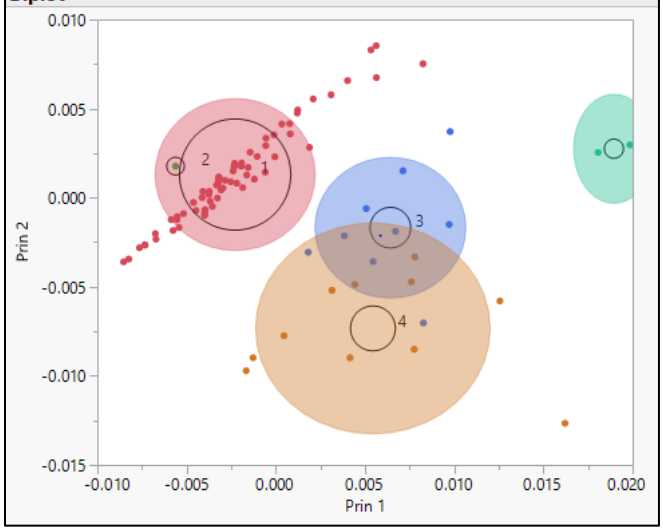
Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	3.68118994	2.61313273	1.00949495	0	0	0	0	0.25284301
2	3.5527e-15	0	1.1102e-16	0	0	0	1.4211e-14	8.8818e-16
3	2.72623188	1.70045541	0.99381548	0.3143035	0	0	2.35354371	0.16804397
4	4.3450542	2.42578173	1.19253385	0.38577044	0	0	4.76003965	0.2952758
5	0	1.50009769	1.00006513	1.1102e-16	1.1102e-16	0	0.367671	0.06618078

Iterative Clustering QUESTIONS=QUESTION 2

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	293.413	
K-Means Clustering	4	301.363	
K-Means Clustering	5	311.537	Optimal CCC

Biplot



Clustering Analysis Question-3:

K Means NCluster=5

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	58	5	0
2	12		
3	8		
4	9		
5	3		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	12.3519167	2.40344223	0.48576809	0	0	0	100	5.77935968
2	9.64926534	4.35129594	0.84017161	1	0	0	93.4024589	5.42412312
3	9.75180061	2.91955882	1.2872132	0.12348227	0	1	92.4817111	5.29003522
4	7.83182489	4.24157276	3.22403271	0	0	0	100	5.29265381
5	9.57302266	4.05809598	2.34792473	0	1	0	94.0963909	5.24787617

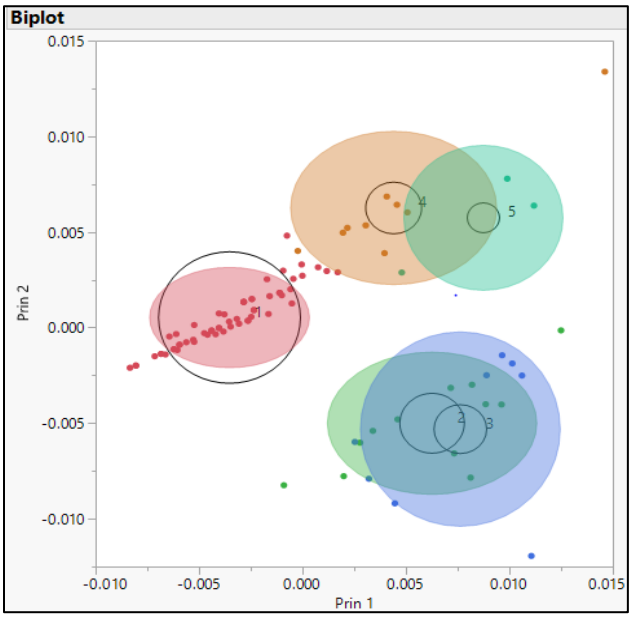
Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	3.78997399	1.76108344	0.67572801	0	0	0	0	0.133855
2	3.27072583	2.83391852	0.68721829	0	0	0	1.66260832	0.18126947
3	2.04633899	1.83340134	1.09035995	0.3307224	0	0	1.8282659	0.18575111
4	3.54209912	1.98771017	1.22726367	0	0	0	0	0.21433088
5	2.05693739	1.41540635	1.24730448	0	0	0	0.28377206	0.15415814

Iterative Clustering QUESTIONS=QUESTION 3

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	309.13	
K-Means Clustering	4	315.619	
K-Means Clustering	5	328.418	Optimal CCC



Clustering Analysis Question-4:

K Means NCluster=5

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	32	11	0
2	10		
3	30		
4	16		
5	2		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	12.25462	2.83539038	0.69068576	0	0.09157048	0	99.4078921	5.70319295
2	7.39797021	5.63133748	1.83511075	1.09215862	0	0	92.9106391	5.21722109
3	5.75826011	4.65429343	2.34808355	0	0	0	100	5.2225951
4	8.78421434	8.1781451	1.06904683	0	0	0	100	5.40415226
5	11.0000217	4.49998913	1	0	0.49998913	1	91.666727	5.25000302

Cluster Standard Deviations

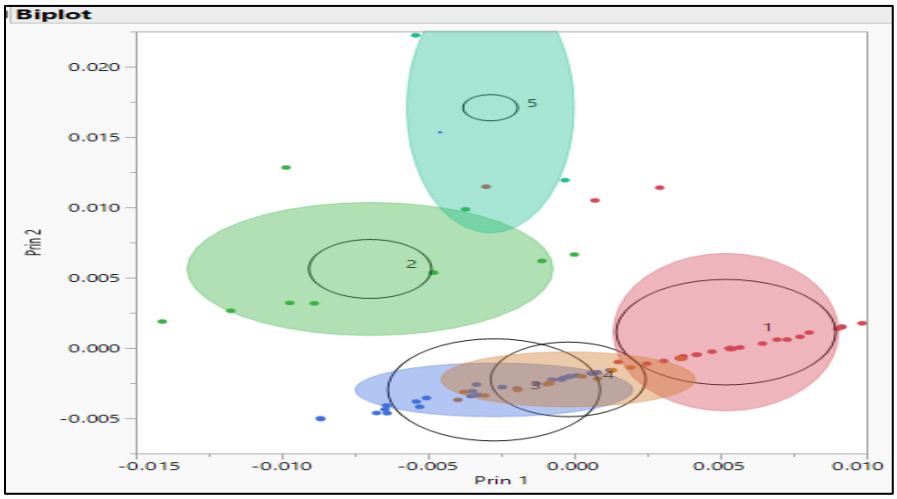
Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	2.4591025	1.43854295	0.63431372	0	0.29148874	0	1.93136414	0.16604043
2	2.65714322	2.05936447	1.66169575	0.30010246	0	0	2.38290037	0.23313005
3	2.26484221	1.79796039	1.1926608	0	0	0	0	0.21424841
4	2.98381364	2.76630281	0.74741997	0	0	0	0	0.15891826
5	1	0.5	0	0	0.5	0	2.77777778	0.13888889

Iterative Clustering QUESTIONS=QUESTION 4

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	316.728	
K-Means Clustering	4	321.044	
K-Means Clustering	5	329.692	Optimal CCC

Biplot



Clustering Analysis Question-5:

K Means NCluster=5

Columns Scaled Individually

Cluster Summary

Cluster	Count
1	2
2	1
3	15
4	34
5	38

Step	Criterion
5	0

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	2.49997814	3.49997814	4.00008745	1.99995627	2.50002186	1	64.3751913	3.9062459
2	12	14	10	0	0	0	100	5.05555556
3	3.50763228	3.15648071	3.76574663	1.14907525	0.39570071	0.4033805	83.1662758	4.47281514
4	9.14830168	4.86799175	1.63470925	0.14861667	0.11756083	0.02864026	98.2527397	5.43468203
5	4.4297327	7.07364572	3.36705134	0.23975149	0.05253891	0.07842815	97.7260583	4.96371403

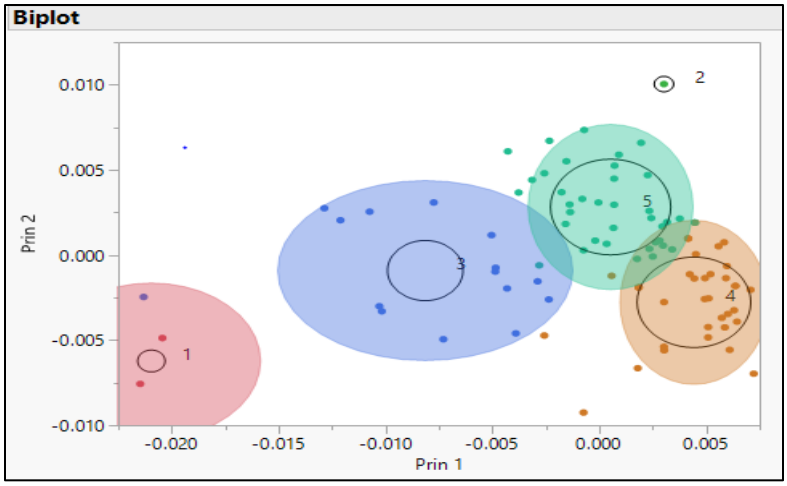
Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	0.5	0.5	2	1	0.5	0	4.375	0.09375
2	1.7764e-15	1.7764e-15	0	0	0	0	1.4211e-14	0
3	1.4998498	2.09350377	1.38922263	0.71819452	0.48991681	0.48990961	8.34449133	0.4501586
4	2.08327628	2.41037234	1.00057792	0.35416797	0.40327381	0.16895949	3.33871514	0.14850615
5	1.9015683	2.42742834	1.4379836	0.42515454	0.2232969	0.2696571	2.99956302	0.21502702

Iterative Clustering QUESTIONS=QUESTION 5

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	271.919	
K-Means Clustering	4	284.007	
K-Means Clustering	5	300.79	Optimal CCC



Clustering Analysis Question-6:

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	46	5	0
2	4		
3	12		
4	25		
5	1		
6	2		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	8.25304834	6.30032669	1.14578875	0.02267114	0	0	99.8740492	5.44148796
2	4.99995384	4.7499004	3.25003644	0.50000243	1	0	89.4145877	4.74998291
3	4.46004678	8.84999875	1.7509018	1	0	0	93.5720274	5.04362297
4	3.24243598	7.08675486	3.22144884	0	0	0	100	4.93169465
5	15	13	6	2	0	0	94.4444444	5.13888889
6	2.94444558	1.58333162	2.94444558	1.52777721	0	0	83.0246977	4.66049395

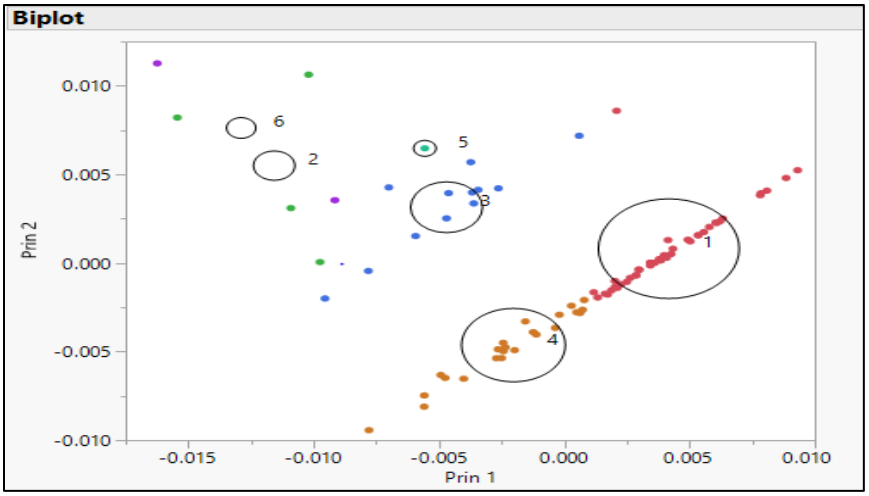
Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	2.48639112	2.34678563	0.85892575	0.1458335	0	0	0.8101861	0.15358825
2	1.22474487	1.47901995	1.78535711	0.5	0	0	3.27872106	0.19507833
3	2.06193993	2.4216041	1.42156046	0	0	0	1.33432713	0.17044214
4	1.65602112	2.54433599	1.41437621	0	0	0	0	0.22152804
5	1.7764e-15	1.7764e-15	8.8818e-16	2.2204e-16	0	0	1.4211e-14	0
6	1.00154196	1.50231294	1.00154196	0.50077098	0	0	5.56412199	0.11128244

Iterative Clustering QUESTIONS=QUESTION 6

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	285.628	
K-Means Clustering	4	284.226	
K-Means Clustering	5	299.248	
K-Means Clustering	6	311.107	Optimal CCC



Clustering Analysis Question-7:

K Means NCluster=5

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	8	5	0
2	66		
3	1		
4	14		
5	1		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	5.71980314	4.15251813	2.76387132	1.47005099	1.52978202	0	80.5629541	4.72891807
2	6.86847377	5.4595396	2.34936506	0.25335911	0.15146677	0	97.3766963	5.2238141
3	14	17	5	0	0	0	100	5.25
4	4.12848361	5.04932616	3.69164967	0.7260362	0.36178458	0.92959315	86.5860109	4.59796395
5	1	2	1	3	0	1	50	3.75

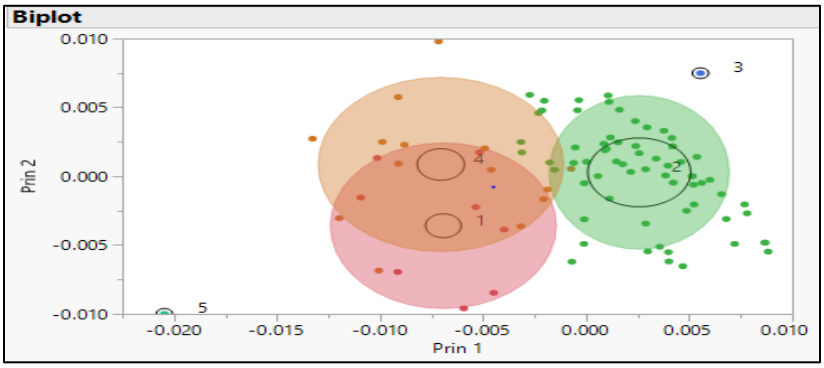
Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	1.5615415	1.83306635	1.78541099	1.00044837	1.11843058	0	3.60562397	0.21656689
2	3.24635793	2.61731565	1.59869089	0.47069236	0.35855029	0	3.63816407	0.26984744
3	1.7764e-15	0	0	0	0	0	1.4211e-14	0
4	2.67875519	1.96458034	1.95023104	0.88070896	0.47917991	0.45736716	5.72713555	0.30275427
5	1.1102e-16	2.2204e-16	1.1102e-16	0	0	1.1102e-16	0	4.4409e-16

Iterative Clustering QUESTIONS=QUESTION 7

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	304.063	
K-Means Clustering	4	313.757	
K-Means Clustering	5	319.754	Optimal CCC



Clustering Analysis Question-8:

K Means NCluster=5

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	5	3	0
2	80		
3	1		
4	1		
5	3		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	3.60737887	4.82190453	3.60711139	0.39282174	1.20241439	0	87.7576716	4.63443691
2	9.73934508	4.1669287	1.07389997	0.20340686	0.01184017	0	98.5514248	5.52101636
3	24	9	2	0	1	0	97.2222222	5.52777778
4	10	4	1	3	0	0	83.3333333	5.16666667
5	3.65444773	3.69102061	2.69105418	0.34553548	0	1	86.9285175	4.62339186

Cluster Standard Deviations

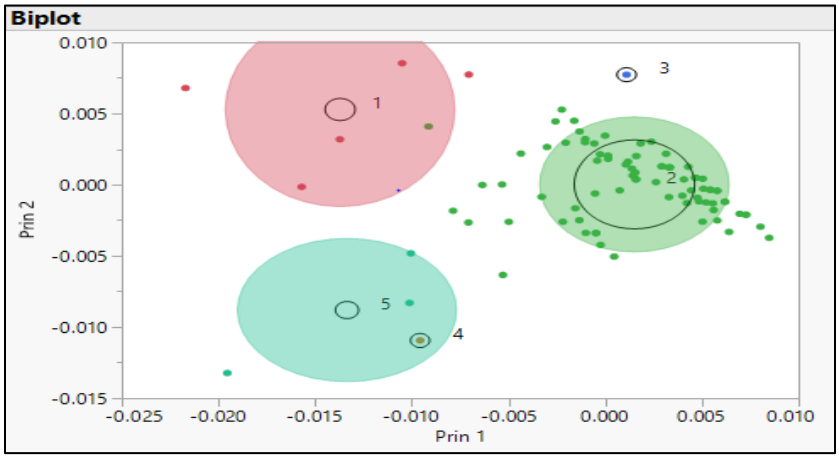
Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	1.35648607	2.56134336	1.0198287	0.48995054	0.40000729	0	5.55069384	0.2662117
2	3.62293338	2.10621296	1.14399463	0.40001451	0.11110439	0	2.85488972	0.26293432
3	3.5527e-15	0	2.2204e-16	0	1.1102e-16	0	1.4211e-14	8.8818e-16
4	0	0	0	0	0	0	0	0
5	1.24727898	1.69984764	0.47203493	0.47156242	0	0	6.68809161	0.28943056

Iterative Clustering QUESTIONS=QUESTION 8

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	288.615	
K-Means Clustering	4	298.358	
K-Means Clustering	5	301.316	Optimal CCC

Biplot



Clustering Analysis Question-9:

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

Cluster	Count
1	1
2	23
3	2
4	17
5	26
6	21

Step	Criterion
4	0

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	7	13	8	7	1	0	77.7777778	4.5
2	7.65873996	3.83998223	3.09270091	0.60902731	0.17207159	0.16990208	93.9528188	5.13285957
3	0	1.50003158	3.00006316	4	2.99993684	4.49996842	28.1255922	2.62501579
4	2.58871027	2.56389499	4.24889502	2.79115522	2.06199961	1.05269557	60.9099336	3.8060731
5	3.14056746	4.57668774	2.43115487	1.79019175	0.34759206	0.56875199	79.12749	4.49788134
6	3.61848913	5.55250723	6.00655917	1.14732322	0.3390225	0.14762823	90.4833248	4.62704503

Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	8.8818e-16	1.7764e-15	8.8818e-16	8.8818e-16	1.1102e-16	0	1.4211e-14	0
2	2.03468172	1.83337167	1.61281345	0.64194891	0.37903916	0.37905591	5.52869524	0.21175074
3	0	0.5	1	0	1	0.5	9.37500002	0.25
4	1.7139605	1.50010801	1.47652151	1.24825539	0.99827345	0.93751282	8.65094182	0.3197581
5	1.74740687	2.27443595	1.21446174	1.18689654	0.5506873	0.68914355	7.29161773	0.25010629
6	1.86081663	2.03838627	1.27243493	0.98975339	0.56346489	0.34995963	6.57887033	0.2470962

Iterative Clustering QUESTIONS=QUESTION 9

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	256.797	
K-Means Clustering	4	271.738	
K-Means Clustering	5	285.546	
K-Means Clustering	6	300.667	Optimal CCC

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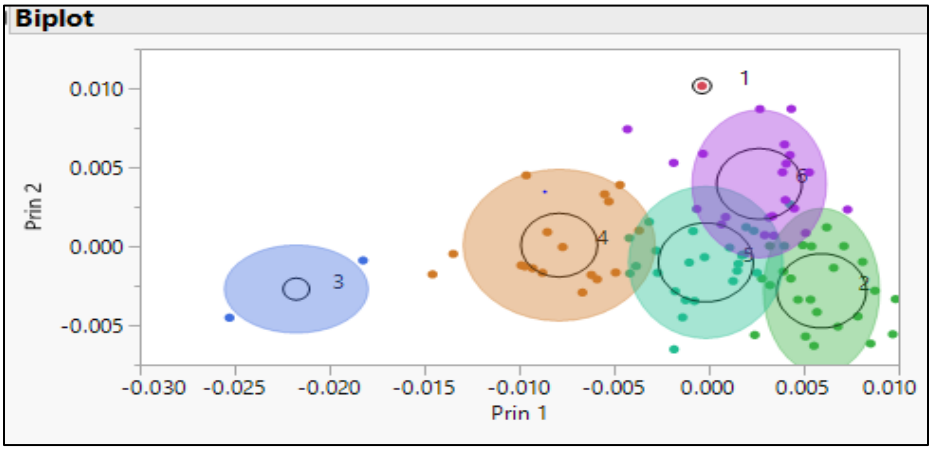

Clustering Analysis Question-10:

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	2	8	0
2	25		
3	1		
4	10		
5	7		
6	45		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	2.00008745	3.50004373	5.99982509	0	1.49995627	2	76.7858705	3.91519848
2	9.02419347	3.4604331	1.92779653	0.16057828	0.07801785	0	98.03006	5.42972127
3	13	14	8	1	0	0	97.2222222	5.08333333
4	1.60108894	4.41931334	5.53214703	0	0.41682975	0.10301344	96.1193839	4.54172517
5	5.56635779	5.31721441	2.69007465	2.15494109	0.43548427	0.13243351	82.808242	4.79328271
6	5.2759477	7.42627693	2.50870565	0.29113062	0.02087042	0.06613002	97.7128482	5.11377812

Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	1	0.5	2.00000001	0	0.5	2.2204e-16	1.78571429	0.22767857
2	2.78578271	1.60212906	1.49454367	0.46303384	0.27130044	0	4.08983848	0.21629033
3	1.7764e-15	1.7764e-15	8.8818e-16	1.1102e-16	0	0	1.4211e-14	0
4	1.28062531	1.74366654	1.96240501	0	0.66353842	0.30001513	4.95343383	0.19779936
5	1.29363639	1.57822311	1.16082942	0.83308077	0.49491994	0.35008232	5.64752311	0.1491729
6	2.21961	2.21525555	1.24047218	0.45325172	0.14741174	0.2494444	2.96670919	0.16601542

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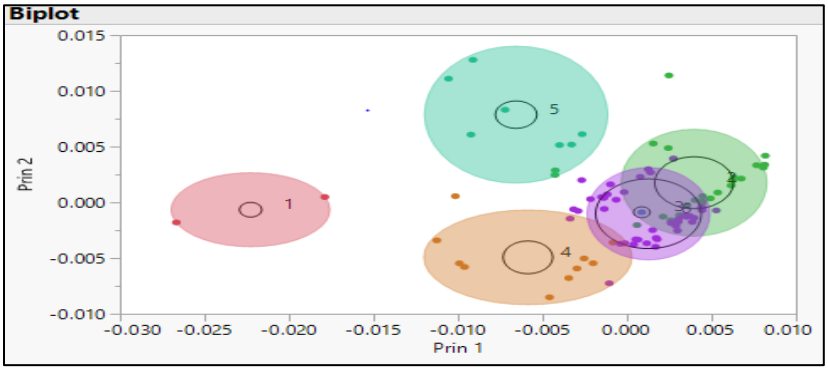

Iterative Clustering QUESTIONS=QUESTION 10

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	300.973	
K-Means Clustering	4	301.184	
K-Means Clustering	5	313.862	
K-Means Clustering	6	323.307	Optimal CCC

Clustering Analysis Question-11:

Iterative Clustering QUESTIONS=QUESTION 11

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	288.469	
K-Means Clustering	4	296.193	
K-Means Clustering	5	307.547	
K-Means Clustering	6	317.948	Optimal CCC

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	1	5	0
2	36		
3	20		
4	25		
5	3		
6	5		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	21	12	2	0	0	0	100	5.54285714
2	10.2599454	3.74153759	1.49419921	0.20569145	0	0	98.7502707	5.53275601
3	7.38054843	7.80857971	0.55069991	0.0511461	0	0.24724387	98.2763573	5.32596314
4	4.83114549	5.67129413	2.95304748	0.56834047	0.35089321	0	93.0127033	4.89292101
5	3	3.68440034	3.00002893	2.33839597	1.33081648	0.33081648	70.5892582	4.28036326
6	2.48836947	3.30018961	1.98746454	0	0.19882123	1.21144092	84.8401877	4.46440276

Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	0	1.7764e-15	2.2204e-16	0	0	0	1.4211e-14	0
2	2.71187492	1.55666714	1.16668109	0.46077961	0	0	2.87650239	0.17782013
3	2.10722053	1.69117522	0.58949172	0.21794796	0	0.43302147	2.6470721	0.17792175
4	2.67852168	2.20712014	1.2628112	0.75264172	0.48008638	0	5.23465633	0.23298328
5	0	1.69976568	0.81649658	0.4714317	0.47141124	0.47141124	3.42484028	0.19799702
6	2.24776809	2.04206708	0.63257975	0	0.40000174	0.40016358	4.44676776	0.37675984

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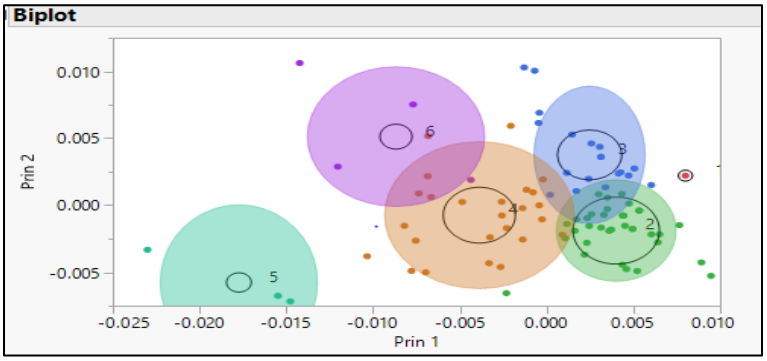


Clustering Analysis Question-12:

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

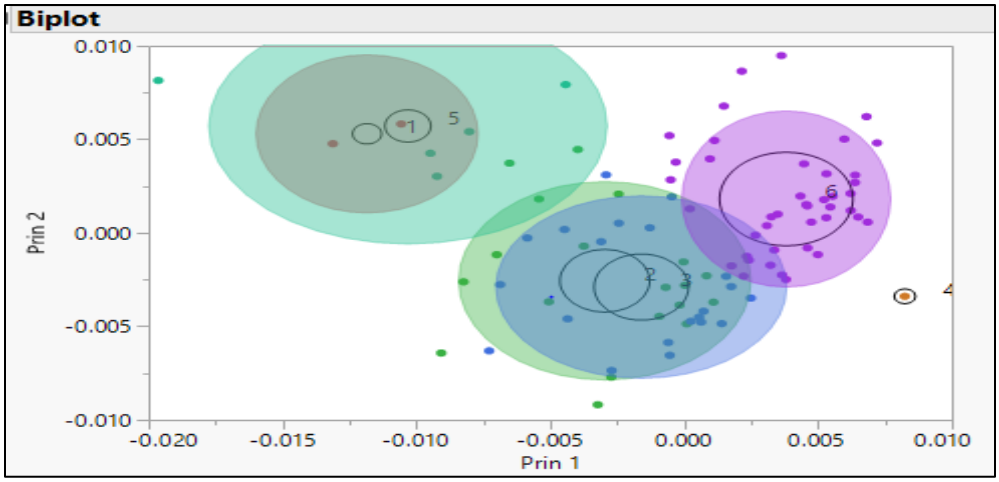
Cluster	Count	Step	Criterion
1	2	5	0
2	19		
3	21		
4	1		
5	5		
6	42		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	7.00028788	2.50014394	3.99942424	0.49985606	1	1.50014394	81.8013118	4.31702075
2	3.03505155	3.65399159	4.78999312	0.25094455	0	0.25667679	95.4310369	4.2402871
3	3.46430282	6.01918349	2.59859644	0.0939574	0.375063	0	96.3589477	3.92374239
4	10	19	4	0	0	0	100	4.75
5	3.74308152	3.37005237	3.41685871	1.59082422	0.61755045	0	80.4301937	4.17258009
6	7.08750183	5.53732287	1.68984497	0.19120872	0	0.02606674	98.6657123	5.08662622

Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	1.00000004	0.50000002	2.00000008	0.50000002	1.1102e-16	0.50000002	0.55147061	0.09477125
2	1.57201246	1.69256263	1.71276763	0.44051672	0	0.44039507	5.31750047	0.57033461
3	2.28077955	1.78578196	1.36553421	0.29354632	0.48565662	0	3.95290057	0.50536852
4	0	0	4.4409e-16	0	0	0	1.4211e-14	0
5	2.4825873	1.02024353	1.35657076	0.48998387	0.49021222	0	9.48063003	0.4064394
6	2.27012983	2.02695236	1.35379719	0.39267741	0	0.15247205	2.53245918	0.378812



Iterative Clustering QUESTIONS=QUESTION 12

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	346.251	
K-Means Clustering	4	347.188	
K-Means Clustering	5	349.77	
K-Means Clustering	6	355.742	Optimal CCC

Clustering Analysis Question-13:

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

Cluster	Count	Step	Criterion
1	30	4	0
2	28		
3	2		
4	19		
5	1		
6	10		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	3.68624135	6.0758575	4.89595369	0.27336641	0.0673736	0.06370332	97.0501647	4.63139927
2	7.84659632	4.81289316	1.85867741	0.10325965	0.03618795	0.06883565	98.7108572	5.30872542
3	6.50003616	5.99996901	2.49999483	0	2.49999483	0	85.784339	4.66666839
4	5.66522222	5.59759964	2.1336454	1.4674562	0.30891289	0.26345252	86.8692471	4.79702999
5	14	16	4	2	0	0	94.4444444	5.16666667
6	1.46379151	4.01720238	3.15553596	0.30410501	0.62405781	1.11132344	81.346781	3.86979182

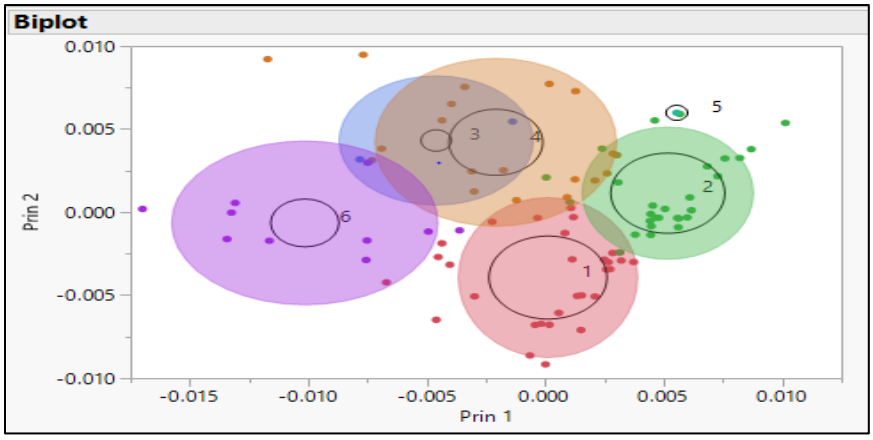
Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	FAVORABILITY PERCENTAGE	Average Weighted Score
1	1.61560803	2.06453547	1.75784424	0.51212021	0.24944483	0.24946143	4.14089206	0.27525612
2	2.70866128	2.12749827	1.21638571	0.30931916	0.18557748	0.25755243	2.58081312	0.21621392
3	3.5	3	0.5	0	0.5	0	2.45098039	0.16666667
4	1.71850782	1.81569458	1.29380669	0.67813906	0.46488038	0.44034748	6.38212558	0.2512894
5	1.7764e-15	1.7764e-15	4.4409e-16	2.2204e-16	0	0	1.4211e-14	8.8818e-16
6	1.36062892	1.61254331	1.57895036	0.45827596	0.49048831	0.53863552	6.25067148	0.38509173

Iterative Clustering QUESTIONS=QUESTION 13

Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	308.92	
K-Means Clustering	4	314.754	
K-Means Clustering	5	321.856	
K-Means Clustering	6	333.136	Optimal CCC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0.010
0.005
0.000
-0.005
-0.010
Prin 2
-0.015
-0.010
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0.000
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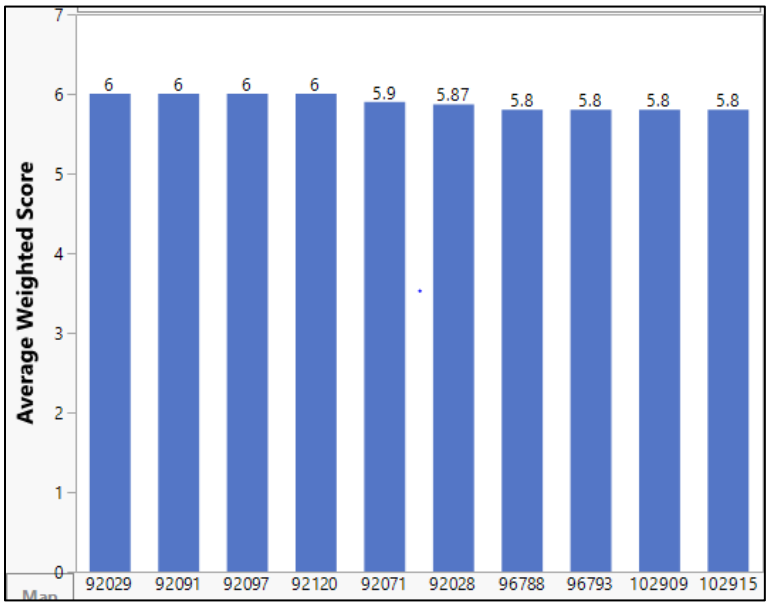
Prin 1
1
2
3
4
5
6

Appendix VII: Advanced Analytics Results for PC survey

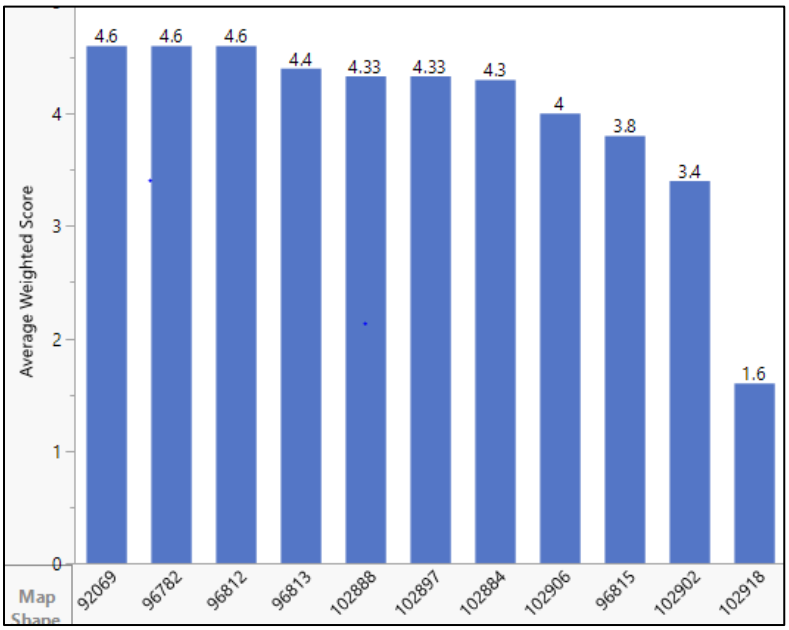
The post course data consists of both the student data and supervisor data. The analysis was done differently for both the data sets. They were sorted according to the categories and made into separate data sets.

Top 10 Classes by Average Weighted Score (Given Data):

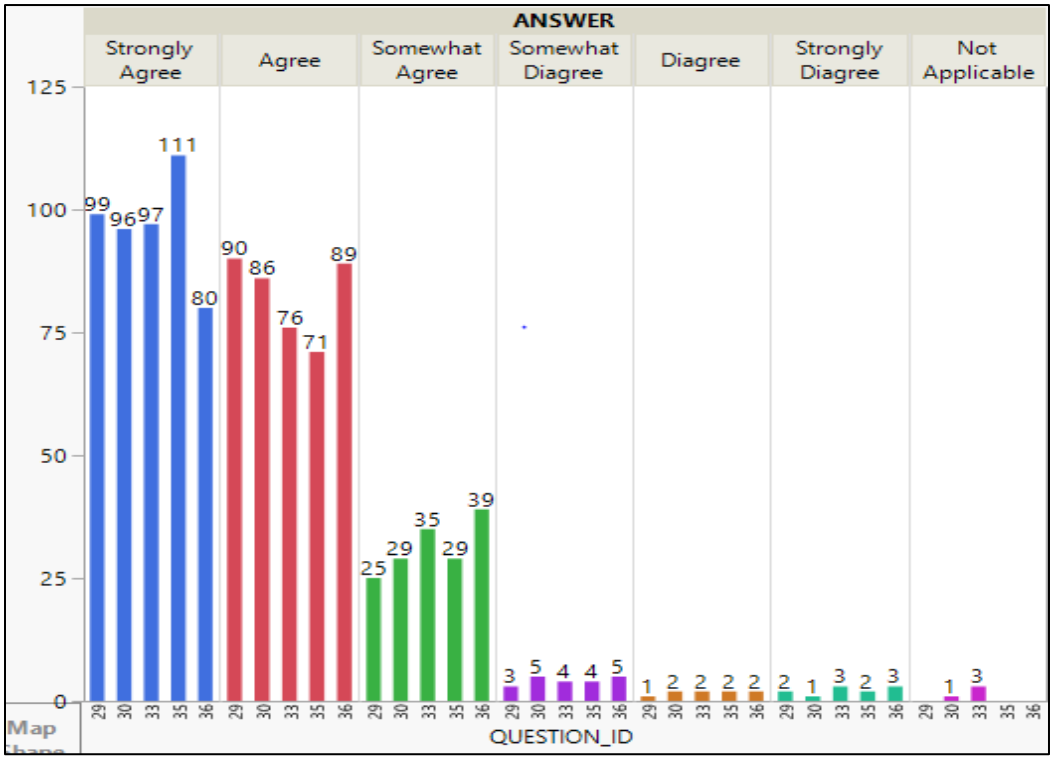


In the top 10 classes by AWS, 50% of the classes are from 2015, the rest 50% are from 2016 & 2017.

Low Average Weighted Score (Given Data):

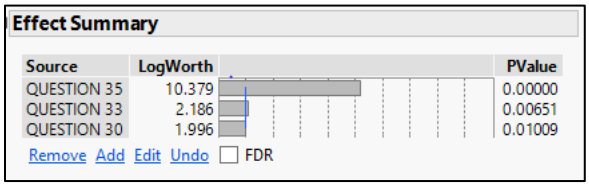


Post Course Data (Student):



Logistic Regression Model:

- Stepwise logistic regression model is run with Question-36 as the dependent variable and the rest of the questions as the independent variables. The reason to run a stepwise model is because we can choose only the questions that are significant with the given p-value of less than or equal to 0.05.
- Here it is evident that the questions 30,33,35 are most significant in prediction of the responses of question-36



Effect Summary

Source	LogWorth	PValue
QUESTION 35	10.379	0.00000
QUESTION 33	2.186	0.00651
QUESTION 30	1.996	0.01009

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- Once the model is run, we can see that the question-29 is not significant in predicting the question-36
- The Model is significant as we can see that the p value is less than 0.001 indicating the test is good for prediction of responses in question-36 with the other independent variables. The R-square value of 0.4512 indicates that 45.21 percentage of the variations in the responses of question-36 are explained by this model.

Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	120.58431	17	241.1686	<.0001*
Full	146.67742			
Reduced	267.26173			

RSquare (U)	0.4512
AICc	342.571
BIC	411.713
Observations (or Sum Wgts)	217

Fit Details

Lack Of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack Of Fit	143	35.28051	70.56103
Saturated	160	111.39691	Prob>ChiSq
Fitted	17	146.67742	1.0000

Effect Likelihood Ratio Tests

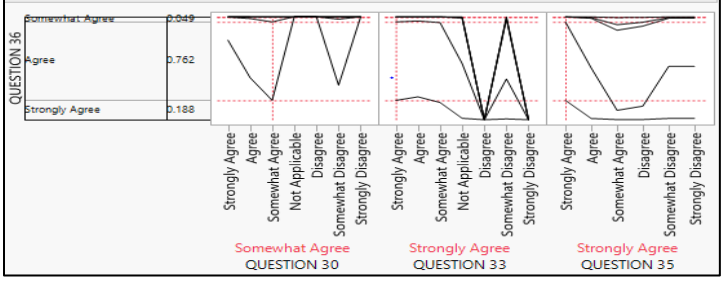
Source	Nparm	DF	L-R ChiSquare	Prob>ChiSq
QUESTION 30	6	6	16.7893961	0.0101*
QUESTION 33	6	5	16.1185807	0.0065*
QUESTION 35	5	4	54.4784406	<.0001*

Confusion Matrix

Training

Actual QUESTION 36	Predicted Count: Strongly Agree	Agree	Somewhat Agree	Disagree	Somewhat Disagree	Strongly Disagree
Strongly Agree	70	10	0	0	0	0
Agree	18	66	4	0	0	0
Somewhat Agree	2	14	23	0	0	0
Disagree	0	0	1	0	1	0
Somewhat Disagree	0	0	3	0	2	0
Strongly Disagree	0	1	0	0	0	2

Prediction Profiler



Clustering Analysis:

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

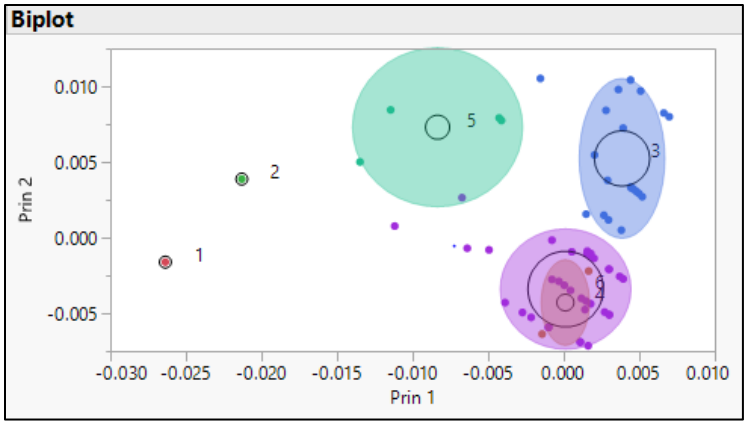
Cluster	Count	Step	Criterion
1	1	6	0
2	1		
3	21		
4	2		
5	4		
6	39		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	Not Applicable	Total Ratings	Favorability Percentage	Average Weighted Score
1	0	0	1	0	0	4	0	5	20	1.6
2	0	4	0	3	2	1	0	10	40	3.4
3	11.9446502	11.05452	4.00231386	0.24259607	0	0	0.04824422	27.2923244	99.1031665	5.28184301
4	5.49941606	2.99953285	0	0	0	0	1.49988321	9.99883212	100	4.73330219
5	5.80270331	7.4721155	5.25987947	1.24418332	1.75581668	0.76338726	0	22.2980855	82.1249768	4.46518407
6	5.03025627	3.62725042	1.36268178	0.21158791	0	0.08161482	0	10.3133912	97.7839797	5.28147196

Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	Not Applicable	Total Ratings	Favorability Percentage	Average Weighted Score
1	0	0	0	0	0	0	0	0	0	0
2	0	4.4409e-16	0	4.4409e-16	2.2204e-16	1.1102e-16	0	0	0	4.4409e-16
3	3.88497494	2.91190022	3.35239337	0.52598883	0	0	0.21295977	5.25103427	1.92241423	0.23228294
4	2.50000007	2.00000005	0	0	0	0	0.50000001	5.00000014	1.4211e-14	0.13333334
5	5.11764376	5.17211538	1.47905294	0.43305177	0.43305177	0.82926426	0	4.20592585	6.22648354	0.44486338
6	3.37735356	2.86998731	1.81852924	0.6068118	0	0.4742089	0	3.79838757	6.15554353	0.52333047



Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	259.725	
K-Means Clustering	3	259.725	
K-Means Clustering	4	267.698	
K-Means Clustering	5	281.338	
K-Means Clustering	6	290.132	Optimal CCC

Clustering Analysis (Student):

Cluster 1 (1 Class): 102902

Cluster 2 (1 Class): 102918

Cluster 3 (21 Classes): 92030, 92059, 92063, 92073, 92076, 92078, 92085, 92088, 92090, 92113, 96786, 96791, 96800, 96805, 96810, 99750, 99752, 99757, 102891, 102899

Cluster 4 (2 Classes): 92026, 92069

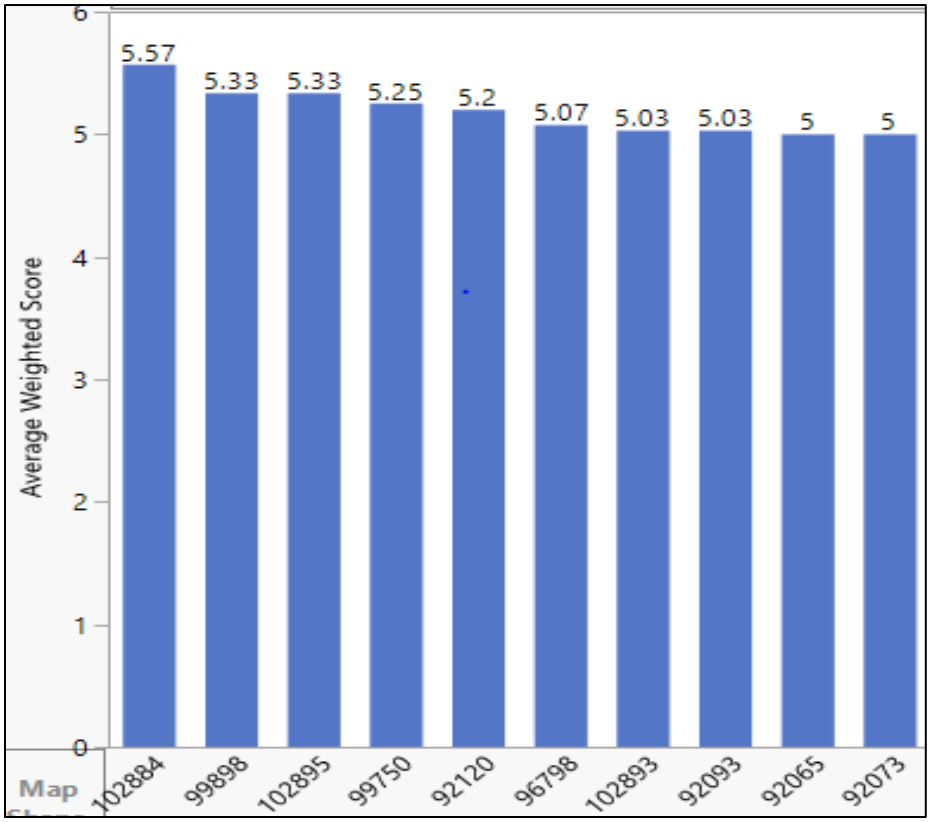
Cluster 5 (4 Classes): 96795, 96815, 99896, 102897

Cluster 6 (39 Classes): 92028, 92029, 92031, 92061, 92065, 92067, 92071, 92082, 92091, 92093, 92097, 92102, 92103, 92116, 92118, 92120, 92122, 96782 96788, 96793, 96798, 96802, 96812, 96813, 99748, 99755, 99899, 102884, 102888, 102893, 102895, 102904, 102906, 102909, 102913, 102915, 102917, 105274, 105276

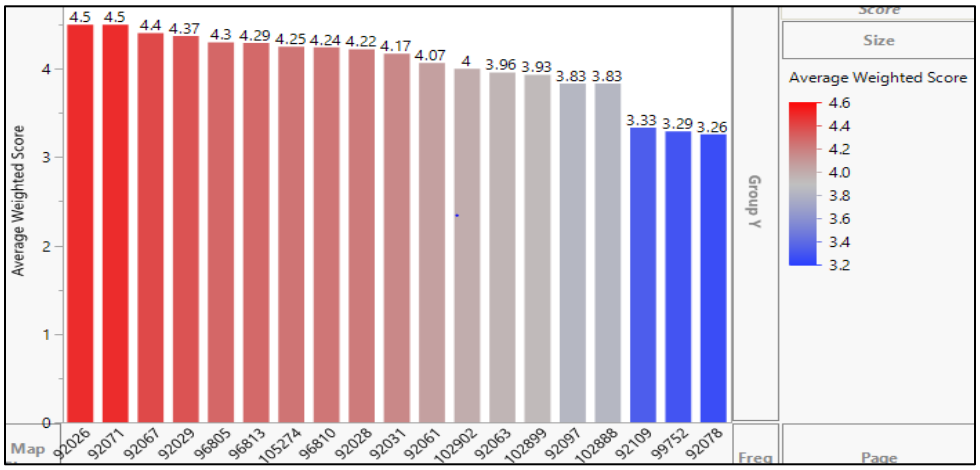
Post Course Supervisor Data:

In the post course data given, there are a total of 295 supervisors who responded for the survey and these 295 members are the supervisors of the trainees from 61 different classes of course 50046

Top 10 Classes by Average Weighted Score (Given Data):



Classes with Low Average Weighted Score (Given Data):



Logistic Regression Model:

- Stepwise logistic regression model is run with Question-39 as the dependent variable and the rest of the questions as the independent variables. The reason to run a stepwise model

is because we can choose only the questions that are significant with the given p-value of less than or equal to 0.05.

- Here it is evident that the questions 34,37,31,38,32 are most significant in prediction of the responses of question-39

Effect Summary

Source	LogWorth	PValue
QUESTION 34	12.216	0.00000
QUESTION 37	9.574	0.00000
QUESTION 31	8.895	0.00000
QUESTION 38	6.898	0.00000
QUESTION 32	2.392	0.00405

Remove Add Edit ☐ FDR

- Once the model is run, we can see that all the questions are significant in predicting the question-39

- The Model is significant as we can see that the p value is less than 0.001 indicating the test is good for prediction of responses in question-39 with the other independent variables. The R-square value of 0.7925 indicates that 79.25 percentage of the variations in the responses of question-39 are explained by this model.

Effect Likelihood Ratio Tests

Source	Nparm	DF	L-R ChiSquare	Prob>ChiSq
QUESTION 31	6	6	52.8233095	<.0001*
QUESTION 32	6	6	19.0655527	0.0041*
QUESTION 34	6	6	69.1573589	<.0001*
QUESTION 37	6	6	56.1880933	<.0001*
QUESTION 38	6	6	42.8199482	<.0001*

Whole Model Test

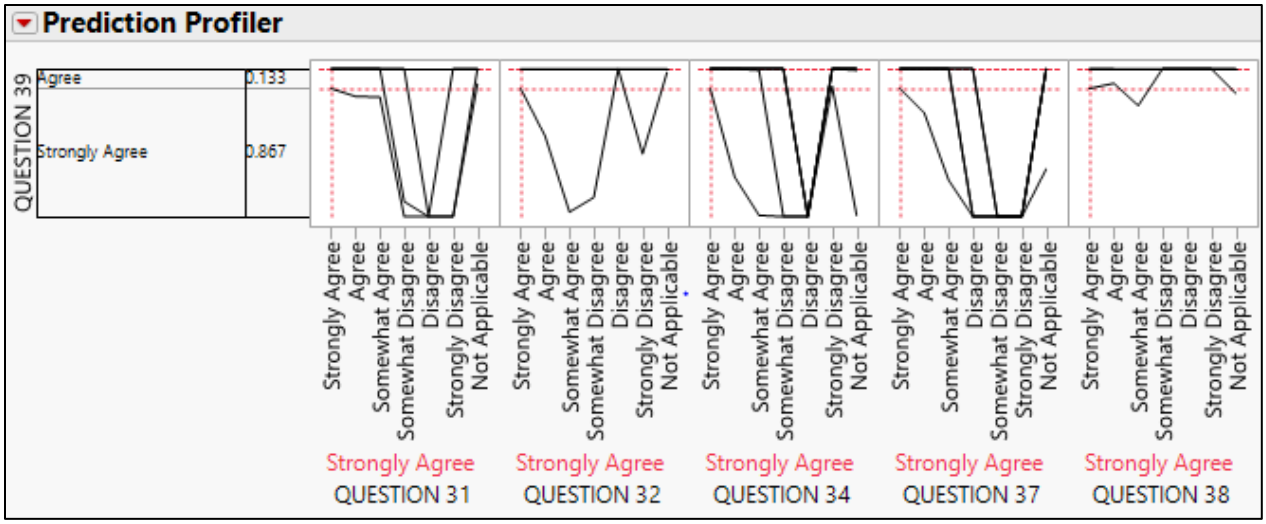
Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	238.50850	30	477.017	<.0001*
Full	62.43680			
Reduced	300.94530			

RSquare (U)	0.7925
AICc	205.244
BIC	321.966
Observations (or Sum Wgts)	279

Confusion Matrix

Training

Actual QUESTION 39	Predicted Count: Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Disagree
Strongly Agree	23	7	0	0	0	0
Agree	4	166	6	0	0	0
Somewhat Agree	0	4	53	0	0	0
Somewhat Disagree	0	0	0	7	0	0
Strongly Disagree	0	0	0	0	3	0
Disagree	0	0	0	0	0	6



Cluster Analysis:

K Means NCluster=6

Columns Scaled Individually

Cluster Summary

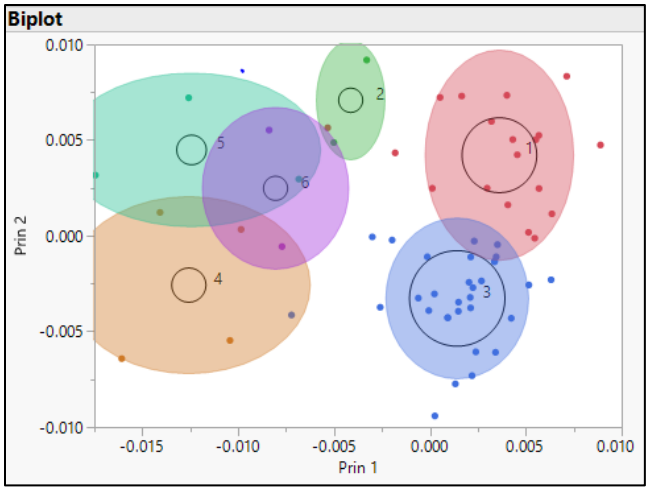
Cluster	Count	Step	Criterion
1	19	3	0
2	2		
3	31		
4	4		
5	3		
6	2		

Cluster Means

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	Not Applicable	Total Ratings	Favorability Percentage	Average Weighted Score
1	5.12939627	25.3373262	9.5243769	0.35696842	0.10385386	0.15185631	1.04618514	41.6499631	98.3417386	4.71570668
2	6.56286037	12	10.5628604	0.51257207	0	5.48742793	0.51257207	35.6382928	82.5628604	4.15751277
3	3.15440613	13.7681043	4.16194292	0.25459069	0.03091392	0.06500021	0.37775257	21.8127107	98.3537677	4.80313414
4	1.07318689	6.26543979	3.7194753	4.07647453	2.4969583	0	0.2347144	17.8662492	57.1011379	3.85337268
5	1.02633258	8.60526514	5.34204227	3.07895657	0.34211086	1.368416	5.63157028	25.3946937	77.168117	3.22934867
6	4.49939162	16	2.99947853	0.49991309	5.99965235	0.50008691	2	32.4985225	77.0979325	4.06451406

Cluster Standard Deviations

Cluster	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	Not Applicable	Total Ratings	Favorability Percentage	Average Weighted Score
1	3.46821467	9.22179549	5.25501344	0.80862276	0.30689544	0.48812254	1.14588872	6.43235059	4.02726301	0.25062136
2	2.50079016	0	2.50079016	0.50015803	0	0.50015803	0.50015803	5.50173835	2.50079016	0.0886459
3	4.00605924	6.75933784	3.08752666	0.80193029	0.17668981	0.35336972	0.54941451	6.60941289	4.44908115	0.35439776
4	1.73359635	4.38038108	3.34491132	2.34645442	0.50000925	0	0.43328241	9.17611104	14.7796001	0.32946437
5	1.4144587	1.70078189	3.68179731	2.45076195	0.47148623	0.94346154	1.24771283	2.62538644	18.3840003	0.06641858
6	3.50000005	0	3.00000005	0.50000001	2.00000003	0.50000001	0	8.50000013	0.17482518	0.10619919



Cluster Comparison

Method	NCluster	CCC	Best
K-Means Clustering	3	270.005	
K-Means Clustering	3	270.005	
K-Means Clustering	4	271.602	
K-Means Clustering	5	274.729	
K-Means Clustering	6	283.865	Optimal CCC

Cluster Division by Classes:

Cluster-1(19 Classes):

92028, 92029, 92030, 92059, 92067, 92069, 92093, 96782, 96786, 96788, 96791, 96793, 96795, 96798, 96805, 96815, 99757, 99896, 102893

Cluster-2 (2 Classes):

92061, 96810

Cluster-3 (31 Classes):

92026, 92065, 92071, 92071, 92076, 92080, 92088, 92090, 92102, 92013, 92113, 92116, 92118, 92120, 92122, 96796, 96800, 96802, 96807, 96812, 96813, 99750, 99755, 99898, 99899, 102884, 102888, 102891, 102895, 102897, 102902

Cluster-4 (4 Classes):

92097, 92109, 102899, 105274

Cluster-5 (3 Classes):

92078, 99748, 99752

Cluster-6 (2 Classes):

92031, 92063