INTEGRATIVE FRAMEWORK FOR SUSTAINABLE DEVELOPMENT OF THE COST ESTIMATING PROFESSION

By

ANWAR SALMAN ALROOMI

Bachelor of Science in Civil Engineering
Kuwait University
Kuwait
2003

Master of Science in Civil Engineering
Kuwait University
Kuwait
2006

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
May, 2013

INTEGRATIVE FRAMEWORK FOR SUSTAINABLE DEVELOPMENT OF THE COST ESTIMATING PROFESSION

Dissertation Approved:

Hyung Seok "David" Jeong, Ph.D.

Dissertation Adviser

Garold Oberlender, P.E., Ph.D.

Oswald W. K. Chong, Ph.D.

Dana Hobson, Ph.D.

ACKNOWLEDGEMENTS

It has been a long journey. It is impossible for me to survive this journey alone and without the continuous support of several people. I wish to personally thank everyone who stood by my side during this challenging journey. First and foremost, I thank God for blessing me with this opportunity, courage, and strength to pursue my dreams.

I would like to express my gratitude to my advisor, Dr. Hyung Seok (David) Jeong for his continuous support, guidance, and encouragement throughout my study. He was always there for me as a teacher and mentor. Thank you for your time and advices you gave me.

I would like to express my gratitude to Prof. Garold D. Oberlender, Dr. Oswald Chong, and Dr. Dana Hobson for their willingness to serve on my doctoral committee and for their insightful comments and suggestions which significantly contributed to finalize this study. I also would like to thank the CII 253 research team members and the study advisory group for supporting my research and contributing to the success of this study.

I would like to thank the Dr. Phil Lewis for his continuous support, guidance, and advices to develop my abilities and be a better teacher. Many thanks to my officemates at 316 Engineering South (Iday, Saeed, and UK). Also I would like to thank the Civil Engineering and Environmental Department staff (Ramona Whitley, Therena Smith, Mary Muth, Artie Southern, Kim Bryant, and Delpha Whitefield) for making my journey easier and enjoyable.

Last but not least, I would like to express my sincere gratitude to my parents, husband, siblings, and son for their support and believing in me more than I believed in myself which made me who I am today, and helped me pursue my dream. I know it was a hard and challenging journey to all of us and I would not survive it without your continuous support, patience, guidance, and encouragement. I would like to dedicate this dissertation to you all because I could not do it without you all. I love you all!

Acknowledgements reflect the views of the author and are not endorsed by committee members or Oklahoma State University.

Name: ANWAR ALROOMI

Date of Degree: May, 2013

Title of Study: INTEGRATIVE FRAMEWORK FOR SUSTAINABLE
DEVELOPMENT OF THE COST ESTIMATING PROFESSION

Major Field: CIVIL AND ENVIRONMENTAL ENGINEERING

Abstract: The main purpose of this study is to develop an integrative learning framework for the estimating profession that will help companies in the construction industry adapt healthier environment and management practices to retain experienced estimators' knowledge and skills. This multi-dimensional framework considers the effect of learning environment and motivation (intrinsic and extrinsic) practices on the retention practices and development of the estimating competencies. To develop effective framework, two phases methodology was adapted.

In the first phase, 23 core estimating competencies were identified and classified into skills, knowledge, and personal attributes and also quantified the degree by which new estimators lack each competency. A criticality matrix was developed to prioritize estimating competencies based on the combined effects of the level of importance of each competency and its associated gap between the ideal and actual level of competency. The factor analysis method was applied to investigate the correlation effects of the 23 estimating competencies and resulted in seven core estimating competency factors representing the core estimating competencies.

The second phase assessed the effectiveness of ten traditional and advanced capture and transfer methods in retaining and developing each of the seven core estimating competency factors. Also, this phase assessed the current level of development of the learning environment, and intrinsic and extrinsic motivations practices and their effects on the improvement of estimators' capabilities. The Structural Equation Modeling (SEM) method was employed to assess the effectiveness of each of the capture and transfer methods, and evaluates the effect of the leaning environment and motivations on the development of the estimators' capabilities by analyzing the embedded correlations between variables. As a result, capture and transfer models for the cost estimating profession was developed showing the effective methods to retain each of the estimating competency factors. Furthermore, the integrative framework result emphasized the significant effects of the learning environment and motivation practices on sustaining the development and retention of the cost estimating competencies.

The findings of this study can help companies in the construction industry assess their estimators' capabilities and design appropriate training programs for their estimators based on their specific needs. Also, the findings will significantly improve companies' practices in retaining estimators' knowledge and skills, and help companies adapting a healthy learning environment that facilitate learning and sustain knowledge transfer.

TABLE OF CONTENTS

Chapter Page

I. INTRODUCTION 1
1.1. Background 1
1.2. Problem Statement 2
1.3. Study Objectives 4
1.4. Research Methodology 4

II. LITERATURE REVIEW 7
2.1. Importance of Estimators' Knowledge and Experience 7
2.2. Capture and Transfer Methods 13
2.3. Learning Organization 15
2.4. Motivation 19

III. PHASE I COST ESTIMATING COMPETENCIES 22
3.1. Introduction 22
3.2. Data Collection 23
3.3. Core Estimating Competencies 23
3.4. Assessment of Estimating Competencies 28
3.5. Estimating Core Competencies Criticality Matrix 29
3.6. Factor Analysis 31
3.7. Chapter Summary 39
3.8. Acknowledgements 40

Chapter Page

IV. PHASE II MANAGEMENT PRACTICES AFFECTING THE RETENTION OF THE COST ESTIMATING COMPETENCIES 41
4.1. Introduction 41
4.2. Management Practices Studied..42
4.2.1 Capture and Transfer Methods..42
4.2.2 Learning Environment 44
4.2.3 Motivation..46
4.3. Data Collection 48
4.4. Data Analysis Strategy: Structural Equation Modeling.................................50
4.4.1 Scale Reliability and Validity 54
4.4.2 Comparison Scenario's Analysis 58
4.4.3 Effective Capture and Transfer Methods to Retain Estimating Competencies 60
4.4.3.1 Overall Effect of Traditional and Advanced Capture and Transfer Methods...60
4.4.3.2 Capture and Transfer Model for the Cost Estimating Profession 61
4.4.4 Effective Learning Environment for Retaining Estimating Competencies .67
4.4.4.1 Overall Effect of Learning Environment 67
4.4.4.2 Gaps in the Current Learning Environment Dimensions 68
4.4.4.3 Significant Dimensions of the Learning Environment 69
4.4.4.4 Recommendations to Close the Gaps in the Learning Environment ...71
4.4.5 Effective Motivations for Retaining Estimating Competencies 73
4.4.5.1 Overall Effect of Intrinsic and Extrinsic Motivation 73
4.4.5.2 Recommendations to Improve Motivation Practices in the Construction Industry...75
4.5. Chapter Summary 76

V. INTEGRATIVE FRAMEWORK FOR SUSTAINING THE DEVELOPMENT OF THE ESTIMATING PROFESSION 78
5.1. Introduction 78
5.2. Integrative Effect of Learning Environment and Motivation on Retaining the Cost Estimating Competencies 81

5.3. Integrative Management Practices Matrix 84
5.4. Chapter Summary 89

VI. CONCLUSION AND RECOMMENDATIONS 90
6.1. Conclusions 90
6.2. Recommendations 93

REFERENCES 95

APPENDIX A “Estimating as a Competency in Capital Projects” Survey 101

APPENDIX B “Estimating as a Competency in Capital Projects” Raw Data 106

APPENDIX C “Assessment of Current Practices in Developing Cost Estimating Competencies” Survey 136

APPENDIX D “Assessment of Current Practices in Developing Cost Estimating Competencies” Raw Data 142

LIST OF TABLES

Table Page

Table 1. Significant Factors Affecting Estimating Accuracy 8
Table 2. Classification and Expanded Definition of Cost Estimating Competencies..26
Table 3. Pricncipal Components Analysis Results 33
Table 4. Factor Analysis Results - Unrotated Factors 34
Table 5. Factor Analysis Results Using the Varimax Orthogonal Rotation 35
Table 6. Seven Estimating Core Competency Factors...36
Table 7. Expanded Definition/Description for Knowledge Transfer Methods............43
Table 8. Description and Sub-Questions for Learning Environment Dimensions (Yang et al., 2004) 45
Table 9. Description and Measures for Intrinsic and Extrinsic Motivations (Amabile et al. 1994) 47
Table 10. SEM Fit Indices Description and Measuring Criteria 54
Table 11. Test of Reliability and Average Variance Extracted 57
Table 12. Comparison Scenarios Analysis Results..60
Table 13. Summary of the Effective Capture and Transfer Model..............................66
Table 14. Best Practices to Adapt Healthier Learning Environment...........................72
Table 15. Best Practices to Advance Motivation Practices 75
Table 16. Summary Results of Integrative Management Practices Model..................83

LIST OF FIGURES

Figure Page

Figure 1. Research Methodology..5
Figure 2. Classification Hierarchy of Estimating Competencies................................25
Figure 3. Assessment of Estimating Competencies..29
Figure 4. Estimating Core Competency Criticality Matrix...30
Figure 5. Factor Analysis Procedure..31
Figure 6. Overall Significance of Factors 39
Figure 7. Effect of Learning Environment on the Retention of Estimating Competencies (Theoretical Model)...46
Figure 8. Effect of Motivation on the Retention of Estimating Competencies 48
Figure 9. SEM Procedure...51
Figure 10. SEM Model (Theoretical Model) 53
Figure 11. Effect of Capture and Transfer Methods on the Development of the Cost Estimating Competencies...61
Figure 12. Capture and Transfer Model for Estimating Profession.............................63
Figure 13. Effect of Learning Environment on the Retention of Estimating Competencies...68
Figure 14. Gaps in Learning Environment 69
Figure 15. Effect of Gaps in Learning Environment on the Retention of Estimating Competencies...70
Figure 16. Effect of Motivation on the Retention of Estimating Competencies 74
Figure 17. Integrated Multi-dimension Framework..81
Figure 18. Integrative Effect of Management Practices on the Development of the Estimating Profession 82
Figure 19. Integrative Management Practices Matrix to Sustain the Development of the Cost Estimating Profession 85
Figure 20. Uses of the Integrative Management Practices Matrix - Example 1..........87
Figure 21. Uses of the Integrative Management Practices Matrix - Example 2..........88

CHAPTER I

INTRODUCTION

1.1. Background

Earlier in the 2000's, the retirement of the baby boomer generation became a global threat facing many industries. The National Science Board statistics in 2006 shows that one of every four engineers and scientists is over 50 years old and expected to retire in few years, and this rate is expected to triple in the next decade. In many companies, the retirement of the senior employees of the baby boomer generation basically translates into the retirement of their years of experience and knowledge as most companies do not have well planned strategies and methods to retain the knowledge and skills of their retiring employees (Styhre et al., 2004; Chinowsky et al., 2007). In addition, there exists evidence of a shortage of qualified engineers who possess the required skills and knowledge to perform reliable engineering tasks (Behrendt, 2005; Zack, 2007). Decades of downsizing and outsourcing management practices also have exacerbated this problem (Behrendt, 2005).

In addition to the escalating retirement rate of engineers in the construction industry, a recent study by the American Society of Civil Engineers (ASCE, 2003) concluded that retaining quality civil engineers within the construction industry is considered as a great challenge facing the industry now. The ASCE study reported that a noticeable gap between the demand and supply of civil engineers exists, in which the educational outcomes cannot meet the industry needs of civil engineers, and this gap is expected to widen in the coming years. Combining the effects of the accelerated rate of the retirement of baby boomer generation along with the gap in supply and demand, the construction industry will experience a shortage of qualified engineers. As the retirement increases, the new engineers will be left without experienced employees to guide them, which will widen the gap in the skills and knowledge between the two generations and will make closing the gap more challenging (Behrendt, 2005). Gradually, the valuable knowledge will be lost, affecting the organization norms, practices, and even the sustainability of its performance. These threats have confronted the construction industry with an immediate need to retain experienced engineers knowledge to minimize the competency gap between different generations of engineers in order to sustain the level of companies’ performance in the industry.

The existing literature from human development, adult education, and business management fields shows rich efforts on knowledge management practices that emphasize on the importance of collecting, sharing, and storing the valuable knowledge within the organizations (Nonaka and Takeuchi, 1995). Furthermore, some researchers reported that the success of knowledge management and knowledge retention practices depend on the organization learning environment and culture. The concept of learning organization has evolved and is well established and its relation to the knowledge management and knowledge retention practices is well documented (Marsick and Watkins, 1999 and 2003; Kivrak et al., 2008; Song, 2008). Previous studies reported that adapting a healthy learning environment where the learning process is continuous and facilitated to all professionals can improve the knowledge retaining and sustaining processes (Love et al., 2000; Kivrak et al., 2008; Song, 2008).

The retention of the knowledge and skills is a very difficult mission and it cannot be attained by using knowledge capture and transfer methods alone. Retention process must be envisioned as a multidimensional process in which different factors interact and affect each other. An immediate need exists to develop a comprehensive framework to promote and facilitate learning of professionals within the organization, and help sustain the knowledge development and transfer.

1.2. Problem Statement

Engineering and construction companies within the construction industry consist of different units such as planning, design, engineering, cost estimating, scheduling, project control, etc. Each unit requires definite sets of skills, knowledge, and behavioral attributes to perform effectively. These differences on the competency requirements and characteristics accentuate the need to customize and tailor the capture and transfer mechanism to effectively retain the professional competencies.

The cost estimating for a capital project is critically important to both owners and engineering/construction companies. Owners rely on cost estimates to perform economic analyses for return on the investment from their capital expenditures. Engineering/construction companies rely on the cost estimate for bidding and negotiating work, which is the basis for securing future work and ensuring profitability. The development of reliable estimates depends heavily on the competency of cost estimators. Tools that aid the estimating process cannot replace the judgment and experience of a competent estimator (Skitmore, 1988; Carr, 1989; Merrow and Schroeder, 1991; Akintoye, 2000; Akintoye and Fitzgerald, 2000; Trost and Oberlender, 2003). Also, a recent article by the president of the Association for the Advancement of Cost Engineering International (AACE-International) described a recent court case that cited the sound judgment of estimators, based on their experience, is equal to and perhaps more important than the cost data information (Zack 2007).

The greatest challenge facing the cost estimating community over the next decade is the loss of knowledge and experience from highly experienced estimators. A large percentage of experienced estimators are retiring and there is a shortage of qualified cost estimators to replace them in the engineering/construction industry. Now, the construction industry is confronted with how to capture the knowledge and skills of highly experienced estimators before they retire.

The current practices in the human development, adult education, and business management field indicates that knowledge management and learning organization practices are critical for proactively capturing, sharing, and retaining knowledge within the organization (Love et al., 2000; Styhre et al., 2004; Kivrak et al., 2008; Song, 2008; Wong et al., 2008). Styhre et al. (2004) examined the organization learning efforts in the construction industry due to its importance in facilitating the sharing of experiences and know-how, providing innovative solutions, and the adaption to continuous changes in the organization. They found that organizations within the construction industry lack the learning formalization and capabilities. There exists dearth of literature that evaluates and examines the effect of the organization environment on the development and skills at the individual level.

Another problem threatening the success of the retention and development practices for the estimating profession is motivation. Motivation plays an important and significant role affecting engineers’ performance, satisfaction, and retention (McQuillen, 1986; Joo and Lim, 2009). The existing literature shows evidence that motivation has a direct relation to and effect on the knowledge retention and advancement practices (O'Dell and Grayson, 1998; Tierney et al., 1999; Osterloh and Frey, 2000). Ko et al. (2005) examined the antecedents of knowledge transfer from a consultant firm to client employees in enterprise system implementation, and they revealed that intrinsic motivation is more significant and effective when transferring tacit knowledge between project members than extrinsic motivation. Companies in the construction industry need an effective tool to assess their learning capabilities and motivational practices, and determine the most appropriate and effective strategy to utilize its resource and efficiently advance their estimating workforce capabilities.

1.3. Study Objectives

The study aims to develop a comprehensive framework that helps engineering and construction companies in retaining estimators' knowledge and sustaining the development of the estimating profession. This work will focus on developing a competency map for the estimating profession that will guide companies when recruiting for estimating positions or when evaluating their estimating workforce capabilities. In addition, an integrated learning framework for facilitating and sustaining the knowledge retention process for the estimating profession is developed. The detail objectives of this study are:

- Develop a competency (skills, knowledge, personal attributes) map for the estimating profession, and assess the significance of each competency in developing competent estimators.
- Develop a capture and transfer model for the estimating profession that considers effective methods to retain each of the estimating competencies.
- Develop an integrated learning framework for the estimating profession. This framework will help companies facilitate and maintain the development of the estimating profession. This framework also, will help companies determine the ideal environment and motivators that will expedite the knowledge capture and transfer process. The development of this framework will require;
    - Assessing the effect of the company learning environment on the retention practices for the estimating profession, and
    - Examining the effects of intrinsic and extrinsic motivation practices on the retention and development of estimating competencies.

1.4. Research Methodology

To achieve the aforementioned objectives, a research methodology as shown in Figure 1 is used in this study. The relevant literature is reviewed to identify the current practices in developing competency models for professions within the industry, the current knowledge capture and transfer methods used by other fields to retain the knowledge, and the existing efforts to capture estimators' knowledge. The concept of learning organization is very well developed in the fields of knowledge management and adult education, and there are many publications in the area of learning organization environment effects on the knowledge retention practices. The current practices of learning organization in the construction industry are reviewed to determine the level of awareness and utilization of the learning organization environment concept. Finally, the literature about motivation is also reviewed to better understand the differences between motivators.

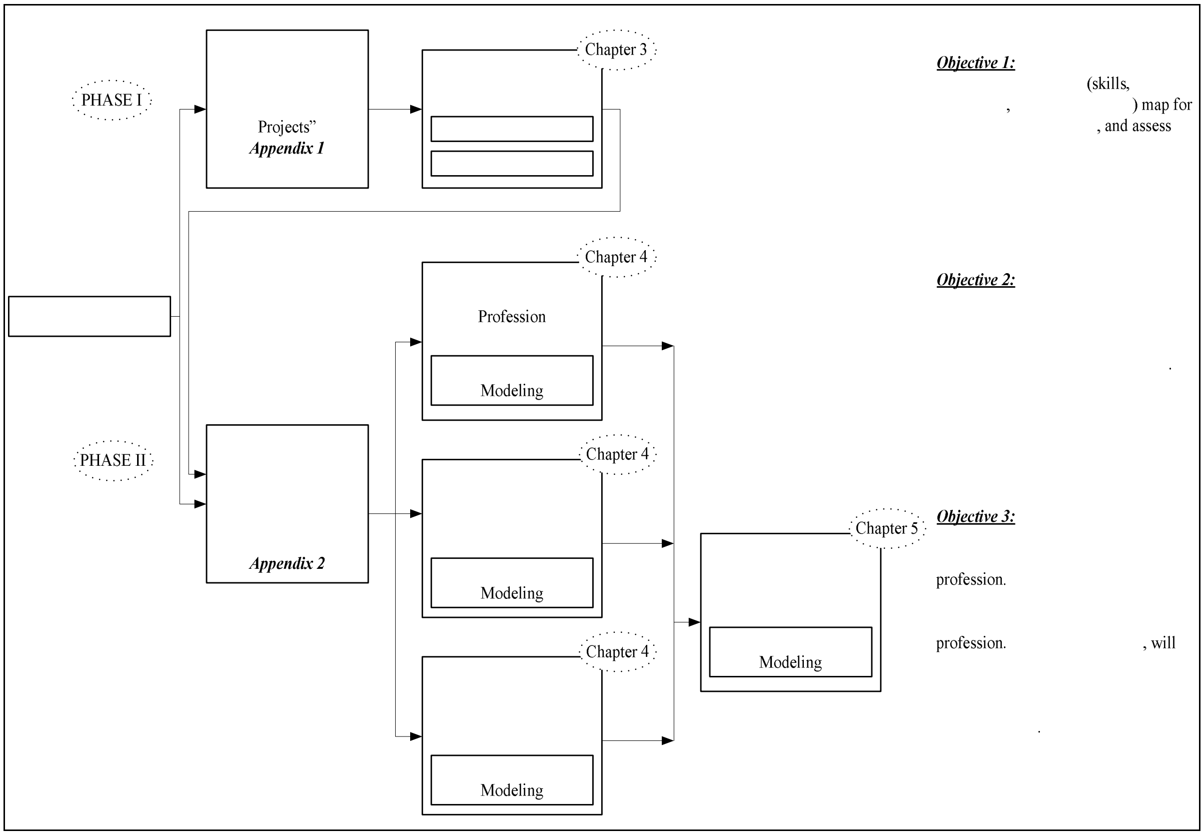

Chapter 3
Objective 1:
(skills,
) map for
, and assess
PHASE I
Projects”
Appendix 1
Chapter 4
Objective 2:
Profession
Modeling
Chapter 4
PHASE II
Objective 3:
Chapter 5
Appendix 2
profession.
Modeling
profession.
, will
Modeling
Chapter 4
Modeling

Figure 1. Research Methodology

To achieve the specific objectives for this study, a two phase’s methodology is adapted. The first phase is designated to identify and assess the core competencies required to develop a competent estimator. The second phase is designed to assess the effect of current management practices on the development of estimators’ capabilities and develop two models; 1) a capture and transfer model for the estimating profession, and 2) an integrative learning framework for the estimating profession. Data collection is then conducted to gather information related to this study. For data collection purposes, two questionnaire surveys are developed; a) estimating as a competency in capital projects, and b) assessment of current practices in developing cost estimating competencies. In designing the first questionnaire survey, a workshop with highly experienced estimators in the construction industry is conducted to determine the required estimating skills, knowledge, and personal attitudes necessary in developing qualified cost estimators. Chapter 3 provides detailed discussions about the identification of estimating competencies, expanded definition of each competency based on its classification, analysis results related to criticality assessment of the competencies using the Euclidian distance concept and assessment of the embedded relationships between those core competencies using factor analysis.

The second questionnaire survey is designed to assess the effectiveness of knowledge capture and transfer methods in retaining estimators' competencies. The survey is also designed to measure the current level of learning environment and its effect on the development of the estimating profession and to assess the effect of different motivators on the retention and development of the cost estimating competencies. The dimension of the learning environment questionnaire (Marsick and Watkins, 2004) for assessing learning environment and the work preference inventory instrument (Amabile et al., 1994) for the effect of motivation are adapted and used in this study. Among different analysis methods, Structural Equation Modeling (SEM) is used in analyzing the data from the second survey and model development. SEM is an analytical approach that simultaneously combines factor analysis and linear regression models to assess empirically the direct and indirect causal relationships between the model variables using the embedded relations between variables (correlations). SEM also provides the advantage of estimating the parameters (relationships) simultaneously and assesses the entire model performance.

Using the second survey results, a capture and transfer model for the estimating profession is developed in Chapter 4. In this model, the effectiveness of the different capture and transfer methods in developing each of the estimating competency factors is assessed. Also, the overall effectiveness of traditional and advanced capture and transfer methods is evaluated. Furthermore, the effect of current learning environment and motivational practices provided to the estimating workforce on the development of the estimating competencies is determined in Chapter 4. The effect of learning environment and motivation on knowledge capture and transfer methods is also quantified and discussed in Chapter 4. In addition, the gaps in the current learning environment and their effect on the development of each factors of the estimating competencies is evaluated.

In Chapter 5, the combined effect of adapting learning environment and employing motivation on the development of the estimating competencies and the traditional and advanced capture and transfer methods is evaluated. Furthermore, an integrative management practices matrix to sustain the development of the cost estimating profession is developed. The results help companies in providing better trainings for their estimating workforce to efficiently retain their estimators' knowledge and experience, adapt a healthier learning environment that provide continuity of learning even past training, and help companies effectively motivate their estimating workforce.

CHAPTER II

LITERATURE REVIEW

This chapter reviews prior studies related to cost estimating including important cost estimating skills and knowledge, and the current efforts in the construction industry to retain estimators' competencies. The current knowledge capture and transfer efforts are discussed. Also, learning organization concepts are discussed and the current level of learning organizational practices in the construction industry is discussed. Finally, the related studies of motivation and its impact in retaining and facilitating learning are reviewed.

2.1. Importance of Estimators' Knowledge and Experience

Table 1 summarizes prior studies on factors that affect estimating accuracy or inaccuracy. Most of them highlight that the estimator's experience and judgment skills are critical for improving estimating accuracy or minimizing estimating inaccuracy.

Table 1. Significant Factors Affecting Estimating Accuracy

Criteria	Objectives of the study	Data source	Responses	Methodology	Number of variables or factors studied	Important factors concluded
Bakewell (1985)	Discuss the effect of the lack of understanding the process and requirements for developing a conceptual estimate	Experience	N/A	N/A	N/A	- Project scope - Estimators' experience in estimating - The accuracy of the database information
Skitmore (1988)	Identify the factors influencing the estimate accuracy	Review of literature and historical data	100 projects	ANOVA	6 factors	- Project type, size and location - The state of the market - Number of bidders - Estimators' ability
Carr (1989)	Discuss the basic principles/factors affecting the estimate quality	Experience	N/A	N/A	7 factors	- The reality which requires extensive amount of experience and judgment skill - The completeness of estimate which is highly dependent on estimator's ability to see the big picture
Merrow and Schroeder (1991)	Develop a statistical model for estimating hydroelectric project cost and schedule based on the known project information	Historical data	56 projects	Regression Analysis	>200 variables	- Team knowledge and skills - Judgment skills and experience
Akintoye and Fitzgerald (2000)	Identify the factors causing the estimate inaccuracy	Questionnaire survey	84 responses	Ranking of the mean and ANOVA	20 variables	- Lack of practical knowledge of the construction process - Insufficient time to prepare cost estimate - Poor tender documentation - Wide variability in subcontractors prices
Akintoye (2000)	Identify the factors affecting estimates practices (accuracy/quality)	Questionnaire survey	84 responses	Ranking of the mean, ANOVA and factor analysis	24 variables grouped into 7 factors	- Project complexity - Technological requirements - Project information - Project team requirements - Contract requirements - Project duration - Market requirements
Trost and Oberlender (2003)	Identify the factors affecting the early estimate accuracy	Questionnaire survey	67 responses	Factor analysis and multivariate regression	45 variables grouped into 11 factors	- The basic process design - The team experience and cost information - Time given to prepare estimate - Site requirements - Bidding & labor environment

Bakewell (1985) discussed theoretical and practical issues considered when preparing a conceptual cost estimate. He concluded that individuals perform conceptual estimating differently depending upon their theoretical definitions in interpreting the project scope and the level of details, knowledge, and experience. He also stated that the accuracy of the conceptual estimates is mainly dependent on three very important factors. They are: 1) the identification of the project scope; 2) the estimator's experience in estimating; and 3) the accuracy of the information in the database. Bakewell also stated that, since conceptual estimates occur in the early stage of the project scope, they require a high degree of estimating knowledge, experience, and judgment to fill in the gaps caused by insufficient information.

Skitmore (1988) extensively reviewed most of the empirical studies related to the factors affecting estimating accuracy. His study identified the following significant factors affecting the bias and consistency of cost estimates: 1) the project type, size, and location, 2) the state of the market, 3) the number of bidders, and 4) the estimator's abilities. He also identified general trends in the literature proving that estimate accuracy increases with an increase in the project size and the bias in overestimating increases as the number of bidders' increases. He also concluded that low estimates were associated with self-professed expertise while high estimates were associated with high recall abilities, high mental imaging, and project experience. This indicates that the accuracy of estimating is highly affected by the estimators' knowledge, experience, and personal behaviors.

Carr (1989) explained the basic seven principles that result in a good cost estimating practice. These principles are 1) the reality; 2) the level of details known about the project; 3) the completeness of the estimate; 4) the documentation of the estimate; 5) the direct and indirect costs; 6) the variable and fixed costs; and 7) the contingency to be assigned. Among all these principles, Carr emphasized that the reality principle is a very challenging principle for cost estimators, because producing an estimate which reflects the project reality requires an extensive amount of experience and judgment skill in addition to the historical data. Also, Carr stated that the completeness of the estimate is highly dependent on the estimator's ability to see beyond the apparent components of the project.

Merrow and Schroeder (1991) identified the causes of cost growth in hydroelectric projects and developed a statistical model to predict the actual cost and schedule for a hydroelectric project. This study concluded that no statistics-based system can substitute for the judgment and experience of the project team. Also, the study reported better results can be achieved by expanding the team knowledge base and arming them with the tools that can improve their performance.

Akintoye and Fitzgerald (2000) studied the causes of inaccuracy in cost estimating practices in the United Kingdom (Belassi and Tukel). This study surveyed contractor companies of different sizes based on the number of employees and classified them into very small, small, medium, and large in order to determine the reasons behind estimate inaccuracy and the shortcomings in skills, knowledge and data in cost estimating practices. They identified that the most important reasons leading to inaccuracies in cost estimating practices are 1) lack of estimator's practical knowledge of the construction process, 2) insufficient time to prepare the estimate, 3) poor tender documents, and 4) the wide variability of subcontractors' prices.

Akintoye (2000) studied the effect of twenty-four factors on estimating accuracy and categorized them into seven main factors using the factor analysis method. These factors are 1) the project complexity factor, 2) the technological requirements, 3) the project information, 4) the project team requirements, 5) the contract requirements, 6) the project duration, and 7) the market requirements. These factors represent the principal elements in cost estimating that are highly dependent on the estimators' experience. Aknitoye also stated that research efforts should consider intangible factors that estimators consider when pricing a project rather than the principles of estimating.

Trost and Oberlender (2003) identified forty-five variables that are considered to be potential reasons for project cost inaccuracy. They used these factors to determine the accuracy of estimates by developing a program to calculate an estimate accuracy score. They used factor analysis of the principal components to classify the forty-five variables into eleven factors based on the major influence of each variable on the factor. The eleven factors explain almost 72% of the variability in the data. They are: 1) the formal estimating process; 2) the basic process design; 3) the bidding and labor climate; 4) the site requirements; 5) the team experience and cost information; 6) the money issues; 7) the technology issues; 8) the contingency and reviews; 9) the team alignment; 10) the time allowed to prepare estimate; and 11) the owner's costs. Among the eleven factors, five factors were determined to be significant when the multivariate regression at the significant level of 10% was used. These factors, according to their importance, are: 1) the process design; 2) the team experience and cost information; 3) the time allowed to prepare the estimate; 4) the site requirements; and 5) the bidding and labor climate. The results of this study show that all the resulted factors are directly dependent and affected by the estimators' knowledge and experience.

Previous studies aimed to examine and identify factors affecting estimating accuracy or inaccuracy show that there is no tool can replace estimators' knowledge, experience and skills, and estimators competency is considered very significant factor affecting the accuracy of estimating. However, few studies discussed the importance of estimators' competencies and identified methodologies to capture and evaluate the necessary skill, knowledge, experience, and judgment requirements that would result in a successful estimate.

Ogunlana (1991) developed a model that can aid cost estimators in learning from experience after studying the reasons behind the inadequate learning from experience in the cost estimating profession, which is considered to be the main contributor to estimating errors. Ogunlana highlighted that learning from experience goes through three stages. The first stage is the awareness of errors and recognition of the need for learning, in which the magnitude of estimating error was ignored and estimators do not recognize the need to learn from experience. The second stage is identifying what learning is necessary. In this stage, what needs to be learned depends on the intensity of information and the relationships between information. The final stage is how to accomplish learning. At this stage, learning from experience can be accomplished in four steps: 1) increasing the amount of useful feedback, 2) creating a social environment that facilitates learning, 3) training estimators to be experts in both the factors that improve predictions and the technical knowledge of estimating tasks, and 4) not expecting infallibility by emphasizing the seriousness of the problem and soundness of the decision made more than the solutions. This study resulted in developing a model for learning from experience for cost estimators. This model emphasizes recording all data related to estimating and bid tasks and analyzing them using ACCEST (ACCuracy in ESTimating) to: 1) make estimators aware of the level of errors in estimates, 2) facilitate fairer comparison of estimates with bids, and 3) help develop relationships between estimating factors and accuracy. The model was tested using data from seven design offices in the United Kingdom. The results help in identifying the sources of error in estimating practices and how errors can be minimized in the future in order to improve estimators' performance.

Lowe and Skitmore (1994) investigated the importance of experiential learning in the development of cost estimators at bidding stage, and compared the preferred learning styles of cost estimators using Kolb's learning style inventory and Honey and Mumford's learning style questionnaire. Experience is considered a very important factor in determining cost estimator's capabilities and the accuracy of the resulting estimates, especially at the bidding stage. Therefore, it is important to determine how an individual can effectively benefit from different experiences acquired. Experience consists of two aspects: the actual participation in an activity and the learning or knowledge resulting from it. As a result, determining the learning style will help in identifying the current learning level and how effectively estimators learn from experience. In this study the authors conducted semi-structured interviews and administered a learning style questionnaire survey of 10 cost estimators. The results of Kolb's learning style inventory indicate that the most preferred learning style of experienced cost estimators is the accommodator. This learning style has great strength in doing things such as to carry out plans, to take risks, and to solve problems in an intuitive, trial and error manner. The results also show that cost estimators score highly in the doing stage of the learning cycle and low in the reflective stage, which is considered very important stage which can prevent the learning potential through experience from vanishing. The results for the Honey and Mumford learning style questionnaire were inconclusive because there were strong preferences for theorist, activist, and pragmatist learning styles. The study shows that cost estimators lack the reflective observation stage of the learning cycle which limits their benefiting from experience and minimizes their contribution to the organization knowledge. The results of this study along with Ogunlana (1991) study shows that the absence of a quality system to monitor estimators' performance highly affects the effectiveness of estimators learning from their experience and contributing to the organization knowledge.

Houseman et al. (2006) described a methodology to investigate differences between how novice and experienced cost engineers use their knowledge and experience in making decisions when performing an estimating task. In this study, the "Think Aloud" method along with the protocol analysis technique was used. In the think aloud method, participants are required to say aloud everything they think of or do while performing the task in order to record everything either as a verbal protocol or a written protocol to be analyzed later using the protocol analysis technique. In this study, eleven cost engineers were selected: seven experienced cost engineers with at least 5 years of experience and 4 novices. The study task was to perform a detailed cost estimate for a standard mountain bike within an hour. Each participant's practice was videotaped to be used to break the estimating task into smaller protocol segments. A coding scheme was developed, validated, and assigned to each protocol to represent the cognitive action of the cost engineer. Then the coding results of the protocol analysis were presented graphically in order to identify the pattern and trends of cost engineers' cognitive activities. The analysis of the collected protocols from one of the participants shows how the estimator was concise in performing estimating tasks and followed a structured methodology through the estimating tasks.

Hollmann and Elliott (2006) discussed the importance of developing competency and career development models for the cost estimating profession in the advancement of their career, and linked these models to the business and organization objectives. They stated that the competency model helps employees understand the level of skills, knowledge and performance requirements at each position of their career path. Also, they highlighted the important roles of competency and career development models in helping companies meet performance requirements. In their study, they gave an example of a competency/career development model for cost estimating work for an owner's company in the process industry. This model was developed to assess estimators' performance and organize the estimating department. This designed model considers the business objective for the owner company. Each estimating competency was associated with examples for the different performance levels to help the manager and the estimator assess the fulfillment of the performance level for each competency.

Zack (2007) realized through his experience in the estimating profession that preparing estimates involves more than adjusting historical numbers for time, size, location, and inflation and consumes a considerable amount of skill, knowledge, and experience in the field in order to prepare a reliable estimate. He pointed out that estimating practices have changed through generations, where today's estimators are heavily dependent on computer software in preparing estimates while earlier generation estimators used their experience, knowledge, and judgment skills to prepare estimates. Zack signified the importance of an estimator's experience and judgment skill using a recent court case, in which the court valued the estimator's knowledge in the estimating trade and his good judgment skill and ruled in favor of the contractor.

2.2. Capture and Transfer Methods

Transferring skills and knowledge has become an essential task in every organization due to the effect of the gap between the baby boomer employee generation and the junior employee generation. Using data collected from more than 500 U.S. firms the American Society for Training and Development (ASTD 2000) Oliver (2001) examined the relation between the returns to stakeholders and the average annual amount expended on training. The results of the study showed that firms spending the most on training scored 86% higher in stakeholder returns than other firms. The study also reported that training methods such as mentoring, on-the-job training, e-learning, computer-based training, classroom-based training, and others play an important role in transferring skills and knowledge and upgrading the current workforce competencies.

A recent study by Jeong et al. (2010) identified the core competencies required to develop qualified cost estimators and effective methods to transfer estimating competencies to new generation of estimators. The study resulted in identifying mentoring and on-the-job trainings as the most effective training methods. However, in their study, the effect of mentoring and on-the-job training methods on transferring estimating competencies was not quantified.

Mentoring and on-the-job training are special kinds of adult education that use a novice-to-expert approach (Aik, 2005; Bryant, 2005). Mentoring usually encompasses the knowledge flow from the highly experienced employee to the less experienced employee. However, with the current challenges facing companies, especially the reduced number of senior employees available to mentor (Eby, 1997), peers mentoring is considered an effective alternative. Each of those methods has its advantages and disadvantages, however, they share a common important advantage in that this type of adult education allows the new employee to interact with different levels of experienced employees, and the success of these methods in transferring and sustaining the knowledge level is highly affected by the learning culture of the organization (Aik, 2005; Bryant, 2005; Ko et al., 2005).

ASCE (2003) indicates that mentoring/on-the-job training and career guidance are the common methods used in the construction industry to prepare junior engineers for their positions. Mentoring and on-the-job training proved their effectiveness in the development of the new engineer's performance and success in addition to other benefits such as: 1) improved employee performance and satisfaction, 2) better organization decisions, 3) improved technical competence, 4) improved quality of work, 5) intrinsic satisfaction of the mentors, and 6) the development of a lasting relationship between the mentored and the mentor. Career guidance is an additional but very important role of the manager to guide new employees in their career decisions (Russell, 2003c).

Arthur (2001) highlighted the benefits and effectiveness of mentoring by defining mentoring as "a developmental, helping relationship whereby one person invests time, ability, and effort in enhancing another person's growth, knowledge, and skills in preparation for greater productivity or future achievement". He also stated that mentoring can help organizations in establishing stronger teams, reducing turnover, increasing productivity, and attracting and retaining employees.

Gushgari et al. (1997) studied the important set of skills the principals and project managers need that affect the long-term profitability of engineering companies and the most effective training methods to be used to transfer these skills. In this study, questionnaires were mailed to 500 engineering firms in the United States and 43 companies responded. The analysis of the collected data shows that the most preferred training methods to train project managers and principals are: 1) working with a mentor, 2) personal study, 3) in-house training, and 4) off-site full-day seminars. Training using out-of town seminars, industry conventions, and college courses were ranked the least-preferred training methods by both the project managers and the principals. All previous studies on identifying methods used to train employees indicated that mentoring and on-the-job training methods are very critical in developing employee competencies.

2.3. Learning Organization

Since the late 1970's, the concept of learning organization and the characteristics defining a learning organization have gain significant attention from researchers and practitioners in the fields of management science and organization behavior (Argyris, 1977). It gained more attention after the Peter Senge work in 1990 "The fifth discipline" and Watkins and Marsick work in 1993 "Sculpting the learning organization." Senge's work formed the basis of the learning organization concept, where Senge characterizes a learning organization by the organization ability to create, acquire, share, and apply knowledge to improve organizational performance. Watkins and Marsick (1993) define a learning organization as "the organization that learns continuously and transforms its self." A broader definition of a learning organization was developed by Jensen (2005) who defines a learning organization as "an organization that is organized to scan for information in its environment, by itself creating information and promoting individuals to transform information into knowledge and coordinate this knowledge between the individuals so that new insight is obtained." Most studies in knowledge management and learning organization focus on transferring tacit (soft) knowledge to explicit (hard) knowledge that can easily be captured and transferred between individuals and groups within the organization (Nonaka, 1994). According to others (Kogut and Zander, 1992; Nonaka, 1994) learning occurs through collaborative interaction that facilitates the sharing of tacit knowledge between individuals and peer groups.

Many studies aimed to identify the critical factors defining the positive learning organization culture. Senge (1990) and Pedler et al. (1991) identified the system perspective of a learning organization which provides the basic principles for building a learning organization. The system perspective consists of five disciplines that a learning organization should acquire: 1) team learning, 2) shared vision, 3) mental models, 4) personal mastery, and 5) system thinking. Pedler et al. (1991) defines the organizational learning perspective that supports the learning-based environment. The organizational learning perspective stresses the importance of facilitating the continuous learning activities by: developing a learning approach to organizational strategy, creating participative policy-making process, developing formative accounting and control flexible reward system, implementing appropriate learning climate, etc. which helps in transforming the organization to meet its strategic goals.

Watkins and Marsick (1993), Marsick and Watkins (1999), and Yang, Watkins, and Marsick (2004) proposed an integrative model of a learning organization. This model consists of seven dimensions of the learning organization: 1) continuous learning opportunities defined as "being designed into work so that people can learn on the job, opportunities are provided for ongoing education and growth," 2) inquiry and dialogue in which “people gain productive reasoning skills to express their views and the capacity to listen and inquire into the views of others,” 3) collaborative and team learning in which “work is designed to use groups to access different modes of thinking, groups are expected to learn together and work together,” 4) systems to capture and share learning in which “both high and low technology systems to share learning are created and integrated with work and access is provided,” 5) empower people toward a collective vision where “people are involved in setting, owning, and implementing a joint vision, responsibility is distributed close to decision making so that people are motivated to learn toward what they are held accountable to do,” 6) connect the organization to its environment where “people can see the effect of their work on the entire enterprise, people can scan the environment and use information to adjust work practices,” and 7) strategic leadership for learning in which “leaders model, champion, and support learning.” The Watkins and Marsick study resulted in the development of the Dimensions of the Learning Organization Questionnaire (DLOQ) which was used and validated to measure the seven dimensions of learning organizations worldwide (Watkins and Marsick, 1993; Marsick and Watkins, 2003; Yang et al., 2004; Zhang et al., 2004; Lien et al., 2006). Although the learning organization and knowledge management concept is very well established in the management and business development fields, it is considered new in the engineering and construction industry (Chinowsky and Carrillo, 2007).

The construction industry is undergoing significant challenges recently such as the aging workforce, globalization, growth of the organizations, and better solutions (Chinowsky et al., 2007). These challenges accentuate the need to retain the knowledge of the experienced workers within the organization and establish a learning culture for the development of individuals through all the organization levels. Many studies investigated the current practices of organization learning in the construction industry. However, it is rare to find any study which evaluated the impact or outcomes of adapting the learning organization culture on the organizational performance or knowledge retention. According to Snyder (1996) “organization learning is critical to long-term performance” however the improvements in performance due to a transformation to the organization learning environment or culture have not been evaluated either at the organizational or at the professional level in the construction industry.

First of all, a clarification needs to be made regarding the interchangeably used terms learning organization and organizational learning. Although these terms have been widely and interchangeably used in the construction industry, there exist differences between the two terms. Learning organization, according to Garvin (1993), “is an organization skilled at creating, acquiring and transforming, knowledge and modifying its behavior to reflect new knowledge and insights.” Argyris (1977) defined organizational learning as ‘the process of detecting and correcting errors.’ Love et al. (2000) stated that learning organization describes the organization’s structure and capabilities to facilitate learning within the organization while organizational learning explains and quantifies the learning activities and training which results in developing a learning organization. This section provides the review of the previous efforts aimed at investigating both learning organization and organizational learning in the construction industry since this study aims to determine the best combination of learning organization and organizational structure that can effectively accelerate the knowledge retaining process and learning within the organization.

Love et al. (2000) highlighted the importance of practicing total quality management (TQM) in the development of learning organization and proposed a conceptual model that can help improving performance through leveraging learning within the organization. Love et al. (2000) stated that although TQM has been poorly practiced in the construction industry, TQM methods and techniques are considered very important in enabling organizational learning at both the individual and group levels. Also, there is a ‘strong philosophical link between the systematic problem solving process of a learning organization and TQM.’ Love et al. (2000) embraces the concept that organizations in the construction industry can improve their performance and sustain their competiveness by transforming to a learning organization culture which can be achieved through TQM and organizational learning methods and technologies. Although Love et al. (2000) provides strong evidence from the literature about the importance of TQM and organizational learning in developing the learning organization, their study lacks the evaluation of the conceptual model and the identification of the best TQM and organizational learning practices that are considered the best practices for organizations in the construction industry.

Styhre et al. (2004) examined the organization learning efforts practiced within the Swedish construction industry due to its importance in facilitating the sharing of experiences and know-how, providing innovative solutions, and the adaption to continuous changes in the organization and construction industry environment. In addition, construction projects are usually classified as network-based organizations because they consist of a mixture of professions with different levels of experiences taking parts in the construction project at different times. For this reason, learning organization capabilities are considered very important in construction projects due to their network-based operational nature that required tremendous communication and sharing of knowledge and expertise. Their study underwent two types of data collection: the case study method using interviews and formal documents, and the action research approach which is based on the involvement at the different phases of the research activities and shares the outcomes with the practitioners’ concerns and findings. Managers and construction workers from six construction projects were interviewed. The collected data was analyzed and structured into categories. The interviews result show that there exists a lack of communication between project architect and other designers on one hand and the different contractors on the other hand. The results also indicated that the organization learning capabilities in the construction industry were not very formalized. They are based on face-to-face interactions, which can be improved by increasing the awareness about the need for time and space for sharing the knowledge. This will help in dealing with the ambiguities and changes in the industry. Although this study examined the current organization learning capabilities in the Swedish construction industry, the study lacks quantifying the impact of practicing the organization learning on the organization performance and knowledge.

Chinowsky et al. (2007) investigated the current organization learning techniques and technologies used in the construction industry and developed a maturity model that can assess organizations in the construction industry in developing organization learning culture. Realizing the current movement in the construction industry toward the knowledge worker and knowledge era, organizations tend to adapt the organization learning techniques that will help in creating, acquiring, sharing, and applying knowledge to embrace changes and innovation at all organizational levels that will positively impact workers' performance and maximize the organization competitiveness. The developed learning organization maturity model helps organizations assess the level of their learning organization efforts to achieve the required learning culture and determine the barriers hindering them from successfully implementing a learning organization. This model consists of two main parts; the learning organization entities and the learning organization characteristics. The learning organization entities represent the learning groups within the organizations that facilitate, develop, and evaluate knowledge such as organization that includes the overall corporate entity of all its levels, community which represents a group of individuals engaged in similar technical activities, and individuals. The learning organization characteristics are measured by five characteristics: 1) leadership, which is a measure of the ability to lead the organization toward implementation of a learning organization, 2) process and infrastructure, which represents the management processes and the technical infrastructure required to implement the learning organization, 3) communication, which is a measure of the interaction between the community and individuals within the organization, 4) education, which is a commitment between the organization and employees to continuous education opportunities and bringing new knowledge, and 5) culture which measures the development of a culture that facilitates and rewards learning within the organization. This model monitors the development of the learning organization culture by evaluating the stages through which the organization passes the process from the starting point to the mature stage. Six levels exist to assess the maturity of the development of the learning organization culture. They range from level 0, where the organization begins the transformation to the learning culture, to level 5, where the organization adopted the complete characteristics of the learning organization. The capability of the developed model in assessing an organization’s efforts to develop the learning culture was evaluated using 10 case studies. This study provided the construction industry with the tool to assess organizations during their long-term transformation to adapt the learning culture, however, it model does not indicate an organization’s need to transform to learning culture or quantify the impact of transforming to learning culture. This implies that developing a learning culture is optional, when actually, it is a necessity to maintain the organization’s performance and competiveness.

Kivrak et al. (2008) studied the current knowledge-capturing practices in the Turkish construction industry, how the tacit and explicit knowledge is captured, stored, and shared to enrich the organization’s knowledge assets and determine the barriers hindering facilitating the knowledge wealth. Organization knowledge plays very critical role in today’s competitive business environment because it can reduce project cost and time, improve quality, and sustain the organization’s competiveness. A survey was conducted to evaluate the current practices of capturing, storing, reusing, and sharing knowledge in the construction industry. The results show that organizations in the construction industry lack a systematic structure to manage and share the knowledge and this prevents organizations from reaching the necessary learning level. This study resulted in developing a conceptual framework to effectively capture the knowledge from individuals and leverage the organization learning. A web-based system to evaluate the effectiveness of framework has been designed and is called Knowledge Platform for Contractors (KPfC). This system provides the means to reduce rework, share and retain tacit knowledge, store innovative ideas, facilitate transferring lessons learned, and facilitate a learning organization environment. This study resulted in an innovative system to improve learning. However, the effectiveness and benefits from using the system have not been quantified.

2.4. Motivation

Investigation of profession based motivators is potentially important for improving individual performance and enhancing management practices in transferring and retaining their knowledge assets. The existing literature shows evidence that intrinsic motivation and extrinsic motivation have a direct relation to transferring tacit/soft knowledge and best practices (O'Dell and Grayson, 1998; Argote, 1999; Tierney et al., 1999; Osterloh and Frey, 2000). Intrinsic motivation is defined as “any motivation that arises from individuals’ positive reaction to qualities of the task itself, this reaction can be experienced as interest, involvement, curiosity, satisfaction, or positive challenge”

(Amabile et al., 1994). According to Calder and Staw (1975) intrinsic motivation occurs when “an activity is valued for its own sake and appears to be self-sustained.” Extrinsic motivation is defined as “deriving satisfaction that is independent of the content of the activity itself” (Calder and Staw, 1975). Existing studies show that intrinsic motivation is considered essential and vital when generating and transferring tacit knowledge and developing employees’ behavior (Amabile et al., 1994; Austin, 1996; Osterloh and Frey, 2000). Amabile et al. (1994) reported that intrinsic and extrinsic motivations have different impacts on the learning and performance outcomes based on the type of profession and working environment.

Amabile et al. (1994) developed the Work Preference Inventory (WPI) to assess the differences in individual intrinsic and extrinsic motivational orientation. WPI was designed to capture the major elements of both intrinsic and extrinsic motivation. Intrinsic motivation includes a) self-determination, b) competence, c) task involvement, d) curiosity, and e) interest. Extrinsic motivation includes a) evaluation concerns, b) recognition concerns, c) competition concerns, d) tangible incentives (compensation), and e) a focus on the dictation of others. WPI underwent several revisions and in its final revision it contains 30 items. Two versions of WPI were tested, one for the working adults and the second college students. A total of 1,363 undergraduates’ students and 1,055 working individuals participated in this study. Using explanatory factor analysis, the analysis resulted in two factors representing the primary scale of the WPI instrument, the intrinsic and extrinsic motivation factors. Then each of the primary factors was analyzed to determine the sub-factors within the intrinsic and extrinsic motivation. The analysis yielded in two intrinsic sub-factors and two extrinsic sub-factors. The two intrinsic sub-factors interpreted as challenge factor with 5 items and enjoyment factor with 10 items. The two extrinsic sub-factors interpreted as compensation factor with 5 items and outward factor with 10 items. This study resulted in developing a reliable instrument to measure the differences in individuals’ intrinsic and extrinsic motivation.

In the construction industry, McQuillen (1986) discussed the different motivational theories and their effect on civil engineers’ performance. In this study, McQuillen reviewed and analyzed four motivational theories: Maslow motivation theory, McGregor motivation theory, Herzberg motivation theory, and, finally, Vroom and Laufer motivation theory. Maslow motivational theory stated that human needs are hierarchical, the lower need level must be satisfied before the succeeding need level becomes important. The human needs in ascending order are: physiological (food, clothing, etc.), safety, social (belonging, acceptance, etc.), egotistic (respect, recognition, etc.), and self-actualization. McGregor motivation theory is the theory X and theory Y view of management and motivation. Theory X describes a person who prefers to be directed, wishes to avoid responsibility, and has little ambition. Theory Y describes a person who asserts the ability to be imaginative, ingenious, and creative. Herzberg defines motivators as behaviors concerned with job satisfaction, and they are: achievement, recognition, work itself, responsibility, advancement, and growth. Herzberg in his theory also identifies the Hygiene factors that cause dissatisfaction to be: company policy and administration, supervision, interpersonal relationships, working condition, salary, and security. In the Vroom and Laufer expectancy theory, the motivational force of an individual is equal to multiplying the personal expectancies concerning future events by the value placed on the outcome. The McQuillen analysis shows that the construction industry applies part of those theories regardless of the differences in men's and women's needs. The analysis also concluded that performance is a function of the mental state of the engineer not his physical attributes. It also concluded that achievement, recognition and praising, increased responsibility, and job growth are the main requirements in the work environment that can help motivate engineers.

Tabassi et al. (2011) investigates the effect of human resources development practices in employing training and motivations on the improvement in performance at the task and teamwork levels in construction projects. In this study, a questionnaire survey was developed and used to assess two relationships; 1) the relationship between employees training and motivation practices with teamwork improvement, and 2) the relationship between employees training and motivation practices with task efficiency. The results of this study indicate that motivation practices and motivating environment had strong effect on the training outcomes, task efficiency, and improving the teamwork performance. However, the different effect of intrinsic and extrinsic motivations was not evaluated. In addition, this study assumed that a team consisting of different professionals can be motivated using similar motivators, which contradict the fact that motivation practices differs between individuals and job tasks.

CHAPTER III

PHASE I COST ESTIMATING COMPETENCIES

3.1. Introduction

Perhaps the greatest challenge facing the cost estimating community over the next decade is the loss of knowledge and experience of highly experienced estimators as high percentage of them are retiring and a shortage of qualified cost estimators is evident in the construction industry (Behrendt, 2005; Hollmann and Elliott, 2006). Cost estimating is a critical function for capital projects to both owner and engineering/construction companies. Owners rely on cost estimates to perform economic analyses for return on the investment from their capital expenditures. Engineering/construction companies rely on the cost estimate for bidding and negotiating work, which is the basis for securing future work and ensuring the profitability of their companies. Recognizing the importance of estimators competency in producing reliable estimates, the construction industry is confronted with how to capture the skills and knowledge of highly experienced estimators as they retire (Behrendt, 2005; Hollmann and Elliott, 2006; Zack 2007).

Most efforts to promote good estimating have focused on developing cost information, adjustments for time/size/location, and estimating tools, in particular automation of the estimating process by computer methods. However, those tools that aid the estimating process cannot replace the judgment and experience of a competent cost estimator. A recent article by the President of the AACE-I described a court case to illustrate that the sound judgment of estimators, based on their experience, is equal to and perhaps more important than the cost data information (Zack 2007).

This study is conducted to identify and prioritize estimating skills, knowledge, and personal attributes required to develop qualified cost estimators. It also quantified the gaps between the current and desired level of the estimating competencies. The competency importance and relative gap results were used to develop an estimating core competency criticality matrix that will help in visualizing and prioritizing estimating competencies based on their criticality scores. Finally, this study grouped the 23 estimating competencies into seven major estimating core competency factors using the factor analysis technique that can be effectively used to reduce the company efforts, time, and costs when designing training programs or courses for estimators.

3.2. Data Collection

During spring and summer 2008, a survey was conducted to obtain expert opinions on various issues in the estimating profession such as estimating functions, required estimating competencies, the gaps between the ideal and the current level of competencies, and current practices in recruiting, attracting, retaining, and training estimators (Appendix A). For this survey, a questionnaire with 37 questions was developed through a two day workshop in Houston, Texas with 22 expert estimators. The questionnaire was sent to all Construction Industry Institute (CII) member companies, and also was distributed at the Association for the Advancement of Cost Engineering – International (AACE-International) and American Society of Professional Estimators (ASPE) national workshops in 2008. A total of 228 completed questionnaires were collected. 79% of the respondents were from CII member companies, and 21% were from AACE-I and ASPE members. 31% of the survey participants were from owner companies and 69% were from non-owner companies. The data collected represented a total of approximately 3,500 years of experience in the estimating profession and 52% of the respondents had at least 15 years of experience in the estimating profession.

3.3. Core Estimating Competencies

Competency is defined as “a standardized requirement for an individual to properly perform a specific job and it encompasses a combination of skills, knowledge, and behavior utilized to improve performance (Brozova and Subrt 2008).” Accordingly, estimating competencies can be defined as a cluster of interrelated skills, knowledge and personal attributes required to properly perform an estimating job. In this study, 23 core estimating competencies were identified as important competencies required for developing good cost estimators through a two day workshop with 22 senior estimators. The identified 23 estimating competencies are classified into skills, knowledge, and personal attributes. Skill is the ability to perform a certain estimating task, while knowledge is information an estimator has attained related to estimating, and personal attributes represent personal attitudes, traits or behaviors required to do good cost estimating. Furthermore, skills and knowledge are divided into soft and hard subcategories. Soft skills or soft knowledge is difficult to be taught or developed and requires more experience and training, while hard skills or hard knowledge is relatively easy to be taught, developed, and learned. Figure 2 shows the hierarchy of estimating competencies identified in this study. An expanded definition of each competency is provided in Table 2.

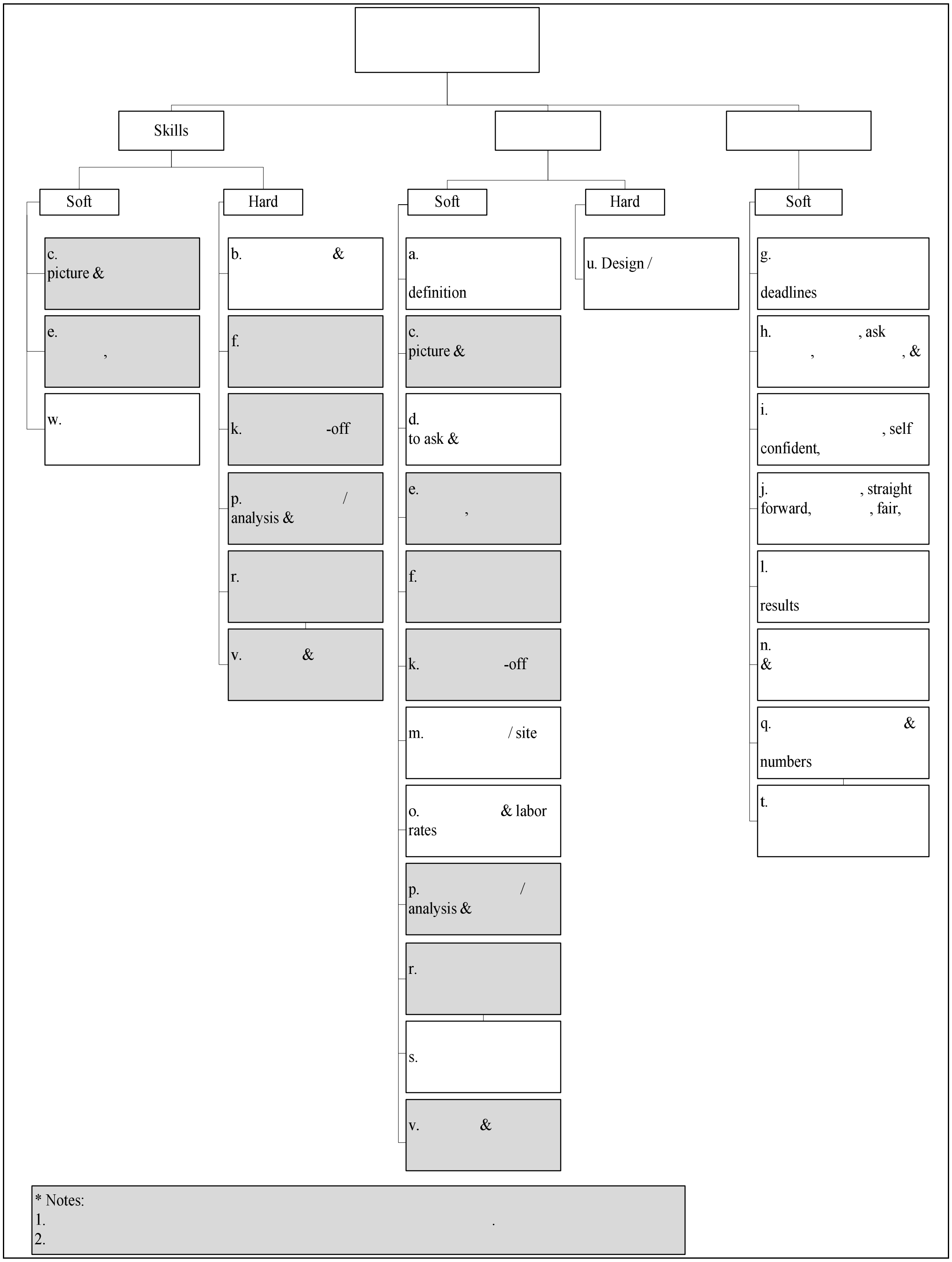

Skills
Soft
Hard
Soft
Hard
Soft
c.
picture &
e.
,
w.
b. &
f.
k. -off
p. /
analysis &
r.
v. &
a.
definition
c.
picture &
d.
to ask &
e.
,
f.
k. -off
m. / site
o. & labor
rates
p. /
analysis &
r.
s.
v. &
u. Design /
g.
deadlines
h. , ask
, , &
i.
, self
confident,
j. , straight
forward, , fair,
l.
results
n.
&
q. &
numbers
t.
* Notes:
1. .
2.

Figure 2. Classification Hierarchy of Estimating Competencies

Table 2. Classification and Expanded Definition of Cost Estimating Competencies

Competency Name	Competency Classification		Expanded Definition/ Examples
a. Analyzing what's missing in the scope definition	Knowledge	Soft	Ability to evaluate the project documents (proposal and drawings) for completeness and to know what is missing; determine the allowance for scope growth, understand the work and construction process, and look for benchmarks and metrics.
b. Develop clear and organized estimates with sound basis	Skills	Hard	Accomplished by using "company" standards for consistency in estimate organization (i.e.. basis of estimate, summary, supporting details, risk assessment, etc.), structures, checklists, and formats.
c. Ability to see the big picture and realize what is important	Skills & Knowledge	Soft	Ability to focus on the areas of the estimate which have the greatest influence on outcome, i.e. 80/20 rule for detailed estimates and 90/10 for conceptual estimates. Because of the limited time allowed for estimate preparation estimator will not have enough time to address every estimate detail with the same level of attention.
d. Know what to ask and who to ask	Knowledge	Soft	Estimators' ability to come up with right question to gather information and the right source of this information. Bad questions create unclear answer that could lead to misunderstanding; questioning the wrong people could have the same result.
e. Able to apply judgment, do reality checks, then explain why	Skills & Knowledge	Soft	Ability to apply judgment is aided by experience. Estimates should be based on input from those with the most expertise in a particular area. That combined input then needs to be reviewed and compared with similar project's benchmarks and metrics. Estimators need to understand not just what is not different from other project's metrics, but why and if the items are justifiable or if estimate adjustments are required.
f. Know how to read and Interpret drawings	Skills	Hard	Ability to read drawings and know the drawings standards
	Knowledge	Soft	The ability to visualize the end product of the design and account for what is missing.
g. Ability to work under pressure with tight deadlines	Personal Attribute	Soft	Estimators' ability to perform estimating task effectively within the tight deadline allocated to prepare the estimate.
h. Be inquisitive, ask question, find resources, and make decision	Personal Attribute	Soft	This attribute is very important and its generally not taught, but can be improved by teaching and mentoring. Locating the right resources and making decisions improves over time as the estimator gains more experience.
i. Have good communication skills, self confident, work with others	Personal Attribute	Soft	Estimators must be capable and competent in communicating and working with others who provide input and information to the estimate.
j. Be dependable, straight forward, objective, fair, and consistent	Personal Attribute	Soft	Establishing a realistic estimate for project execution and competitive bidding is highly dependent on estimators' competencies and it is very vital that the estimator be dependable, objective, fair, and consistent when preparing an estimate.

Table 2. (Cont.)

Competency Name	Competency Classification		Expanded Definition/ Examples
k. Quantity take-off	Skills	Hard	The actual process of performing a quantity take-off may be taught based on only "taking off" what is shown.
	Knowledge	Soft	The ability to know what must be added and quantified, to what is shown on drawings, requires knowledge gained through experience.
l. Be task oriented with the drive to achieve the end results	Personal Attribute	Soft	The requirement to be task oriented with the drive to achieve results is needed to coordinate multiple estimate development activities and pull together the estimate within normally tight time periods. As the estimate has many "moving parts" the inability to focus on each task and drive to completion can be disastrous.
m. Construction/site condition knowledge	Knowledge	Soft	Necessary knowledge for estimating profession, mainly acquired by multiple site experience, and site knowledge such as understanding of the site work process and activities, durations, etc.
n. Have interest in details and numbers with ability to organize work	Personal Attribute	Soft	Preparing estimates requires dealing with many level and types of details, and this type of work requires a lot of patience and clear organized thought to produce high quality document.
o. Productivity and labor rates	Knowledge	Soft	Understanding what conditions impact labor productivity and how to adjust the required labor hours consistent with project specific requirements and influences. Know the labor wage & fringe benefits rates that must be included in any payroll burdens / taxes included and any overtime premiums included as appropriate.
p. Risk assessment/analysis and contingency	Skills	Hard	Ability to analyze risks (i.e. perform Monte Carlo simulation).
	Knowledge	Soft	Ability to assess risk elements to be included in the estimate and the necessary contingency percentage to be considered.
q. Able to stand ground and resist pressure to change numbers	Personal Attribute	Soft	Ability to explain and defend the estimate as appropriate to assure the estimated cost is realistic and achievable. There are always many pressures to change estimated costs to be more competitive.
r. Obtaining quotation accurately from vendors	Skills	Hard	Ability to gather data and specifications, standard contract terms, etc; inquiry preparation provided to vendors and the ability to assess if a vendor quotation complies technically with required specifications and commercially with contract terms / conditions.
	Knowledge	Soft	Understand the risks involved with vendor selection based on past performance, ability to fulfill scheduled deliveries, etc.
s. Escalation impact	Knowledge	Soft	The ability to assess the impact of cost changes over time due to (escalation / de-escalation) labor wage increases (raises), materials & equipment prices, etc. must be understood as it will change the current cost basis. The Estimator must make provisions for all escalation by utilizing company procurement groups, published cost/price indices, and other sources.
t. Open to working in new areas where you may not feel comfortable	Personal Attribute	Soft	Most projects are not the same. They have different scope, different locations, execution basis, etc. To enable the estimator to be effective, an attitude open to new areas with maybe little background or previous knowledge is required.

Table 2. (Cont.)

Competency Name	Competency Classification		Expanded Definition/ Examples
u. Design/engineering knowledge	Knowledge	Hard	The estimator must understand design/engineering basics in order to understand the project scope and requirements.
v. Planning and Scheduling	Knowledge	Soft	Planning requires knowledge of the various work process and conditions such as limited working areas causing congestion.
	Skills	Hard	Scheduling is a skill which can be learned in relation to standard principles and software programs.
w. Development of reports for management	Skills	Soft	Ability to understand the requirements for level of detail and format in a report that must be adapted to differing end user needs.

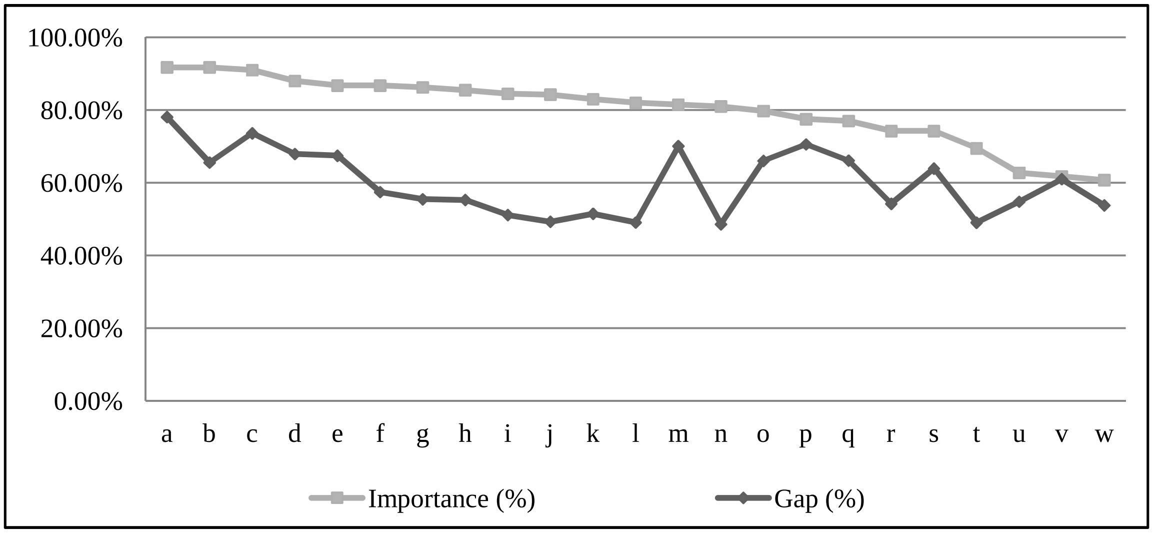
3.4. Assessment of Estimating Competencies

In the survey, the importance of each of the 23 estimating competencies and the degree to which junior estimators typically lack in each competency were assessed using a 5-point Likert scale. The 5-point Likert scale used to assess the importance of estimating competency was “1=least important” to “5=most important.” The 5-point Likert scale used to assess the degree of lacking in estimating competency was “1=not lacking” to “5=most lacking.” Figure 3 shows the assessment results of the survey data. The results are the average values after the 5-point Likert scale was converted into a “0-100” percentage scale using Equation (1) (Myatt, 2007c) to allow the comparison between the competency importance and the gap in competency. The competencies are sorted in a descending order on the X-axis in terms of their importance values.

$$\text{Scale in Percentage} = \frac{\text{Mean}-1}{(\text{Max.Scale}-\text{Min.Scale})} * 100 \qquad \text{(Eq. 1)}$$

where, the mean is the average of the 228 responses for each of the estimating competencies, maximum scale is 5, and minimum scale is 1.

The top five most important estimating competencies are “a) analyzing what’s missing in the scope definition,” “b) develop clear and organized estimates with sound basis,” “c) ability to see the big picture, realize what is important,” “d) know what question to ask and who to ask,” and “e) know how to read and interpret drawings.” The top five biggest gaps existing in the competencies include “a) analyzing what’s missing in the scope definition,” “c) ability to see the big picture, realize what is important,” “p) risk assessment/analysis and contingency,” “m) construction/site condition knowledge,” and "d) know what question to ask and who to ask." It is noteworthy that competencies with the largest gaps are mainly soft skills or soft knowledge. The nature of these competencies makes them very hard to be captured or learned.



Note: the letters on the x-axis match with the letters in Table 2.

Figure 3. Assessment of Estimating Competencies

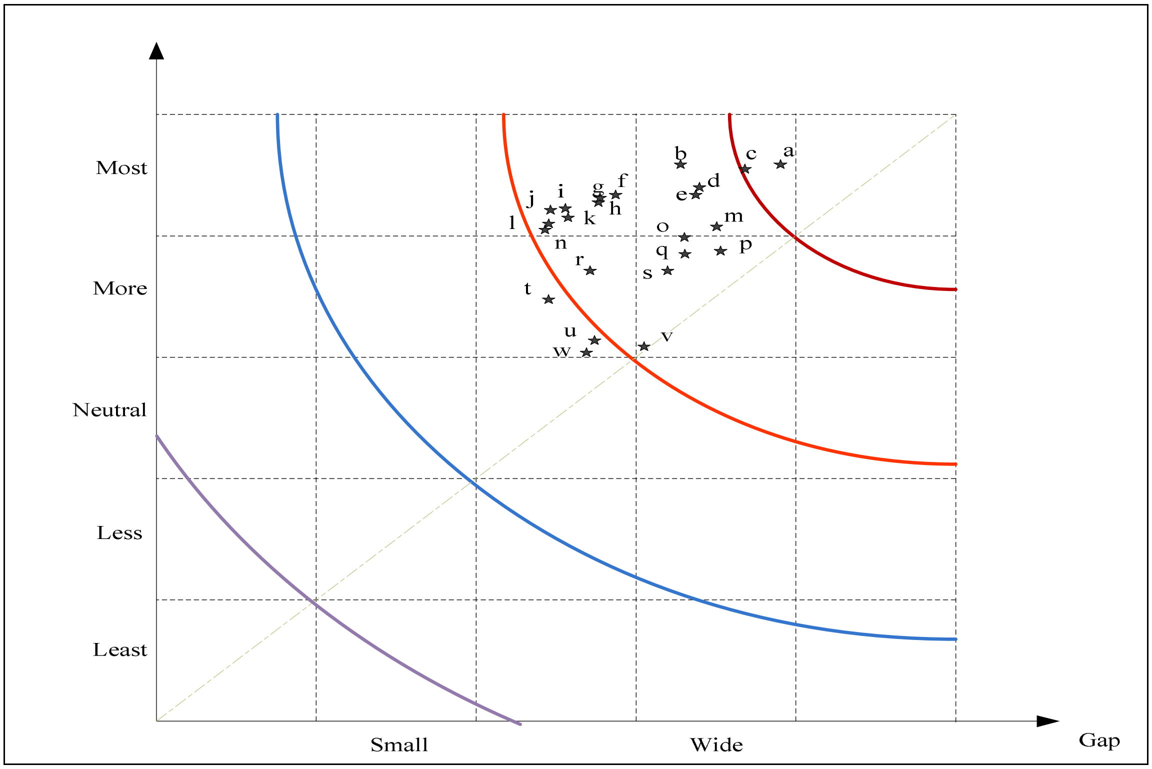
3.5. Estimating Core Competency Criticality Matrix

An estimating core competency criticality matrix was developed to prioritize the competencies based on the scores which are calculated using the importance value of each competency and the value of the associated gap with the competency. In calculating the criticality index of each competency using Equation (2), both the importance and the gap values of each competency are equally weighed. The criticality index is a normalized value ranging from 0% to 100%. The criticality index measures the Euclidian distance from the point where an imaginary competency has the highest importance (100%) and the widest gap (100%) to a point where the competency is located in Figure 4. The estimating core competency criticality matrix classifies the competencies based on their criticality index into five zones; most critical, more critical, critical, less critical and least critical zones. The estimating core competency criticality matrix provides an idea about which competencies should be given more efforts and time in training and educating estimators in order to improve the overall performance in estimating.

$$\text{Criticality Index} = \frac{\sqrt{(100\% - \%\,Gap)^2 + (100\% - \%\,Importance)^2}}{141.42} \qquad \text{(Eq. 2)}$$

$$\text{Criticality Index} \begin{cases} 0 - 20 & \text{Most Critical} \\ 20 - 40 & \text{More Critical} \\ 40 - 60 & \text{Critical} \\ 60 - 80 & \text{Less Critical} \\ 80 - 100 & \text{Least Critical} \end{cases}$$

The estimating core competency criticality matrix (Figure 4) shows that all estimating competencies fall on three zones; most critical, more critical and critical zones. The two most critical competencies are “a) analyzing what’s missing in the scope definition” and “c) ability to see the big picture, realize what is important.” These competencies are determined to be most critical because 1) they are most important competencies for high quality estimating and also 2) they are the competencies that most estimators are significantly lacking (their gaps are very wide between the current level and the ideal level). The majority of estimating competencies fall on the more critical zone while few others fall on the critical zone. The results indicate that new estimators’ lack the important competencies that build an estimator and emphasized the urgent need to capture and transfer these competencies to young estimators.



Note: the letters on the Figure represent competencies on Table 2.

Figure 4. Estimating Core Competency Criticality Matrix

3.6. Factor Analysis

The factor analysis method is one of the commonly used dimension reduction statistical methods. It was applied to the identified 23 competencies in order to determine whether these competencies can be grouped under different factors and to categorize them into a manageable number of factors in order to design better training programs for estimators with less cost and effort. The factor analysis investigates the correlation relationships between the estimating competencies. The Statistical Package for Social Sciences (SPSS 16.0) was used in performing the factor analysis using the procedure shown in Figure 5. In order to use the factor analysis method, the reliability of the scale used in the collected data and the appropriateness of using the factor analysis method on the data must be assessed first. The Cronbach alpha coefficient was used to test the reliability of the scale used in the collected data. Then the appropriateness of factor analysis was assessed using three tests which include; Kaiser-Meyer-Olkin (KMO) for measuring the accuracy of the sample, Anti-image correlation for measuring the sample adequacy (MSA) for each variable, and the Bartlett test of sphericity (Field, 2005).

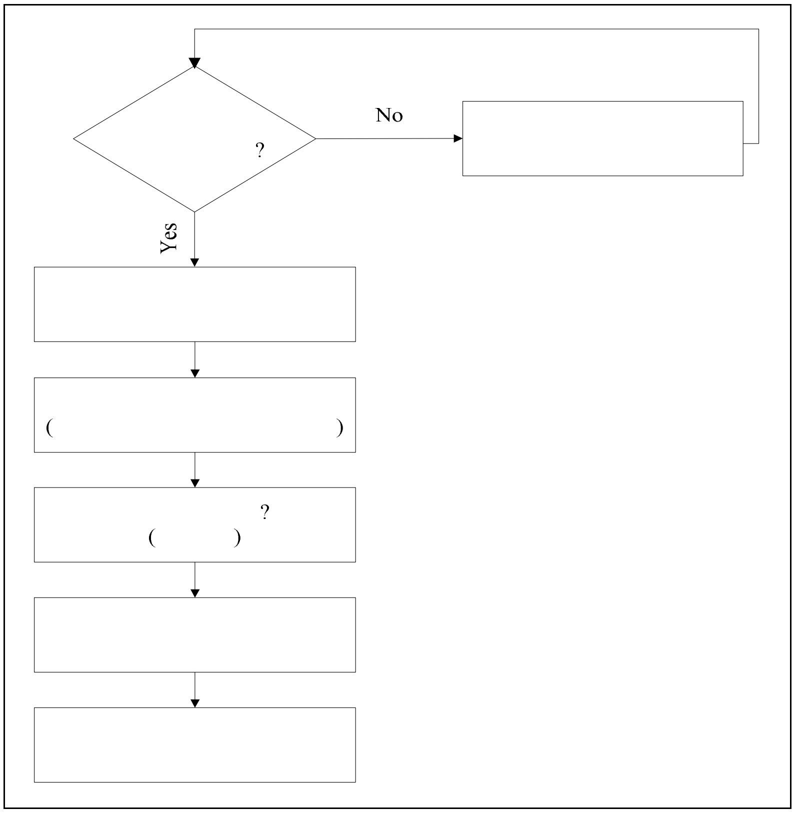


Figure 5. Factor Analysis Procedure

The Cronbach alpha coefficient is calculated using the Equation (3), and it determines the internal consistency between the competencies that measures particular characteristics, and the scale is determined to be reliable with cronbach alpha higher than 0.7 (Nunnally, 1978).

$$\alpha = \frac{N^2 . \overline{Cov}}{\sum S^2 + \sum Cov} \qquad \text{(Eq. 3)}$$

where, N is the number of competencies, $\overline{Cov}$ is the average covariance between the competencies, Cov is the covariance of the competencies which measures the strength of relation between two competencies, and S2 is the variance of the competencies. The cronbach alpha coefficient on the 5-point Likert scale used in studying the importance of the estimating competencies is 0.86, which indicates the scale is reliable.

The Kaiser-Meyer-Olkin measure tests whether the collected sample size and the number of variables is adequate for applying factor analysis method and result in reliable factors or not. KMO is the ratio of the squared correlation between competencies to the squared partial correlation between variables as shown in following equation (Field, 2005).

$$KMO = \frac{(correlation\ between\ variables)^2}{(partial\ correlation\ between\ variables)^2} \qquad \text{(Eq. 4)}$$

where, correlation between variables measures the degree of relationship between all variables (estimating competencies), and partial correlation between variables measures the degree of relationship between two variables while eliminating the effect of other variables in order to determine whether or not the collected data is sufficient to apply factor analysis. The result of the KMO statistic is 0.82 which means that the correlation pattern between variables is compact and thus makes the factor analysis appropriate. The Anti-image correlation matrix test shows that the measure of the sample adequacy (MSA) for all variables ranges between 0.68 to 0.91 (≥ 0.5) (Field, 2005) which indicates that none of the variables needs to be eliminated and the factor analysis is appropriate. Finally, the Bartlett's test of sphericity was conducted to test whether the correlation matrix is an identity matrix or not. The result of the sphericity test is 1238.49 and its associated p-value is 0.000, which indicates that the correlation matrix of the variables is not an identity matrix and the factor analysis is an appropriate method.

After validating the appropriateness of using the factor analysis, the 23 estimating competencies were subjected to the factor analysis, with principal component analysis and varimax rotation. The factor analysis with the principal component extraction method is a linear transformation of the data into a new axis system so that the first axis is in the direction of the largest variance in the data, the second axis is in the direction of the second largest variance, and so on. The principal component analysis uses eigenvalues to reduce the number of variables into a smaller number of components/factors. The eigenvalue represents the variance explained by the component/factor resulted from the principal component analysis. Based on the eigenvalues and the interpretability of the factors the number of factors to be extracted is decided. There are many criteria available to assist in determining how many factors to extract. The most common criterion used is the minimum eigenvalue criteria, or what is known as the Kaiser's criteria. This criterion requires taking the principal components for all the variables and rank their eigenvalues from the largest to the smallest then select the eigenvalues greater than one as the number of factors to be retained. The results of the principal component analysis to determine the number of factors to be retained are shown in Table 3. According to Kaiser's criteria seven components have eigenvalues greater than 1.0 and this is the suggested number of factors to be retained, these seven estimating core competency factors explains 60.34% of the total variance in the data. The results as seen in Table 4 show that the loadings of the 23 estimating competencies are scattered between the seven factors, where most competencies load highly onto the first factor and also load highly on the other factors. For example the competency "Ability to see the big picture, realize what is important" loads highly on the first, the second, the third, and the sixth factor. This makes the interpretation of the factors more difficult due to the unclear pattern of the factor matrix. In order to interpret the factors more effectively, a factor rotation needs to be performed.

Table 3. Pricncipal Components Analysis Results

Principal Component	Eigenvalue	% of Variance Explained	Cumulative Variance %
1	5.87	25.54	25.54
2	2.00	8.70	34.24
3	1.56	6.79	41.03
4	1.20	5.22	46.25
5	1.15	5.02	51.27
6	1.08	4.68	55.95
7	1.01	4.40	60.35
8	0.96	4.16	64.51
9	0.92	4.02	68.53
10	0.83	3.61	72.14
11	0.75	3.26	75.40
12	0.70	3.05	78.45
13	0.68	2.94	81.39
14	0.64	2.77	84.16
15	0.55	2.38	86.54
16	0.53	2.30	88.84
17	0.44	1.93	90.77
18	0.41	1.80	92.57
19	0.40	1.73	94.30
20	0.38	1.67	95.97
21	0.34	1.47	97.44
22	0.32	1.41	98.85
23	0.26	1.15	100.00

Table 4. Factor Analysis Results - Unrotated Factors

No.	Estimating Competencies	Factors						
		1	2	3	4	5	6	7
i	Have good communication skills, self confident, work with others	.653						
j	Be dependable, straight forward, objective, fair, and consistent	.643						
n	Have interest in details and numbers with ability to organize work	.632		-.426				
t	Open to working in new areas where you may feel not comfortable	.622				-.378		
r	Obtaining quotations accurately from vendors	.601						
l	Be task oriented with the drive to achieve the end results	.595						
k	Quantity take-off	.561		-.336		.469		
g	Ability to work under pressure with tight deadlines	.539			-.311			
o	Productivity and labor rates	.539	-.459					
p	Risk assessment/analysis and contingency	.517	-.487					
v	Planning and scheduling	.496	-.441					.316
w	Development of reports for management	.492			-.333			-.327
e	Able to apply judgment, do reality checks, then explain why	.468	.380					
q	Able to stand ground and resist pressure to change numbers	.443		.363				
u	Design/engineering knowledge	.342	-.327					
s	Escalation impact	.516	-.526					
h	Be inquisitive, ask questions, find resources, and make decisions	.425	.464					.438
d	Know what question to ask and who to ask	.380		.466				
m	Construction/site condition knowledge	.410			.499		.305	
a	Analyzing what's missing in the scope definition	.336			-.492		.325	
f	Know how to read and interpret drawings	.461		-.425		.468		
c	Ability to see the big picture, realize what is important	.326	.353	.340			-.484	
b	Develop clear and organized estimates with sound basis	.394				.328		-.603

Different rotation techniques were performed and the varimax rotation was determined to lead to the most interpretable factors. The varimax rotation is an orthogonal rotation used to maximize the high correlations and minimize the low correlations. The results of applying the varimax rotation are shown in Table 5. The results show only the highest loadings on each factor, loadings less than ±0.4 are removed because they considered insignificant for factor interpretation (Rencher, 2002). Table 6 shows the final seven estimating core competency factors resulted from the factor analysis along with the percentage of the variance that each factor explains. The following section describes each factor in detail, which consists of interrelated competencies (skill, knowledge, and personal attributes).

Table 5. Factor Analysis Results Using the Varimax Orthogonal Rotation

No	Estimating Competencies	Factors						
		1	2	3	4	5	6	7
l	Be task oriented with the drive to achieve the end results	.698						
t	Open to working in new areas where you may feel not comfortable	.683						
j	Be dependable, straight forward, objective, fair, and consistent	.674						
i	Have good communication skills, self confident, work with others	.652						
n	Have interest in details and numbers with ability to organize work	.639						
g	Ability to work under pressure with tight deadlines	.533			.521			
s	Escalation impact		.735					
p	Risk assessment/analysis and contingency		.720					
o	Productivity and labor rates		.688					
v	Planning and scheduling		.656					
u	Design/engineering knowledge		.522					
r	Obtaining quotations accurately from vendors		.495	.451				
f	Know how to read and interpret drawings			.785				
k	Quantity take-off			.748				
a	Analyzing what’s missing in the scope definition				.745			
d	Know what question to ask and who to ask				.544			
q	Able to stand ground and resist pressure to change numbers				.469			
c	Ability to see the big picture, realize what is important					.762		
h	Be inquisitive, ask questions, find resources, and make decisions					.750		
m	Construction/site condition knowledge						.611	
e	Able to apply judgment, do reality checks, then explain why						.493	
w	Development of reports for management						-.421	
b	Develop clear and organized estimates with sound basis							.845

Table 6. Seven Estimating Core Competency Factors

Factors of Estimating Competencies	Variance Explained	Competencies Included in Each Factor
Factor 1: Estimator's communication and work behavior	25.54%	• Be task oriented with the drive to achieve the end results • Open to working in new areas where you may feel not comfortable • Be dependable, straight forward, objective, fair, and consistent • Have good communication skills, self confident, work with others • Have interest in details and numbers with ability to organize work • Ability to work under pressure with tight deadlines
Factor 2: Basic knowledge required by an estimator	8.70%	• Escalation impact • Risk assessment/ analysis and contingency • Productivity and labor rates • Planning and scheduling • Design/ engineering knowledge • Obtaining quotations accurately from vendors
Factor 3: Preliminary tasks for developing quantity of work	6.80%	• Know how to read and interpret drawings • Quantity take-off • Obtaining quotations accurately from vendors
Factor 4: Estimator's ability to analyze project scope and deal with the profession pressure	5.22%	• Analyzing what's missing in the scope definition • Know what question to ask and who to ask • Able to stand ground and resist pressure to change numbers • Ability to work under pressure with tight deadlines
Factor 5: Ability to put together the project pieces and make decision	5.02%	• Ability to see the big picture, realize what is important • Be inquisitive, ask questions, find resources, and make decisions
Factor 6: Construction process knowledge and judgment skill	4.68%	• Construction/site condition knowledge • Able to apply judgment, do reality checks, then explain why • Development of reports for management
Factor 7: Ability to produce a reliable estimate	4.40%	• Develop clear and organized estimates with sound basis

Factor 1: Estimator's communication and work behavior

The first factor group explains 25.54% of the total variance in the data. This factor identifies the personality characteristics for a good estimator. Estimating is the result of a team work in which an estimator deals with all the project parties in the design and construction phases, and this requires estimators to have good communication skills to communicate the project information with the project parties.

Factor 2: Basic knowledge required by an estimator

The second factor explains 8.70% of the total variance in the data. In this factor the basic engineering and estimating skills and knowledge that an estimator needs to produce reliable estimates are grouped. All those competencies are dependent on each other; for example determination of the escalation impact is highly dependent on the risks considered and analyzed on the project estimate. It is also noteworthy that some of those competencies are of the mathematical nature that requires certain mathematical and analytical abilities.

Factor 3: Preliminary tasks for developing quantity of work

The third factor explains 6.80% of the total variance in the data. This factor represents the necessary skills and knowledge required to perform an essential estimating task for developing a quantity of work. This task is more important for estimators working in developing detailed estimates than estimators developing conceptual estimates, because detail estimating takes place when the final design drawings are finalized and those drawings are very detailed drawings and contains a lot of information that requires high level of skills and knowledge in understating and communicating that information. Lacking these skills and knowledge is the main cause of omitting quantities or double counting of quantities which result in estimating errors.

Factor 4: Estimator’s ability to analyze project scope and deal with the profession pressure

The fourth factor explains 5.22% of the total variance in the data. This factor represents the estimator’s ability to analyze the project scope, identify the missing information necessary to develop the project estimate and know the information source. These skills and knowledge are highly important for both conceptual and detailed estimators since more accurate information is gathered about the project the more reliable estimate will be produced. Estimators are known for working under a high pressure environment due to the high importance of estimates for management decisions regarding the projects. This tight relation between estimates and management decisions requires special patience and ability from the estimator to deal with the high pressures to alter the estimates numbers to fit their budget or maximize their profits. It is also associated with the limited amount of time typically given to prepare estimates. Usually estimates depend on the completeness of information produced for the project from the other professionals working on the project, and this increases the importance of the estimator’s ability to gather and analyze project information to efficiently utilize the estimate preparation time.

Factor 5: Ability to put together the project pieces and make decision

The fifth factor explains 5.02% of the total variance in the data. This factor represents estimator's ability to imagine and visualize the end product of the resulted project, and identify the important information required to estimate the project, identify the required resources required for completing the project, and the ability to make project related decisions to complete the estimate tasks.

Factor Group 6: Construction process knowledge and judgment skill

The sixth factor explains 4.68% of the total variance in the data. It is noteworthy that these competencies are grouped together, because for an estimator to make good judgments and justify his or her decisions, the estimator needs an extensive amount of experience in the construction field in order to familiarize himself/herself with the construction process, the different execution methodologies, the different site conditions and the construction process requirements. This experience of estimator affects the estimator ability to communicate the estimate information and results with top management.

Factor 7: Ability to produce a clear and organized estimates

The last factor explains 4.40% of the total variance in the data. This factor is an important factor because the clarity and the systematic procedure used in developing the estimate affects the accuracy of the resultant estimate, and the final decision about whether to go for the project or not. Also, Trost and Oberlender (2003) identified the formal estimating process factor as the most important factor affecting estimate accuracy which includes the standards and procedure to develop an estimate along with procedures to document, check, and validate the estimates.

Each factor consists of a different number of competencies with a different level of criticality. These seven Estimating Core Competency factors can be prioritized using the criticality indexes of competencies developed in this study. The prioritization of these factors will help companies identify which factors should be considered earlier than others in developing training and education programs for cost estimators in order to quickly improve the overall estimating capabilities of the company. The following equation is used to calculate the overall significance of each factor.

$$OS_i = \sum_{j=1}^{n}(100 - CI_{ij}) \qquad \text{(Eq. 5)}$$

where, OSi is the overall significance of factor i (i=1,….,7), and CIij is the criticality index of a competency j (j=1,…, n) in factor i. Unlike the criticality index of a competency, the higher the OS value, the more significant the factor is by using this equation. Figure 6 shows the overall significance of each factor. The top three most significant factors in developing competent cost estimators are “Factor 2: basic knowledge required by an estimator,” “Factor 1: estimator’s communication and work behavior,” and “Factor 4: Estimator’s ability to analyze project scope and deal with the profession pressure.” These three factors represent 15 competencies out of 23 required core competencies from cost estimators. Training and education programs for cost estimators focused on these factors in this given order will greatly help companies achieve the efficiency and effectiveness of the programs in terms of improving the company’s cost estimating capabilities. It is important to note that the results from Figure 5 represent a global view of the significance of each factor generated from 228 obtained data points. The cost estimating team in a particular company might have a very different level of gaps in competencies from the generally assessed level of gaps in this study.

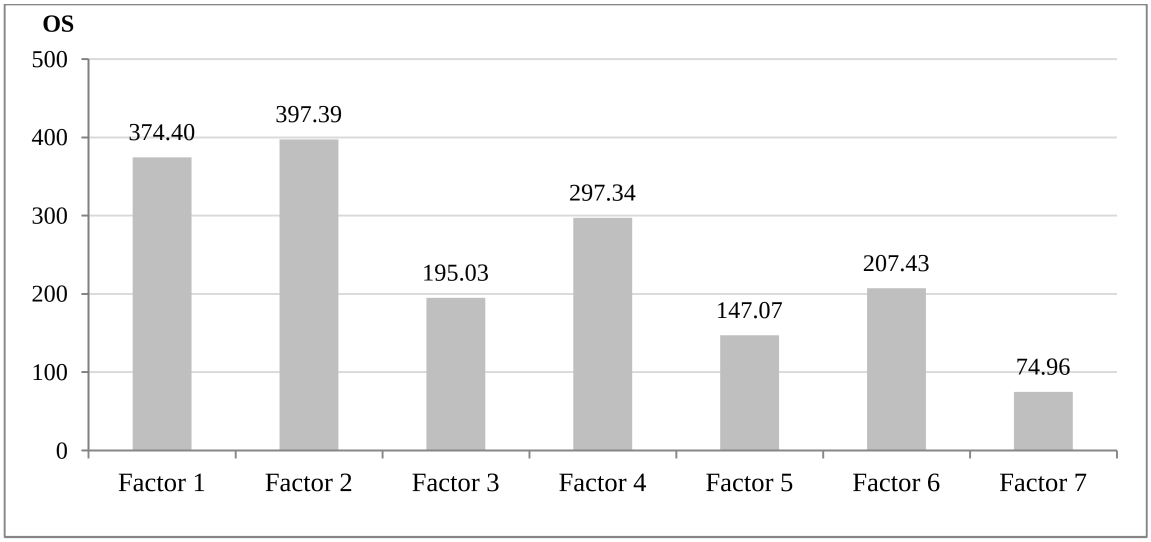


Figure 6. Overall Significance of Factors

3.7. Chapter Summary

This study has addressed a growing concern about the loss of knowledge, skills and experience of cost estimators. This study has identified 23 core estimating competencies for developing qualified cost estimators. The competencies were classified into skills, knowledge, and personal attributes and were further classified into soft and hard subcategories. The gap analysis results show that new estimators lack the main estimating capabilities especially for the soft skills and knowledge. The soft skills and knowledge are very difficult to capture and transfer and cannot be taught by using simple training methods. The concept of the estimating core competency criticality matrix was used to prioritize the estimating competencies based on their criticality score. The criticality of each competency was assessed based on the importance of the competency and the associated gap of the competency between the current level and the ideal level. The study has found that most critical competencies are soft skills or knowledge which are difficult to be transferred.

The study has grouped the 23 competencies into seven different factors using the factor analysis method. They are; 1) estimator's communication and work behavior, 2) basic knowledge required by an estimator, 3) preliminary tasks for developing quantity of work, 4) estimator's ability to analyze project scope and deal with the profession pressure, 5) ability to put together the project pieces and make decision, 6) construction process knowledge and judgment skill, and 7) ability to produce a clear and organized estimates. Among these factors, factors 2, 1, and 4 are the most significant factors which require immediate attention when developing training and education programs for cost estimators.

3.8. Acknowledgements

The authors would like to thank CII RT253 members and the study advisory group for their voluntary support and significant contributions to this study. The authors are also indebted to CII member companies and estimators from AACE-I and ASPE workshops who participated in the lengthy surveys. The financial support from the CII for this study is also greatly appreciated.

CHAPTER IV

PHASE II MANAGEMENT PRACTICES AFFECTING THE RETENTION OF THE COST ESTIMATING COMPETENCIES

4.1. Introduction

Recent studies have shown that 80% of the baby boomer generation who have the critical “know-how” and “how-to” knowledge and skills will be retiring within the next decade. The retirement of experienced employees basically translates into the retirement of their years of experience and knowledge as most companies do not have well planned strategies and methods to retain the knowledge and skills of their retiring employees (Styhre et al., 2004; Chinowsky et al., 2007). In the construction industry, the escalating retirement rate along with the lack of effective management practices to retain the experienced engineers knowledge and expertise confronted the industry with an immediate need to determine and adapt effective strategies to capture and transfer senior engineers’ knowledge and skills to the next generations of employees.

Researchers found that an organization ability to capture, transfer, and retain knowledge is highly affected by the learning environment and motivation practices (Chawala and Renesch, 1995). Kozlowski and Farr (1998) and Kozlowski and Hults (1987) found out that organization environments that include support to the transfer of specific skills and knowledge learned on the job as well as promotes continuous learning can increase the probability that skills and knowledge acquired in training will be transferred back to the job and will influence job performance. Furthermore, studies found that motivational processes play a vital role at the training phase, post training phase, and organization competitiveness (Kozlowski and Salas, 2010). In the construction industry, motivation is considered a very important factor affecting engineers’ performance, satisfaction, and retention (McQuillen, 1986; Joo and Lim, 2009).

Phase II of this study is designated to the evaluation of the current management practices related to the capture and transfer methods used, and the effect of both the learning environment and motivation on the development of estimating competencies. As a result a capture and transfer model for the estimating profession will be developed. This chapter will briefly explain each of the study variables affecting the retention of estimating competencies; 1) the capture and transfer methods used, 2) the learning environment, and 3) the intrinsic and extrinsic motivations, and the hypothesis investigated. Followed by, data collection and data analysis strategies. The data analysis underwent three main phases. The first analysis phase considers the evaluation of the retention methods on capturing and transferring estimating competencies. The second phase of the analysis assesses the effects of both the learning environment and motivation on the development and retention of estimating competencies. Finally, in the last phase of the analysis, the effect of both the learning environment and motivation on the retention and development of estimating competencies will be assessed.

4.2. Management Practices Studied

4.2.1. Capture and Transfer Methods

Knowledge capture and transfer in this study is defined as "the process in which the source of the knowledge is identified, examined, and then shared with adaptors (department or individuals)." The existing literature indicates that there are many knowledge capture and transfer (Training) methods available in the fields of adult education, knowledge management, and human resources. A synthesis of the existing literature suggests that the selection of capture and transfer methods is mainly dependent on the type or classification of the knowledge or competency to be transferred (Ardichvili et al., 2003; and Vestal, 2006). Based on the classification results of estimating competencies into soft and hard skills and knowledge, and personal attitudes, and based on the existing literature, ten knowledge capture and transfer methods were selected to examine their effectiveness in capturing and transferring each competency. The capture and transfer methods used in this study are: 1) mentoring from experienced estimators, 2) on-the-job training, 3) lectures, workshops, and seminars, 4) documentation manuals, 5) online courses, 6) communities of practice (CoP), 7) peer mentoring, 8) virtual communities of practice (VCoP), 9) audiovisual trainings, and 10) Simulation. The ten selected capture and transfer methods were classified into traditional capture and transfer methods and advanced capture and capture and transfer methods. Traditional capture and transfer methods represent the conventional training methods that are commonly practiced by the companies within the construction industry which includes; 1) mentoring from experienced estimators, 2) on-the-job training, 3) lectures, workshops, and seminars, 4) documentation manuals, and 5) online courses. Advanced capture and transfer methods represent the recently developed methods and limitedly employed by companies within the construction industry such as; 1) communities of practice (CoP), 2) peer mentoring, 3) virtual communities of practice (VCoP), 4) audiovisual trainings, and 5) Simulation. Table 7 provides an extended definition or description of each method used in the study.

Table 7. Expanded Definition/Description for Knowledge Transfer Methods

Knowledge Transfer Methods		Definition/ Description	Source
Traditional Capture and Transfer Methods	Mentoring from experienced estimators	a relationship between a younger and older, more experienced adult in order to accomplish a task	Kram (1985)
	On-the-job Training	training provided to employees in the work setting and during the work by observing peers or managers doing the job and trying to imitate their behavior.	Noe (2008)
	Lectures, Workshops, and Seminars	verbal presentations by an instructor to a group of professionals sharing a common interests or skills	
	Documents and Manuals	manuals, books, and references	
	Online courses	Online-based classes or courses that provide learning about specific topics or material. These courses can be designed by the company or/and outside the company.	Noe (2008)
Advanced Capture and Transfer Methods	Communities of Practice (CoP)	a network of people who have common interests, share field of specialization, have known each other over a period of time, and trust each other	Pasher and Ronen (2011)
	Peer mentoring	a relationship between peers, where workers present their work and progress to their peers to receive feedback	Kram and Isabella (1985) Pasher and Ronen (2011)
	Virtual Communities of Practice (VCoP)	online social networks in which people with common interests, goals, or practices interact to share information and knowledge, and engage in social interactions	Chiu, Hsu, and Wang (2006)
	Audiovisuals	Computer-aided instruction programs or videotaped actual situations or knowledge that can be retrieved for learning. It helps the trainee to customize the learning base and can provide the same knowledge to multiple trainees	Noe (2008)
	Simulation	a “presentation of some aspects of the real world where abstract models are developed and then manipulated in dynamic ways to create learning.” Simulation helps in developing decision making and judgment skills.	Davis (1998)

4.2.2. Learning Environment

A learning organization according to Armstrong and Foley (2003) "has appropriate cultural facets as visions, values, assumptions and behaviors that support a learning environment; processes that foster people's learning and development by identifying their learning needs and facilitating learning, structural facets that enable learning activities to be supported and implemented in the workplace." The concept of learning organization environment is very well established and developed (Watkins and Marsick, 1993; Marsick and Watkins, 1999; Marsick and Watkins, 2003; Yang et al., 2004; Zhang et al., 2004; Lien et al., 2006). To assess the gap and diagnose the level of learning facilitated by the organization, Watkins and Marsick (1993, 1996, and 2004) developed the Dimensions of the Learning Organization Questionnaire (DLOQ). The DLOQ instrument is used to measure and diagnose the learning environment in the organization and its association to the improvement in organization performance (financial and knowledge). The DLOQ instrument measures the learning environment using seven dimensions established, modified, and evaluated by Watkins and Marsick, 1993; Marsick and Watkins, 1999; Marsick and Watkins, 2003; Yang et al., 2004. Table 8 provides brief descriptions for each of the seven dimensions of learning environment along with sub-questions used to measure each dimension. Many studies adapted DLOQ to assess the effect of the learning environment on the improvement of financial performance (Watkins and Marsick, 1993; Marsick and Watkins, 1999; Marsick and Watkins, 2003; Styhre et al., 2004; Yang et al., 2004; Zhang et al., 2004; Lien et al., 2006; Chinowsky and Carrillo, 2007; Chinowsky et al., 2007; Song, 2008). Although some studies emphasized the significant effect of the learning environment on facilitating the sharing of tacit knowledge between individuals and peer groups (Kogut and Zander, 1992; Nonaka, 1994), the existing literature revealed a lack of empirical research that assesses the association and effect of the learning environment on the development or capture of individual competencies. Some studies evaluated the knowledge performance using DLOQ which is considered very generic and at broader level (organization/company level) (Watkins and Marsick, 1993; Marsick and Watkins, 1999; Yang et al., 2004; Song, 2008). In this study, the effect of the learning organization environment on the capture and transfer process of the estimating competencies will be evaluated as shown in Figure 7. The specific hypotheses are:

- **H1**: the current organization learning environment is positively related to the difficulty in capturing and transferring estimating competencies.
- **H2**: the current organization learning environment and structure has had a positive effect on the effectiveness of the capturing and transferring methods used to develop estimating competencies.

Table 8. Description and Sub-Questions for Learning Environment Dimensions (Yang et al., 2004)

Dimensions of Learning Environment	Definition/ Description	Sub-questions
Continuous Learning	Learning is designed into work so that people can learn on the job; opportunities are provided for ongoing education and growth	▪ people help each other learn ▪ people take time to support learning ▪ people are rewarded for learning
Inquiry and Dialogue	People gain proactive reasoning skills to express their views and the capacity to listen and inquire into the views of others.	▪ people give open and honest feedback to each other ▪ whenever people state their view, they also ask what others think ▪ people spend time building trust with each other.
Team Based Learning	Work is designed to use groups to access different modes of thinking; groups are expected to learn together and work together.	▪ people have the freedom to adapt their goals as needed ▪ people revise thinking as a result of organization discussion or information collecting ▪ people are confident that the organization will act on their recommendation
Embedded System	Availability of low and high technology systems to capture and share learning	▪ creates systems to measure gaps between current and expected performance ▪ makes its lessons learned available to all employees ▪ measures the results of the time and resources spent on training and learning.
Empowerment	Empower people toward collective vision, where responsibilities are distributed close to decision-making and people are motivated to learn toward what they are held accountable to do.	▪ recognizes people for taking initiatives ▪ gives people control over the resources they need for their work ▪ supports members who take calculated risks
System Connection	People helped to see the effect of their work on the entire company, and scan the environment and use information to adjust work practices	▪ encourages people to think from a global perspective ▪ works together with the outside community or outside resources to meet mutual needs ▪ encourages people to get answers from multiple locations and perspectives when solving problems
Strategic Leadership	Strategic leadership for learning where leader models champion and support learning.	▪ leaders mentor and coach those they lead ▪ leaders continually look for opportunities to learn ▪ leaders ensure that the organization’s actions are consistent with its values

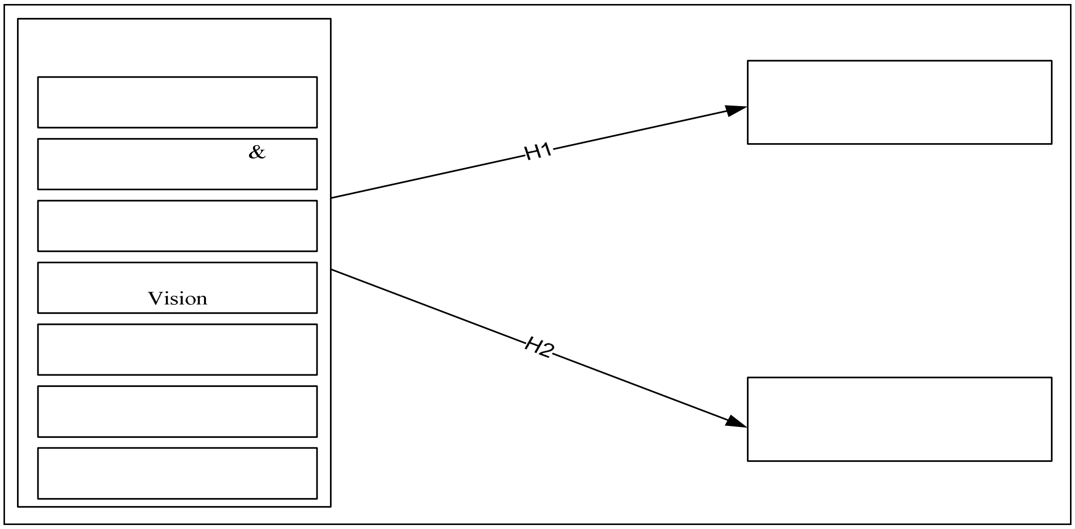


Figure 7. Effect of Learning Environment on the Retention of Estimating Competencies (Theoretical Model)

4.2.3. Motivation

A trained and skillful workforce has not always the insurance of high performance or quality product. Motivation differs between individuals and similar motivators applied to all are not applicable, people have different kind of motivators with different amount (Rayan and Deci, 2000). People with the same level of skills and knowledge may perform differently, depending on the motivators provided or practices either extrinsic motivators or intrinsic motivators. Amabile et al. (1994) in their study to assess and develop an instrument to evaluate the intrinsic and extrinsic motivations, they found that intrinsic and extrinsic motivations have different impacts on the learning and performance outcomes based on the type of profession and working environment. Table 9 provides brief descriptions of intrinsic and extrinsic motivations along with the sub-scales used to measure each motivation type. In this study, the effect of intrinsic and extrinsic motivations on the capture and transfer process of the estimating competencies will be evaluated as shown in Figure 8. The specific hypotheses are:

- **H3**: the intrinsic motivation has a greater effect than the extrinsic motivation on the difficulty in capturing and transferring estimating competencies.
- **H4**: the intrinsic motivation has a greater effect than the extrinsic motivation on the selection of capture and transfer methods to develop estimating competencies.

Table 9. Description and Measures for Intrinsic and Extrinsic Motivations (Amabile et al. 1994)

Motivation	Sub-Scale	Questions
Intrinsic Motivation: Any motivation that arises from individuals' positive reaction to qualities of the task itself, this interaction can be experienced as interest, involvement, satisfaction, etc.	▪ Enjoyment Scale: oriented toward interest, creativity, and enjoyment	▪ I want to find out how good I really can be at my work ▪ I prefer to figure things out for my self ▪ What matters most to me is enjoying what I do ▪ It is important for me to have an outlet for self-expression ▪ No matter what the outcome of a project, I am satisfied if I feel I gained a new experience ▪ I am more comfortable when I can set my own goals ▪ I enjoy doing work that is so absorbing that I forget about everything else ▪ It is important for me to be able to do what I mostly enjoy
	▪ Challenge Scale: oriented toward curiosity, and competence	▪ I enjoy tackling problems that are completely new to me ▪ I enjoy trying to solve complex problems ▪ The more difficult the problem, the more I enjoy trying to solve it ▪ I want my work to provide me with opportunities for increasing my knowledge and skills ▪ Curiosity in the driving force behind much of I do ▪ I prefer work I know I can do well over work that stretches my abilities ▪ I enjoy relatively simple, straightforward tasks
Extrinsic Motivation: Deriving satisfaction that is independent of the activity itself, such as compensation, promotion, etc.	▪ Outward Scale: oriented toward recognition and the dictates of others	▪ I am strongly motivated by recognition I can earn from other people ▪ I want other people to find out how good I really can be at my work ▪ To me, success means doing better than other people ▪ I have to feel that I am earning something for what I do ▪ I believe that there is no point in doing a good job if nobody else knows about it ▪ I am concerned about how other people are going to react to my ideas ▪ I prefer working on projects with clearly specified procedures ▪ I am less concerned with what work I do than what I get for it ▪ I am not that concerned about what other people think of my work ▪ I prefer having someone set clear goals for me in my work
	▪ Compensation Scale: oriented toward income and promotion	▪ I am strongly motivated by the money I can earn ▪ I am keenly aware of the promotion goals I have for myself ▪ I seldom think about salary and promotions ▪ I am keenly aware of the income goals I have for myself ▪ As long as I can do what I enjoy, I am not that concerned about exactly what I am paid

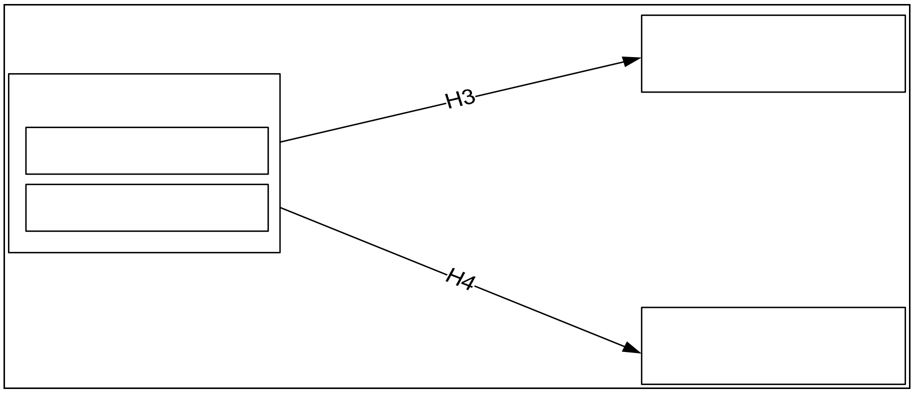


Figure 8. Effect of Motivation on the Retention of Estimating Competencies (Theoretical Model)

4.3. Data Collection

During summer 2010, a questionnaire survey "Assessment of Current Practices in Developing Cost Estimating Competencies" (see Appendix C) was developed to obtain expert opinions on the current management practices such as the capture and transfer methods, learning environment, and motivational aspects provided to the cost estimating workforce. The collected data will be used to determine and evaluate the effect of management practices on the development of the cost estimating competencies, and determine the effective capture and transfer methods to be employed to retain each of the estimating competencies using Structural Equation Modeling (SEM) method. SEM method is a multi-level modeling process that allows assessing the effectiveness of each of the traditional and advanced capture and transfer methods on retaining and developing the estimating competencies by analyzing the embedded correlations between variables. For this survey, a four page long questionnaire with four main sections was developed. The first section contains the general information questions such as the industry sector, years of experience, position, etc. The second section contains 21 sub-questions to diagnose the learning environment. The third section contains a 23x11 matrix aimed to assess the effectiveness of the capture and transfer methods identified in this study. Finally, the fourth section contains 30 sub-questions to measure the importance of intrinsic and extrinsic motivations in retaining cost estimators. The development of this questionnaire survey underwent two stages; in the first stage a pilot questionnaire survey was sent to 14 professional estimators, who have at least 15 years of experience in the estimating profession, to assess the quality of the survey design, and obtain comments to enhance the instrument. Six completed pilot surveys were collected and used to finalize the questionnaire survey used for the main data collection phase.

To assess the effectiveness of the different capture and transfer methods in developing each of the estimating competencies a 23 X 11 matrix was developed. The 23 rows of this matrix represent the 23 competencies required for the cost estimating profession. The first column in the matrix is used to rate the difficulty to capture and transfer each of the 23 cost estimating competencies using a 5-points Likert scale “1= least difficult” and “5= most difficult.” Columns 2 to 11 each represents one of the capture and transfer methods selected for this study to examine their effectiveness in retaining each of the estimating competencies using a 5-points Likert scale “1= least effective” and “5= most effective.” Definitions of the capture and transfer methods are provided in Chapter 4.

To assess the level of development of learning environment in organizations within the construction industry, the shortened version of the Dimensions of the Learning Organization Questionnaire (DLOQ) developed by Marsick and Watkins (1999, 2004) with 21 questions has been adapted for this study. DLOQ is an assessment tool used to measure the level of development of the learning environment of an organization in seven dimensions; continuous learning dimension, inquiry and dialogue dimension, team based learning dimension, embedded system dimension, empowerment dimension, system connection dimension, and strategic leadership dimension. Descriptions for each of the seven dimensions of learning environment along with sub-questions used to measure each dimension Marsick and Watkins (1999, 2004) are discussed in Table 8. The scale used to assess the learning environment is a 5-point s Likert scale “1= never” and “5 = always.”

Motivation orientation of the estimating profession is assessed using the Work Preference Inventory (WPI) developed by Amabile et al. (1994). WPI is a tool designed to assess individual differences in intrinsic and extrinsic motivation orientations. Description for the intrinsic motivation and extrinsic motivation along with their sub-scales are provided in Table 9. Amabile et al. (1994) WPI consists of 30 questions; intrinsic motivation and extrinsic motivation are assessed using 15 questions each. For the intrinsic motivation, eight questions are designated to assess the enjoyment scale, and seven questions are used to assess the challenge scale. For the extrinsic motivation, ten questions are designated to assess the outward scale, and five questions are used to assess the compensation scale. The scale used to assess intrinsic and extrinsic motivation is a 5-points Likert scale with “1 = never true for me” and “5 = always true for me.”

In October 2011 the questionnaire was sent to all Construction Industry Institute (CII) member companies, and the members of American Society of Professional Estimators (ASPE). A total of 77 completed questionnaires were collected. 33% of the survey participants were from owner companies and 67% were from non-owner companies. At the industry level, 66% of the survey participants were from process/manufacturing industry and 34% of the survey participants were from the building industry. The data collected represents a total of approximately 1,400 years of experience in the estimating profession and 78% of the respondents had at least 15 years of experience in the estimating profession.

4.4. Data Analysis Strategy: Structural Equation Modeling

In phase II the main analysis method used to assess the effect of the management practices on the retention of the estimating competencies and develop reliable capture and transfer model for the cost estimating profession is the Structural Equation Modeling (SEM). However, before applying SEM the reliability and validity of the scale used and the constructs developed along with comparison scenarios are assessed. The reliability and validity of the scale and constructs can be evaluated using; scale reliability test (alpha coefficient), composite reliability test, and average variance extracted test. After validating the reliability and validity of the variables, two comparison scenarios are examined to determine whether differences exist in the estimating competency requirement and management practices in the capture and transfer methods, learning environment capacity, and motivation practices between owner and non-owner companies or companies within different sectors (building sector, heavy civil sector, process/manufacturing industry sector) in the construction industry. Then the overall effectiveness of the traditional and advanced capture and transfer methods, effect of learning environment, and effect of intrinsic and extrinsic motivation on the development of the estimating competencies are assessed using Structural Equation Modeling (SEM). SEM is also used to develop the capture and transfer model for the cost estimating profession. SEM is a multi-level analytical approach that simultaneously combines factor analysis and linear regression models to assess empirically the cause and effect relationships between the model variables. SEM also has the advantages of assessing the model performance as a whole and estimates the parameter (relationships) simultaneously. In addition, because SEM analysis is based on the correlations or covariances between variables the differences in the categorical scales are conquered. The SEM analysis follows the flow shown in Figure 9.

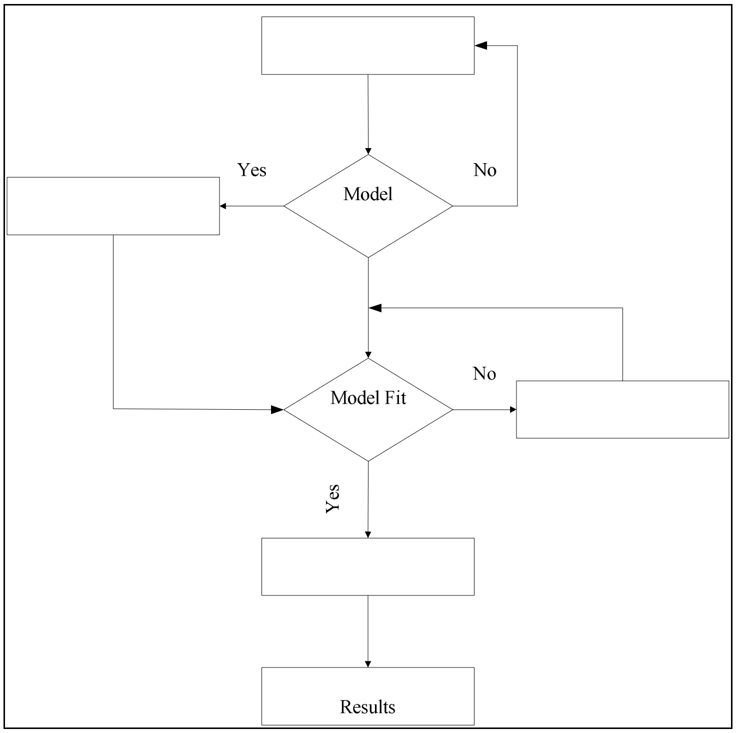


Figure 9. SEM Procedure

As shown in Figure 9, SEM analysis starts with the specification phase, in which the studied hypothesis is represented in a diagram forming a structural equation model as shown in Figure 10. The SEM model is a composite model consisting of two parts: the measurement model and the structural model. The measurement model is a confirmatory factor analysis model (CFA) that assesses the relation between the variables and latent factors (construct) used in the study (Kline, 2011), which is represented using equations (6) and (7) (Kline, 2011). The structural model represents the relationships among the variables, which is represented using equation (8) (Kline, 2011).

Measurement Model:

$$X = \lambda_x \xi + \delta \qquad \text{(Eq. 6)}$$

$$Y = \lambda_y \xi + \varepsilon \qquad \text{(Eq. 7)}$$

Structural Model:

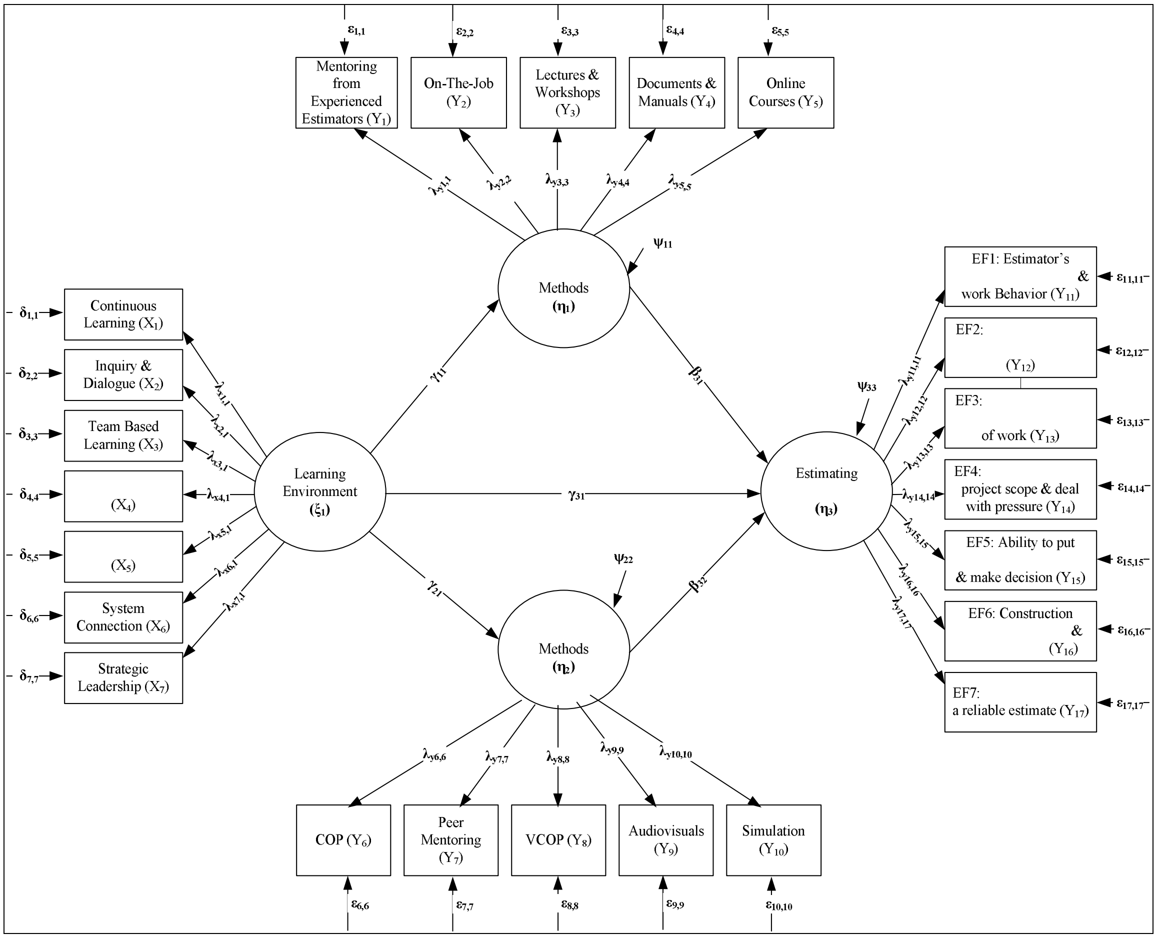
$$\eta = \beta\eta + \gamma\xi + \psi \qquad \text{(Eq. 8)}$$

where, X represents an exogenous measured variable, Y represents an endogenous measured variable, λx represents a parameter associated with the relationship between and exogenous variable and a corresponding observed variable X (factor loading), λy represents a parameter associated with the relationship between an endogenous variable and a corresponding observed variable Y (factor loading), δ represents residual variance of an observed measure (X), and ε represents residual variance of an observed measure (Y), η represents an endogenous latent variable (dependent variable), ξ represents an exogenous latent variable (independent variable), β represents a parameter associated with the structural relationship between two endogenous variable, γ represents a parameter associated with the structural relationship between two exogenous variable, ψ represents a parameter associated with the residual variance of an endogenous variable.

In this sense, SEM will help identify the direct and indirect causal relationships between variables. For example, Figure 10 represents a hypothesis model to assess the direct and indirect effect of the learning environment on the effectiveness of the capture and transfer methods and the development of the cost estimating competencies. In the model the direct effects $\gamma11$ and $\gamma22$ represents the direct effect of the learning environment on the traditional and advanced capture and transfer methods, respectively, and $\gamma33$ represent the direct effect of the learning environment on the development of the cost estimating competencies. The indirect effect of the learning environment on the development of the cost estimating competencies is represented by the following paths:

- Learning Environment ➔ Traditional C&T Methods ($\gamma11$) ➔ Estimating Competencies ($\beta31$)

- Learning Environment ➔ Advanced C&T Methods ($\gamma22$) ➔ Estimating Competencies ($\beta32$)



ε1,1
ε2,2
ε3,3
ε4,4
ε5,5
Mentoring from Experienced Estimators (Y1)
On-The-Job (Y2)
Lectures & Workshops (Y3)
Documents & Manuals (Y4)
Online Courses (Y5)
λy1,1
λy2,2
λy3,3
λy4,4
λy5,5
ψ11
Methods (η1)
δ1,1
δ2,2
δ3,3
δ4,4
δ5,5
δ6,6
δ7,7
Continuous Learning (X1)
Inquiry & Dialogue (X2)
Team Based Learning (X3)
(X4)
(X5)
System Connection (X6)
Strategic Leadership (X7)
λx1,1
λx2,1
λx3,1
λx4,1
λx5,1
λx6,1
λx7,1
Learning Environment (ξ1)
γ11
γ31
γ21
β31
β32
ψ33
ψ22
Estimating (η3)
Methods (η2)
λy11,11
λy12,12
λy13,13
λy14,14
λy15,15
λy16,16
λy17,17
EF1: Estimator's & work Behavior (Y11)
EF2: (Y12)
EF3: of work (Y13)
EF4: project scope & deal with pressure (Y14)
EF5: Ability to put & make decision (Y15)
EF6: Construction & (Y16)
EF7: a reliable estimate (Y17)
ε11,11
ε12,12
ε13,13
ε14,14
ε15,15
ε16,16
ε17,17
λy6,6
λy7,7
λy8,8
λy9,9
λy10,10
COP (Y6)
Peer Mentoring (Y7)
VCOP (Y8)
Audiovisuals (Y9)
Simulation (Y10)
ε6,6
ε7,7
ε8,8
ε9,9
ε10,10

Figure 10. SEM Model (Theoretical Model)

After specifying the SEM model and before collecting data it is important to check whether the model is identified or not. The model is said to be identified if it is theoretically possible to derive a unique estimate of every parameter in the specified model; this means that we have enough parameters in the model to solve for the equations in the model. For example, to determine whether the model in Figure 10 is identified or not, the degrees of freedom of the model need to be calculated. For this model there are 7 X's and 17 Y's resulted in (24*25/2) = 300 known parameters, and there are 7 δ's, 7 λx's, (17-3) λy's, 17 ε's, 3 γ's, 3 ψ, and 2 β's resulted in 53 unknown parameters to be estimated, in conclusion the model will have 300-52=247 degrees of freedom indicating that the model is algebraically identified. If the specified model is not identified, we need to re-specify the hypothesized model to reach the model identification (Kline, 2011). Then the model will be analyzed using LISREL 8.8 to solve the measurement model and structural model equations and calculate the path coefficients along with their significance.

In SEM the Maximum-Likelihood estimation is commonly used and it estimates the parameters simultaneously and assesses the model performance as a whole. To determine the adequacy of the overall structural model fit several indices were assessed such as Chi-square ($\chi2$), root mean square error of approximation (RMSEA), comparative fit index (CFI), and standardized root mean square residual (SRMSR). Table 10 provides brief description and the cutoff or measuring criteria for each of the indices used to evaluate the SEM models. The estimated parameter in the model represents the assessment of the direct and indirect influential relationship among the variables. In order to determine the whether the estimated parameter is statistically significant or not, the t-value should be higher than |1.96|.

Table 10. SEM Fit Indices Description and Measuring Criteria

Indices	Assessment	Measuring Criteria
Chi-Square (χ^2)	The magnitude of discrepancy between the sample and fitted covariance matrices	The smaller the value the better fit the model to the data
Root mean square error of approximation (RMSEA)	How well a model fits a population not just a sample used for estimation	<0.06 Good Fit
Comparative fit index (CFI)	Indicates the relative improvement in fit of the specified model compared to a statistical baseline model	>0.90 Good Fit
Standardized root mean square residual (SRMR)	Measure the overall difference between the observed and predicted correlations	<0.08 Good Fit

4.4.1. Scale Reliability and Validity

Before using the SEM analysis procedure, the scale reliability and validity of the measured variables needs to be assessed. This process starts with assessing the distribution of the variables and checking for Heywood cases (negative error variance), followed by the assessment of the item reliability. Item reliability is calculated to check if the scales used are reliable or not using Cronbach alpha as explained earlier in Chapter 3. Before proceeding with the analysis it is important to examine whether classifying the identified capture and transfer methods into traditional and advanced capture and transfer methods is appropriate or all methods represents one group of capture and transfer methods and this is called the construct validity, and similarly for the estimating competencies, learning environment, and motivations constructs. Construct validity examines whether or not the items selected under each construct are adequately measuring the construct, meaning that the 5 capture and transfer methods selected to represent traditional capture and transfer methods statistically can be grouped under the traditional capture and transfer factor. Using confirmatory factor analysis technique (CFA) the validity of each construct can be assessed by determining the composite reliability and convergent validity of each construct. CFA model is an oblique exploratory factor analysis model, in which the intercorrelations between the variables within each construct and with other constructs are examined (Fornell and Larcker, 1981). This means that CFA model is a way to determine how well measurement variables represent the grouping factor (construct). CFA can be expressed using Equation (9) (Jöreskon and Sörbom, 1993).

$$x_i = \lambda_{i1}\,\xi_1 + \lambda_{i2}\,\xi_2 + \dots\dots + \lambda_{in}\,\xi_n + \delta_i \qquad \text{(Eq. 9)}$$

Where x_i is the response variable, λ is the factor loading, ξ is the underlying latent factor, and δ is the measurement error inx_i. The factor loadings and standardized error results from the CFA model are used to calculate the composite reliability and convergent validity of the constructs. Composite reliability measures the internal consistency of all the items within the construct. Composite validity is calculated using Equation (10) (Fornell and Larcker, 1981).

$$\text{Composite Reliability (CR)} = \frac{(\sum\lambda)^2}{(\sum\lambda)^2 + \sum e} \qquad \text{(Eq. 10)}$$

Where λ is the standardized factor loadings, and e is the standardized error. Composite reliability > 0.70 indicates that the items all together (combined) shows adequate internal reliability. Convergent validity measures the degree to which a set of variables measure the same construct based on their intercorrelations (Kline, 2011). Convergent validity calculated using the average variance extracted Equation (11) (Fornell and Larcker, 1981). Average variance extracted > 0.5 indicates convergent validity in which the variance captured by the construct is larger than the variance due to measurement error.

$$\text{Average Variance Extracted} = \frac{\sum\lambda^2}{\sum\lambda^2 + \sum e} \qquad \text{(Eq. 11)}$$

Where λ is the standardized factor loadings, and e is the standardized error. The discriminant validity compares whether the items share more variance in the construct than the other constructs or not, by checking whether AVE is greater than the correlation between constructs or not.

After running several CFA models the reliability and validity of the variables and constructs in this study were assessed. Table 11 summarizes the reliability, composite reliability, and average variance extracted results for estimating competencies, traditional and advanced capture and transfer methods, and intrinsic and extrinsic motivations. The scale reliability and validity analysis results indicate the following:

- **Scale reliability (α):** The scale reliability results show that all variables have a cronbach alpha greater than 0.7, which indicates the appropriateness of the scale used to assess each item; estimating competencies, traditional capture and transfer methods, advanced capture and transfer methods, intrinsic motivation, and extrinsic motivation (Nunnally, 1978).

- **Composite reliability (CR):**
    - The composite reliability results for the 23 estimating competencies show adequate internal consistency. This result indicates that the 23 estimating competencies all together shows adequate internal reliability in measuring the estimating competencies construct with CR value 0.89 > 0.70.
    - The composite reliability results for the traditional and advanced capture and transfer methods show adequate internal consistency for both constructs. This result indicates that the items within the traditional capture and transfer methods construct all together shows adequate internal reliability in measuring the construct with CR value 0.81 > 0.70. The result also indicates that the items within the advanced capture and transfer methods construct all together shows adequate internal reliability in measuring the construct with CR value 0.86 > 0.70.
    - The composite reliability results for the seven dimensions of the learning environment show adequate internal consistency. This result indicates that the seven dimensions of the learning environment all together shows adequate internal reliability in measuring the learning environment construct with CR value 0.91 > 0.70.
    - The composite reliability results for intrinsic motivation construct and extrinsic motivation construct show adequate internal consistency for both constructs. The result shows that the items within the intrinsic motivation constructs together shows adequate internal reliability in construct with CR value 0.76 > 0.70. The result shows that the items within the extrinsic motivation construct together shows adequate internal reliability in construct with CR value 0.77 > 0.70.

- **Average variance extracted (AVE):**
    - The average variance extracted results shows that estimating competencies construct have AVE values greater than 0.5 indicating that variables within this construct share more variance in the construct.
    - The average variance extracted results shows that traditional capture and transfer methods construct and advanced capture and transfer methods construct have AVE values greater than 0.5. This means that the variables within each construct share more variance in the construct than with other constructs. Also, the standardized factor covariance between the traditional and advanced capture and

transfer methods is 0.47 and considered significant at t-value (-4.75). AVE (traditional C&T) = 0.51 > $(0.47)^2$ = 0.221 and AVE (advanced C&T) = 0.61 > $(0.47)^2$ = 0.221 indicating that the items share more variance with their construct than the other constructs.

- The average variance extracted results shows that learning environment construct has AVE values greater than 0.50. This means that the variables within the learning environment construct share more variance in the construct.
- The average variance extracted results shows that intrinsic motivation construct and extrinsic motivation construct have AVE values greater than 0.5. This means that the variables within each construct share more variance in the construct than with other constructs. Also, the standardized factor covariance between the intrinsic and extrinsic motivations constructs is 0.50 and considered significant at t-value (2.05). AVE (intrinsic motivation) = 0.53 > $(0.50)^2$ = 0.25 and AVE (extrinsic motivation) = 0.65 > $(0.50)^2$ = 0.25 indicating that the items share more variance with their construct that the other constructs.

Table 11. Test of Reliability and Average Variance Extracted

Construct/Indicator	Indicator Reliability	Composite Reliability	Average Variance Extracted
Estimating Competencies (23 Competencies)	0.93	0.89	0.57
Traditional C & T Methods:		0.81	0.51
- Mentoring from experienced estimators	0.91		
- On-the-job Training	0.97		
- Lectures, Workshops, and Seminars	0.87		
- Documents and Manuals	0.93		
- Online courses	0.96		
Advanced C & T Methods:		0.86	0.61
- Communities of Practice (CoP)	0.97		
- Peer mentoring	0.96		
- Virtual Communities of Practice (VCoP)	0.98		
- Audiovisuals	0.98		
- Simulation	0.98		
Learning Environment:		0.91	0.60
- Continuous Learning	0.73		
- Inquiry and Dialogue	0.86		
- Team Based Learning	0.83		
- Embedded System	0.78		
- Empowerment	0.81		
- System Connection	0.83		
- Strategic Leadership	0.79		
Intrinsic Motivation:		0.76	0.53
- Enjoyment Scale	0.76		
- Challenge Scale	0.75		
Extrinsic Motivation:		0.77	0.65
- Outward Scale	0.84		
- Compensation Scale	0.78		

4.4.2. Comparison Scenario’s Analysis

After validating the reliability and adequacy of the variables and measures used, two comparison scenarios are examined to determine whether the developed capture and transfer model for the estimating competencies is appropriate to sustain the development of estimators working for owner or non-owner companies and within which industry sector (process/manufacturing sector or building sector). The first scenario examines whether there exists any differences in the effective capture and transfer methods used by owner companies and non-owner companies (contractors, consultants, and vendors). The second scenario examines whether there exists any differences in the effective capture and transfer methods used by companies in the different sectors in the construction industry (building sector, heavy civil sector, and process/manufacturing industry sector). Both comparison scenario analyses were performed using the Mann-Whitney test statistics because the collected data is categorical with heterogeneous variance.

The Mann-Whitney test statistic is used to compare the differences in responses between two different group/participants. In this test, the studied variables for each group are assigned a rank based on their scores in ascending order where the lowest score is assigned the lowest rank and the highest score is assigned the highest rank. When two variables have the same score values, called a tie, then an average rank will be given to both of them. The Mann-Whitney test statistic (U) is calculated using Equation 12 for Group 1 (Owner) and Equation 13 for Group 2 (Non-Owner) (Field 2005):

$$U = N_1 N_2 + \frac{N_1(N_1+1)}{2} - R_1 \tag{Eq. 12}$$

$$U = N_1 N_2 + \frac{N_2(N_2+1)}{2} - R_2 \tag{Eq. 13}$$

where; N_1 is the sample size for Group 1, N_2 is the sample size for Group 2, R_1 is the sum of the ranks in Group1, and R_2 is the sum of the ranks in Group 2. Also, the p-value of the Mann-Whitney test is calculated. P-values of less than 0.05 are considered significant and indicate that the two groups have different views in evaluating the effectiveness of this method. The Mann-Whitney analysis was performed using the Statistical Package for Social Sciences (SPSS 16.0). The analysis results are summarized in Figure 12.

For the company type scenario, 33% of the survey participants were from owner companies and 67% were from non-owner companies. The analysis results of the company type scenario for evaluating the difficulty of retaining estimating competencies, the effectiveness of each traditional and advanced capture and transfer method, the development of the learning environment, and motivation practices shows that owner and non-owner companies respondents have the same opinion in rating the variables with p-values 0.724, 0.927, and 0.190, 0.190, 0.659, respectively. The results indicate that estimators regardless of the company type they work for, they have the same understanding in the effectiveness of the capture and transfer methods. This result also shows that the maturity level of the learning environment is similar for both owner and non-owner companies in the construction industry. In addition, the result indicates that the motivation requirements for estimators are similar for both owner and non-owner companies in the construction industry.

For the industry sector scenario, as mentioned earlier, responses from the process/manufacturing industry sector and the building sector only were collected and will be used in the analysis, 66% of the survey participants were from the process/manufacturing industry and 34% of the survey participants were from the building industry. The analysis results of the industry sector scenario for evaluating the difficulty of retaining estimating competencies, traditional and advanced capture and transfer method, the development of the learning environment, and motivation practices shows that respondents from process/manufacturing industry sector and building sector respondents have the same opinion in rating the variables with p-values 0.817, 0.851, and 0.250, 0.250, 0.420, respectively. The results indicate that estimators within the construction industry experience similar management practices regardless of the type of company or industry sector. The results also indicate that the level of development of the learning environment is similar for companies within process/manufacturing industry sector and building sector in the construction industry. Finally, the results indicate that motivators' requirements and practices are not sector specific in the construction industry. As a result, the developed capture and transfer model for the estimating profession is appropriate to be employed by owner and non-owner companies within the process/manufacturing industry and building sectors.

Table 12. Comparison Scenarios Analysis Results

Construct	Company Type Scenario			Industry Sector Scenario		
	Owner (33% of Responses)	Non-Owner (67% of Responses)	Mann-Whitney (P-Value)	Process/ Manufacturing Industry Sector (66% of Responses)	Building Sector (34% of Responses)	Mann-Whitney (P-Value)
	Mean	Mean		Mean	Mean	
Estimating Competencies	3.59	3.63	0.724	3.61	3.62	0.817
Traditional Capture and Transfer Methods	3.26	3.19	0.927	3.23	3.17	0.851
Advanced Capture and Transfer Methods	2.77	2.39	0.190	2.61	2.36	0.250
Learning Organization Environment	3.59	3.65	0.190	3.53	3.83	0.250
Motivation	3.47	3.54	0.659	3.54	3.36	0.420

4.4.3. Effective Capture and Transfer Methods to Retain Estimating Competencies

4.4.3.1.Overall Effect of Traditional and Advanced Capture and Transfer Methods

After validating the reliability and adequacy of the variables and measures used, the overall effectiveness of the traditional and advanced capture and transfer methods in developing the cost estimating competencies is examined using SEM. Figure 11 summarizes the SEM analysis result. The resultant model is an adequate fit to the data with χ^2 = 123.45 (df = 116, p-value = 0.30). All of the fit indices provide acceptable results RMSEA = 0.029, CFI = 0.91, and SRMR = 0.06. The analysis result shows that both traditional and advanced capture and transfer methods have significant effect on the development of the cost estimating competencies with significant parameter estimates of 0.33* and 0.42*, respectively. The results also, show that the advanced capture and transfer methods have greater effect on developing estimators' knowledge and skills than the traditional capture and transfer methods by approximately 27%. This result indicates that, even though traditional capture and transfer methods are effective in developing estimators' knowledge and skills, adapting and employing advanced capture and transfer methods can help companies escalate estimators' competency development and retention process. The results also show that there is a significant reciprocal relation of 0.18* between the effectiveness of the traditional and the advanced capture and transfer methods. This relationship indicates that the effectiveness of the advanced or traditional capture and transfer methods can be increased and is dependent on utilizing both types of capture and transfer methods to efficiently retain estimators' competencies.

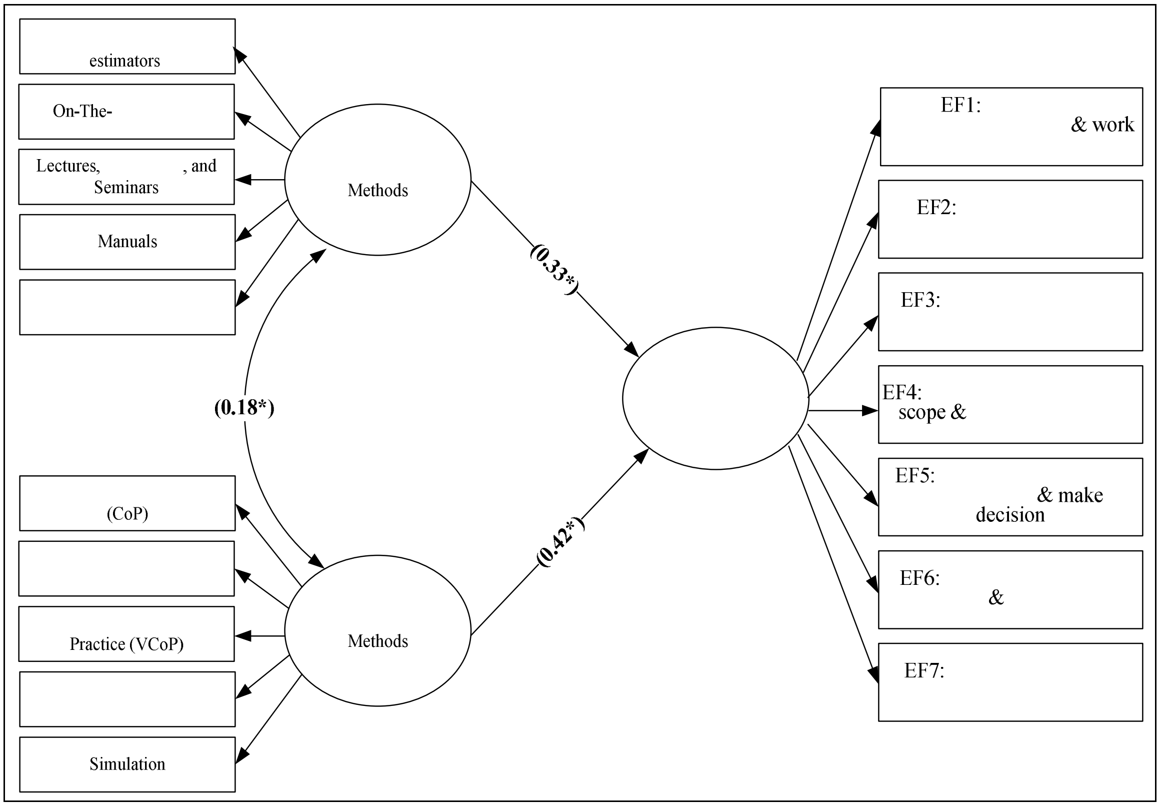

estimators
On-The-
Lectures, , and Seminars
Manuals
Methods
(0.33*)
(0.18*)
(0.42*)
(CoP)
Practice (VCoP)
Simulation
Methods
EF1: & work
EF2:
EF3:
EF4: scope &
EF5: & make decision
EF6: &
EF7:

Figure 11. Effect of Capture and Transfer Methods on the Development of the Cost Estimating Competencies

4.4.3.2.Capture and Transfer Model for the Cost Estimating Profession

After validating the reliability and adequacy of the variables and measures used and the appropriate users of the model, the SEM analysis can be applied. For developing the capture and transfer model for the estimating competencies shown in Table 10, for each of the seven estimating competencies factors an SEM model was analyzed to determine the most effective capture and transfer methods to efficiently retain the competencies within the competency factor. All SEM models performed to determine the effective method to capture and transfer each factor for the estimating competencies are considered perfect fit models with Chi-square value $\chi^2 = 0.00$ and df= 0, these models are also called saturated SEM model (kline, 2011). The results of the SEM analysis are summarized in Figure 12.

Figure 12 represents the capture and transfer model for developing the cost estimating competencies. In Figure 12 for each of the cost estimating factors; the right side shows the competencies forming the cost estimating factor, and the left side shows the capture and training methods. In this model, the dark arrows with the (*) indicate that the capture and transfer method has significant effect on the retention of the estimating competency factor, which means that this method is an effective method for the particular set of estimating competencies. The grey arrows with no (*) indicate that the capture and transfer method has no significant effect on the retention of the estimating competency factor and this method can be eliminated from the model. For example, for competency factor 2 “Basic knowledge required by an estimator” all traditional and advanced capture and transfer methods are accompanied with (*) because there t-values are greater than 1.96 indicating their effectiveness in developing competencies within this factor except for audiovisuals capture and transfer method (grey arrow) which has t-value less than 1.96 meaning that this method is considered ineffective to retain and develop the competencies within this factor. In the SEM model, the significant relationships only are considered and interpreted.

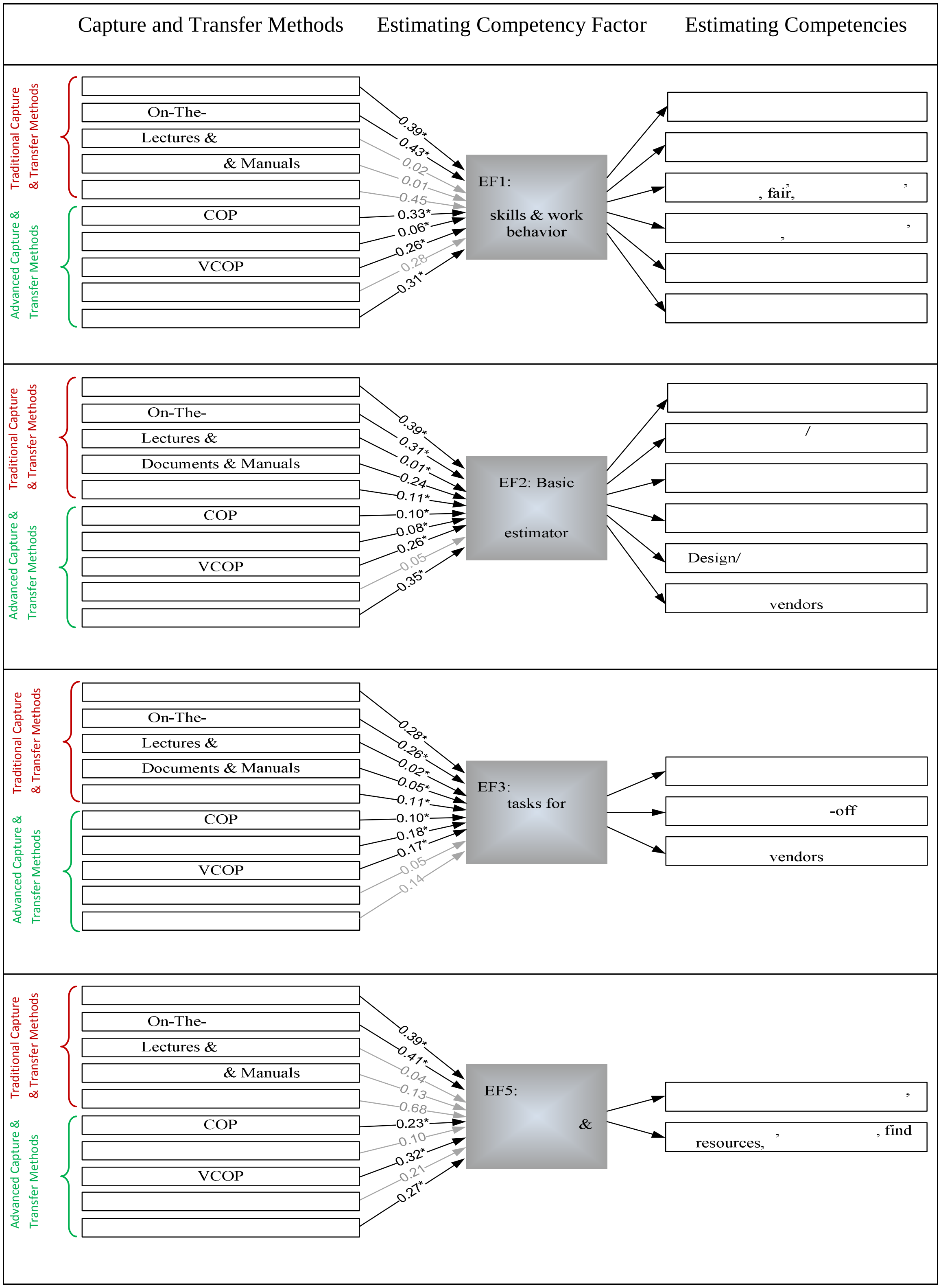

Capture and Transfer Methods
Estimating Competency Factor
Estimating Competencies
Traditional Capture & Transfer Methods
Advanced Capture & Transfer Methods
On-The-
Lectures &
& Manuals
Documents & Manuals
COP
VCOP
EF1:
skills & work behavior
0.39*
0.43*
0.02
0.01
0.45
0.33*
0.06*
0.26*
0.28
0.31*
, fair,
EF2: Basic
estimator
0.39*
0.31*
0.01*
0.24
0.11*
0.10*
0.08*
0.26*
0.05
0.35*
/
Design/
vendors
EF3:
tasks for
0.28*
0.26*
0.02*
0.05*
0.11*
0.10*
0.18*
0.17*
0.05
0.14
-off
vendors
EF5:
&
0.39*
0.41*
0.04
0.13
0.68
0.23*
0.10
0.32*
0.21
0.27*
, find
resources,

Figure 12. Capture and Transfer Model for Estimating Profession

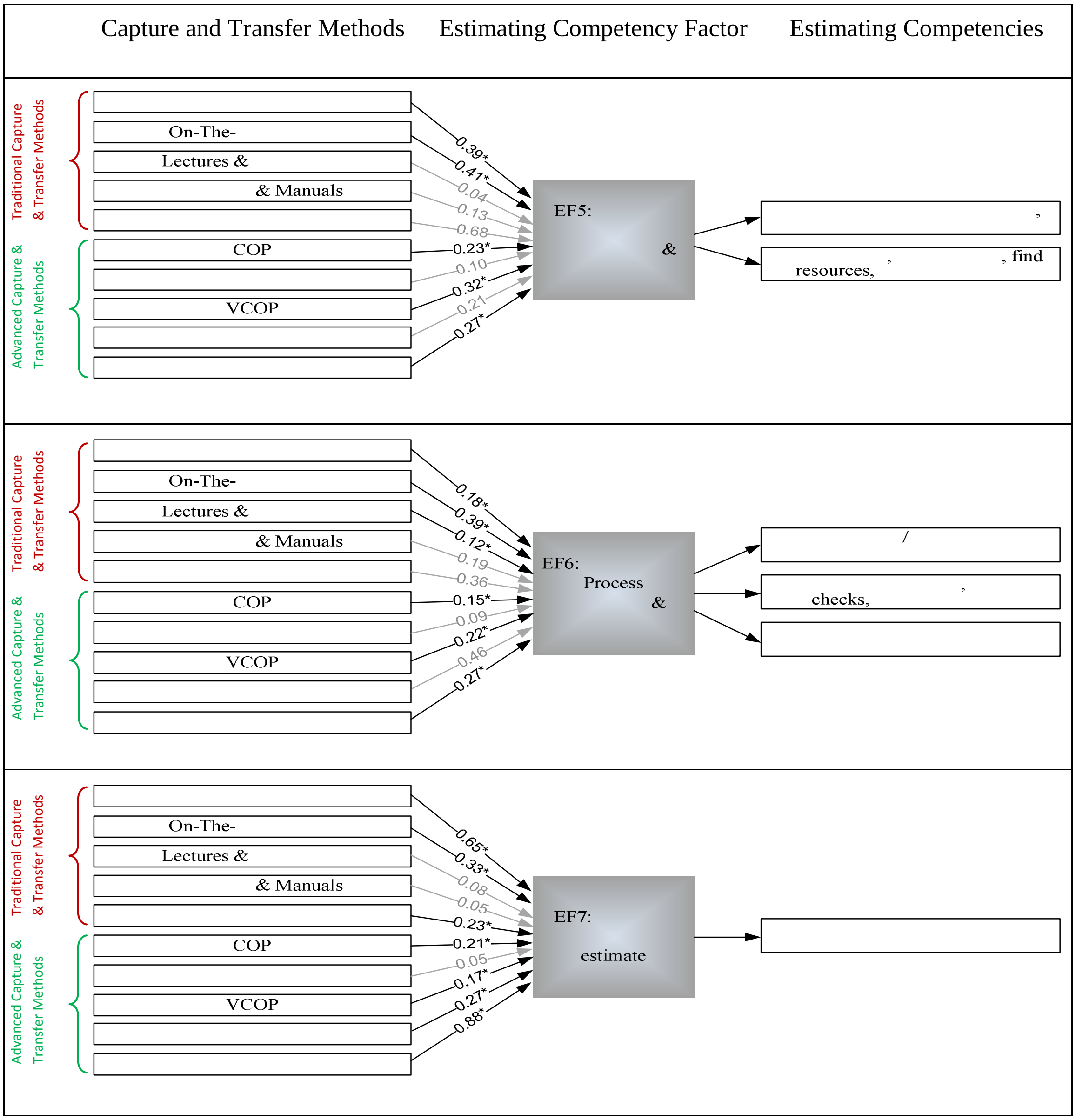

Capture and Transfer Methods
Estimating Competency Factor
Estimating Competencies
Traditional Capture & Transfer Methods
Advanced Capture & Transfer Methods
On-The-
Lectures &
& Manuals
COP
VCOP
0.39*
0.41*
0.04
0.13
0.68
0.23*
0.10
0.32*
0.21
0.27*
EF5:
&
,
, find
resources,
,
On-The-
Lectures &
& Manuals
COP
VCOP
0.18*
0.39*
0.12*
0.19
0.36
0.15*
0.09
0.22*
0.46
0.27*
EF6:
Process
&
/
checks,
,
On-The-
Lectures &
& Manuals
COP
VCOP
0.65*
0.33*
0.08
0.05
0.23*
0.21*
0.05
0.17*
0.27*
0.88*
EF7:
estimate

Figure 12. (Cont.)

It is noticeable from the resulted capture and transfer model for the estimating profession (Figure 12) that the effectiveness of the ten selected capture and transfer methods differs among the seven factors of the estimating profession competencies. The top three significant capture and transfer methods for each of the cost estimating competency factor are summarized in Figure 13. For instance, the results show that to effectively develop estimating competency factor 1 "estimator's communication skills and work behavior", training methods based on interaction with experienced estimators such as "on-the-job training" where an experienced estimator is supervising the trainee performance, “mentoring from experienced estimator,” and “communities of practice” (where the trainee can interact with a group of experienced estimators and grasp their knowledge, skills and behavior) are more effective capture and transfer methods to be employed. The development of the estimating factor 2 “basic knowledge required by an estimator” can be effectively captured and transferred using “mentoring from experienced estimator,” “simulation,” and “on-the-job training”. It is noticeable that the development of this competency factor which consists of “risk assessment/analysis and contingency,” “planning and scheduling,” etc. requires hands-on practice methods to effectively retain these competencies with thinking and analytical nature.

Competency factor 3 “preliminary tasks for developing quantity of work” can be effectively retain using “mentoring from experienced estimator,” “on-the-job training,” and “peer mentoring.” Competency factor 4 “ability to analyze project scope and deal with pressure” can be effectively captured and transferred to new generation of estimators using “virtual communities of practice,” “on-the-job training,” and “communities of practice.” These methods allow new estimators to interact with more than one experienced estimator and gain different views and manners on how to analyze the project scope and what pressure a combined the estimating profession and how to deal with these pressures. Estimating competency factor 5 “ability to put together the project pieces and make decision” can be effectively retained using “on-the-job training,” “mentoring from experienced estimator,” and “virtual communities of practices.” Estimating factor 6 “construction process and judgment skill” can be effectively developed and retained using “on-the-job training,” “simulation,” and “virtual communities of practice.” This result indicates that the development of the judgment skill requires hands-on practice, scenario analysis and assessment, and decision making ability in addition to the openness and interaction with others experience and judgment ability.

Finally, estimating competency factor 7 “ability to produce a reliable estimate” can be effectively developed using “virtual communities of practice,” “on-the-job training,” and “communities of practice.” This result indicates that in order to develop reliable estimate with sound bases, openness and interaction with more than one experienced estimator will provide new estimators with the insight and intuition on how to develop reliable estimates.

Table 13. Summary of the Effective Capture and Transfer Model

Cost Estimating Competency Factor	First Effective Capture and Transfer Method	Second Effective Capture and Transfer Method	Third Effective Capture and Transfer Method
EF 1: Estimator’s communication skills and work behavior	On-the-job training	Mentoring from experienced estimator	COP
EF 2: Basic knowledge required by an estimator	Mentoring from experiment estimator	Simulation	On-the-job training
EF 3: Preliminary tasks for developing quantity of work	Mentoring from experiment estimator	On-the-job training	Peer mentoring
EF 4: Ability to analyze project scope and deal with pressure	VCOP	On-the-job training	COP
EF 5: Ability to put together project pieces and make decision	On-the-job training	Mentoring from experienced estimator	VCOP
EF 6: Construction process knowledge and judgment skill	On-the-job training	Simulation	VCOP
EF 7: Ability to produce a reliable estimate	Simulation	Mentoring from experienced estimator	On-the-job training

The results also show that “mentoring from experienced estimators,” “on-the-job training,” “COP,” “VCOP,” and “Simulation” play vital roles in capturing and transferring most of the estimating competencies factors especially the top three most significant factors in developing competent estimators which are “Factor 2: basic knowledge required by an estimators,” “Factor 1: estimator’s communication and work behavior,” and “Factor 4: estimator’s ability to analyze project scope and deal with the profession pressure” determined in Chapter 3. These significant estimating competencies factors represent around 65% of the required core estimating competencies for cost estimators. The most significant and interesting finding of this analysis is that simulation plays a very significant role in capturing and transferring estimating competencies that requires thinking skills and high-level of cognitive skills and knowledge such as decision making, planning, coordination, and situation assessment. This result agrees with Kozlowski and Salas (2010) finding that simulation, scenarios, and use of exercises have an impact in thinking skills training.

The capture and transfer models developed for retaining the estimating competencies will help companies designing better and effective training programs for their estimating workforce. The developed models will provide companies with a tool to help them customize their training efforts to efficiently capture and transfer a set of estimating competencies together by employing the most effective methods in retaining and developing this set of competencies. For example, if company X in their assessment of their estimating workforce determined that their estimating workforce is lacking the "Factor 2: basic knowledge required by an estimator", this model shows several effective capture and transfer alternatives that the company training developers can choose from. The top three effective capture and transfer methods to develop the competencies within this factor are "mentoring from experienced estimators," "simulation," and "on-the-job training". The company can use any of these effective methods, in case when mentoring from experienced estimator is not feasible, simulation can efficiently be utilized to retain this competency factor instead of "on-the-job training." Employing effective capture and transfer methods will ensure the retention and development of targeted estimating competencies.

4.4.4. Effective Learning Environment for Retaining Estimating Competencies

4.4.4.1.Overall Effect of Learning Environment

The direct and indirect effects of the current level of learning environment on the retention and development of estimating competencies are assessed using SEM. Using LISRE 8.8, the hypothesized SEM model is analyzed and the effect of the learning environment is evaluated and summarized in Figure 13. Using the collected data the resultant model is an adequate fit to the data with χ^2 = 237.87 (df = 247, p-value = 0.65). All o f the fit indices provide acceptable results RMSEA = 0.00, CFI = 0.96, and SRMR = 0.017.

The results in Figure 13 show that the learning environment has a significant direct effect on the effectiveness of both traditional and advanced capture and transfer methods by 0.06* and 0.14*, respectively, which indicate that improving the learning environment, will enhance the efficiency and effectiveness of the capture and transfer methods. The results also show that the learning environment has a significant direct effect of 0.35* on the development of estimating competencies, which indicates that improving the learning environment will sustain the development of the estimating competencies past training or even when no training was employed. Figure 13 also shows that the learning environment has significant indirect effects on the development of the cost estimating competencies illustrated by the paths:

- Learning environment ➝Traditional C&T methods ➝ Estimating Competencies
    - This indirect effect is estimated to equal (0.06 x 0.31) = 0.019

- Learning environment ➝ Advanced C&T methods ➝ Estimating Competencies

- This indirect effect is estimated to equal (0.14 x 0.46) = 0.064

The total effect of the learning environment on the development and retention of estimating profession competencies is equal to the sum of all direct and indirect effects of learning environment on the estimating competencies and equals (0.35 + 0.019 + 0.064) = 0.433. This result indicates that employing traditional and advanced capture and transfer methods in an learning environment company can advance the retention and development practices of the estimating profession competencies by around 24% more than when no capture and transfer methods are used. The results collectively indicate that in order to effectively retain the estimating competencies, companies need to promote and adapt ideal learning environment that can facilitate learning and knowledge flow in the organization. These results indicate that there is a need to investigate the gaps between the current learning environment and ideal learning environment.

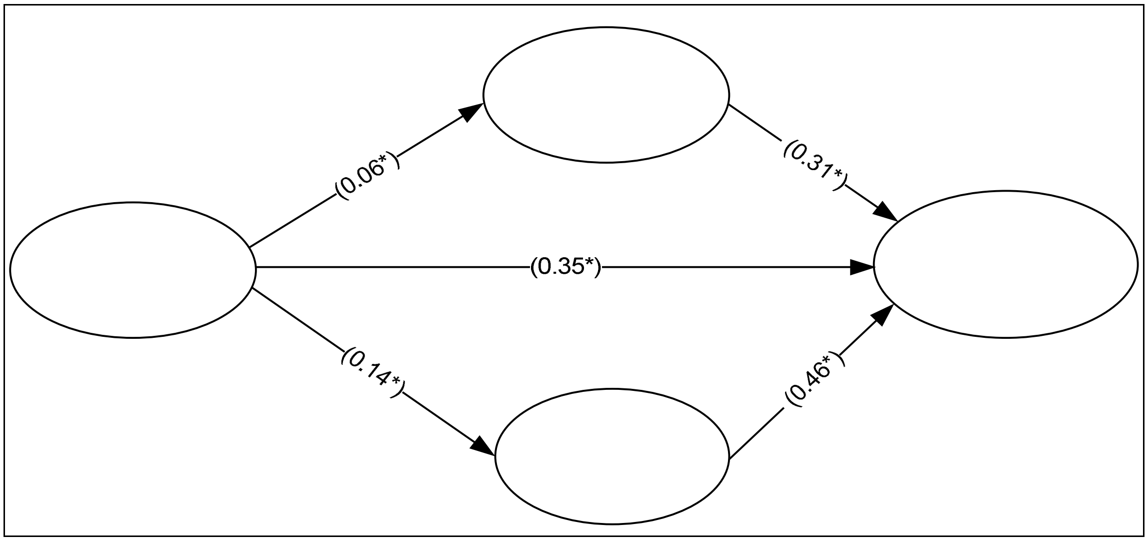


Figure 13. Effect of Learning Environment on the Retention of Estimating Competencies

4.4.4.2.Gaps in the Current Learning Environment Dimensions

Gaps in the dimensions of the learning environment are calculated by measuring the difference between the current learning environment level and the ideal learning environment level that companies should develop using Equation (14). Figure 14 summarizes the gap analysis results. The results show that the largest three gaps exist in embedded system dimension (45.7%), team learning dimension (37.3%), and empowerment dimension (36.4%) of the learning environment. However, this gap analysis results do not indicate which of the gaps are significant and need immediate attention when adapting and transforming the organization to reach the ideal learning environment. Advanced analysis methods need to be employed to assess the significant relationship between each of the seven dimensions of the learning environment and the development of the estimating profession.

(Eq. 14)

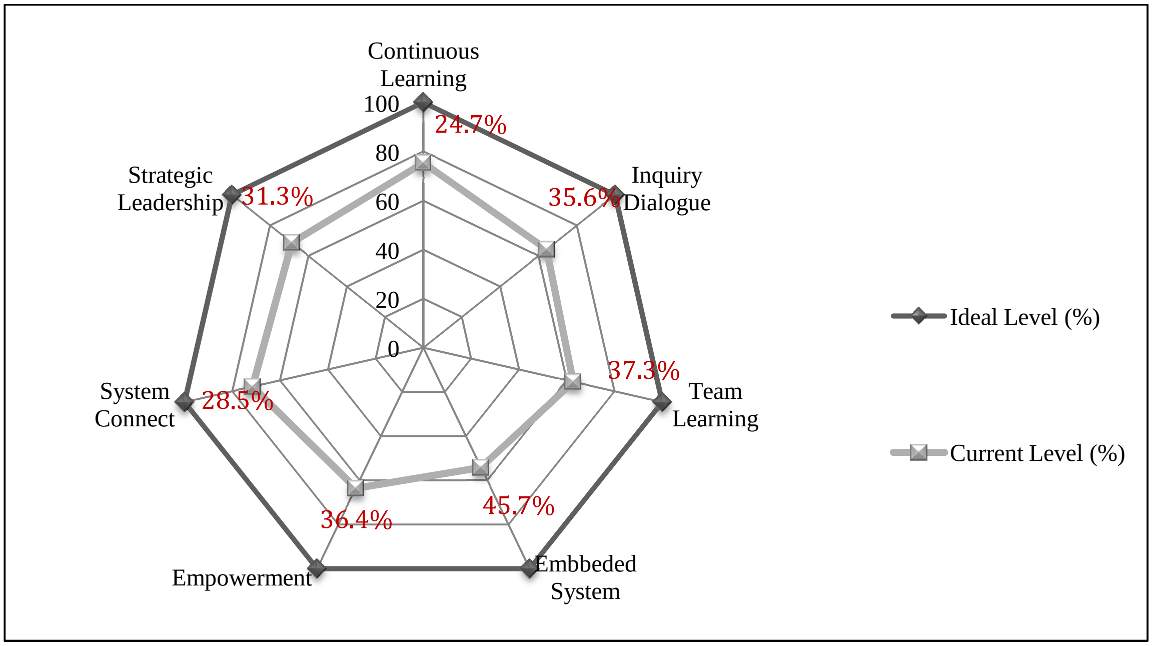


Figure 14. Gaps in Learning Environment

4.4.4.3.Significant Dimensions of the Learning Environment

The effect of each of the seven dimensions of the learning environment is assessed using SEM. The SEM analysis results of the significant effect of the seven dimensions of the learning organization environment are summarized in Figure 15. The resultant model is an adequate fit to the data with χ^2 = 47.96 (df = 56, p-value = 0.77). All o f the fit indices provide acceptable results RMSEA = 0.00, CFI = 0.97, and SRMR = 0.052. The analysis results shows that most dimensions of the learning environment have significant effect on the retention of estimating knowledge and skills, except the system connection dimension has insignificant effect on the development of the cost estimating competencies. The top three significant dimensions that need immediate attention since they have greater effect on the development of the estimating competencies are; continuous learning opportunities (0.39*), team learning dimension (0.36*), and strategic leadership dimension (0.34*). It is noteworthy that although the gap in the continuous learning dimension is the smallest gap (24.7%) among all dimensions of the learning environment as shown in Figure 14, it is the most critical gap affecting the development and retention of the estimating competencies, because the continuous learning dimension has the greatest significant effect (0.39*) on the development of estimating competencies factor than other dimensions of the learning environment (refer to Figure 15). The results of this analysis will help companies within the construction industry to direct their efforts when transforming their environment to a healthy learning environment that will enhance their retention practices of the estimating competencies.

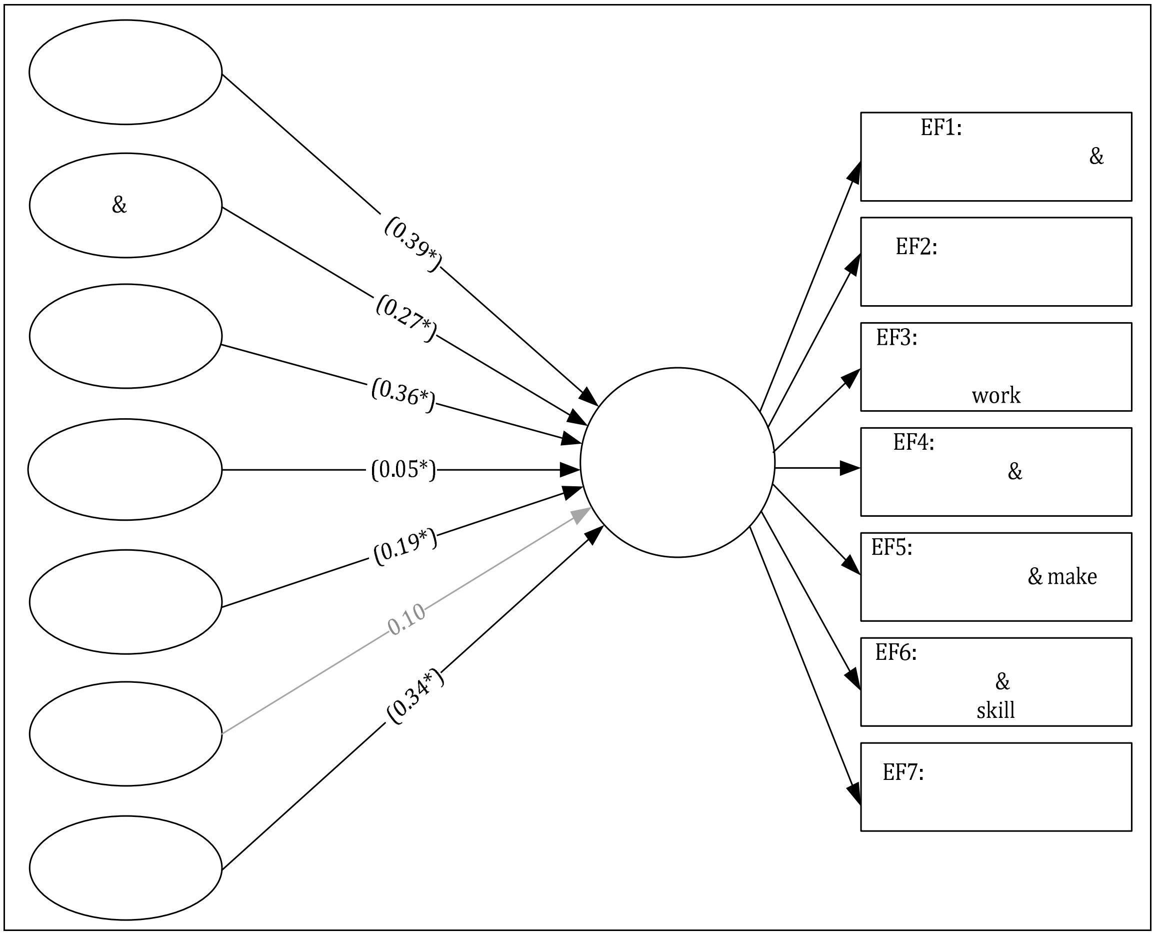


Figure 15. Effect of Gaps in Learning Environment on the Retention of Estimating Competencies

4.4.4.4.Recommendations to Close the Gaps in the Learning environment

This study concluded that adapting healthy learning environment has a significant effect on the development and retention of the cost estimating profession. Transforming the organization environment to a learning environment is considered very challenging (Bui and Brauch, 2010), and the literature dearth of studies investigating and developing specific methodologies on how to effectively close the gaps in the learning environment, however, there exists successful practices employed to improve the learning environment within the organization. Table 14 summarizes the best practices employed to adapt a healthier learning environment that can be as a guide to improve the learning environment provided for the estimating profession. It is noteworthy, that the successfulness of improving each aspects of the learning environment may differ from one company to another because there are many factors affecting it as; the company structure, size of the company, etc.

Table 14. Best Practices to Adapt Healthier Learning Environment

Dimension of the Learning Environment	Best Practices	Source
Continuous Learning	– **Informal work and learning practices:** Job rotation found to be one of the most effective methods used by the US Army to facilitate continuity of learning and knowledge development. – **Rewards:** Tuition reimbursement program employed by "Fowler Product, Inc.", helped in transforming their uneducated workforce to an educated workforce with the same employee base.	Marsick and Watkins, 1999
Inquiry and Dialogue	– **Special Meetings:** John MacCarthy used the special meetings strategy to enhance the dialogue aspects between team members. In the special meeting sessions employees are required to share the assumptions, programs, and responsibilities to gain understanding of each other vision and examine directions. Also, participant supposed to questions "what leads you to say or believe this?, what makes you ask about this?. Etc"	Senge (2006)
Team Based Learning	– **Holding back and getting others to talk:** Brendan a project manager decided to held back and be the facilitator of the project meeting in order to get others to be involved and share their thoughts and visions in order to help other team members learn from each other. – **Judging vs. making them thin**k: Scott a project manager role the meeting as facilitator by creating a scenario or analogy and let everyone share his ideas and ask questions in order to share the knowledge with one another and advance the team capabilities	Marsick and Watkins, 1999
Embedded System	– **Technology to support formal and informal learning:** US Army developed an informal learning practices (resource center) is called the After Action Review (AAR) which is a means of systematically learning from experience. In this system people share their experience about what went wrong or well, how can they improve what happened, and why did it happen that way.	Marsick and Watkins, 1999
Empowerment	– **Jerry Marlar of Sulzer Orthopedics and Ralph Stayer of Jonsonville Sausage:** They empowered people who work with them to take seriously their role in paving new grounds and challenge their people to be all that they can by encouraging, persistence, and convince people that they can do it.	Marsick and Watkins, 1999
System Connection	– **Involving Members in Business outcomes:** Johnsonville Sausage developed a system to support learning, knowledge creation and management, and change to ensure that employees remain connected to their environment and use that information to make a difference in business results. The system also helps employees use what they learned to determine how their abilities would contribute to the work and entire organization.	Marsick and Watkins, 1999
Strategic Leadership	– **Helping people grow**: A manager (Ellen) believes that her role as a leader is to help her employee to learn and develop by: • Instituted department meetings (weekly/as needed) to talk about the things that are really going on in her work group, and give her employees the opportunity to be in charge and conduct the meeting. • She had her employees work outside their department for a day, to get them to be able to think outside of just what their area is.	Marsick and Watkins, 1999

4.4.5. Effective Motivations for Retaining Estimating Competencies

4.4.5.1. Overall Effect of Intrinsic and Extrinsic Motivation

The effect of extrinsic and intrinsic motivations on developing estimating competencies and facilitating the knowledge capture and transfer is assessed. The SEM analysis results are summarized in Figure 16. The resultant model is an adequate fit to the data with $\chi^2 = 76.21$ (df = 58, p-value = 0.055). All of the fit indices provide acceptable results RMSEA = 0.07, CFI = 0.96, and SRMR = 0.071. The analysis results show both intrinsic and extrinsic motivations have significant direct effect on the development of the cost estimating competencies, and that intrinsic motivation has greater direct effect of (0.65*) on the development of the cost estimating competencies than extrinsic motivation (0.28*). This result indicates that by motivating cost estimators intrinsically, companies can escalate the development of their estimating workforce capabilities by around 130% more than using extrinsic motivation. The results also shows that intrinsic motivation has greater direct effect than extrinsic motivation on the effectiveness of both traditional capture and transfer methods (0.24*/0.14*) and advanced capture and transfer methods (0.47*/0.09*). The results show that extrinsic motivation have greater effect on the effectiveness of the traditional capture and transfer methods than on the advanced capture and transfer methods of 0.14* and 0.09*, respectively. Meaning that if the company is dependent on employing extrinsic motivators, adapting traditional capture and transfer methods is more effective to retain their estimators' competencies due to minimal effect of extrinsic motivation on enhancing the effectiveness of the advanced capture and transfer methods. Figure 16 also shows that intrinsic and extrinsic motivations have a significant indirect effect on the retention and development of the estimating profession competencies. Total indirect effect of intrinsic motivation and extrinsic motivation are represented by the following paths:

- ✓ **Intrinsic Motivation:**
  - Intrinsic motivation → Traditional C&T methods → Estimating Competencies
    - This indirect effect is estimated to equal (0.24 x 0.36) = 0.086

  - Intrinsic motivation → Advanced C&T methods → Estimating Competencies
    - This indirect effect is estimated to equal (0.47 x 0.40)= 0.188

- ✓ **Extrinsic Motivation:**
  - Extrinsic motivation → Traditional C&T methods → Estimating Competencies
    - This indirect effect is estimated to equal (0.14 x 0.36) = 0.050

  - Extrinsic motivation → Advanced C&T methods → Estimating Competencies

- This indirect effect is estimated to equal (0.09 x 0.40)= 0.036

The total direct and indirect effect of intrinsic motivation and extrinsic motivation on the development of estimating competencies are equal to (0.650 + 0.086 + 0.188) = 0.924 and (0.280 + 0.050 + 0.036) = 0.366, respectively. The achieved results support both hypotheses investigated in this study. These results indicate that by effectively employing intrinsic motivators companies can escalate the efficiency of retaining estimators' competencies by approximately two times than adapting extrinsic motivators. The results in Figure 16 shows that there is a significant relation between intrinsic and extrinsic motivators, indicating that to effectively retain estimators' knowledge and skills and enhance the effectiveness of the training methods, companies need to employ both intrinsic and extrinsic motivators instead of depending on and utilizing only one motivational aspect.

This result will help human resources development and top management in providing effective motivators to their estimating workforce in order to effectively retain their knowledge and retain estimators in the estimating profession. The results also help companies in enhancing the effectiveness of using both traditional or advanced capture and transfer methods by supporting their training practices with effective intrinsic motivators which will facilitate the training transfer and knowledge retention post training.

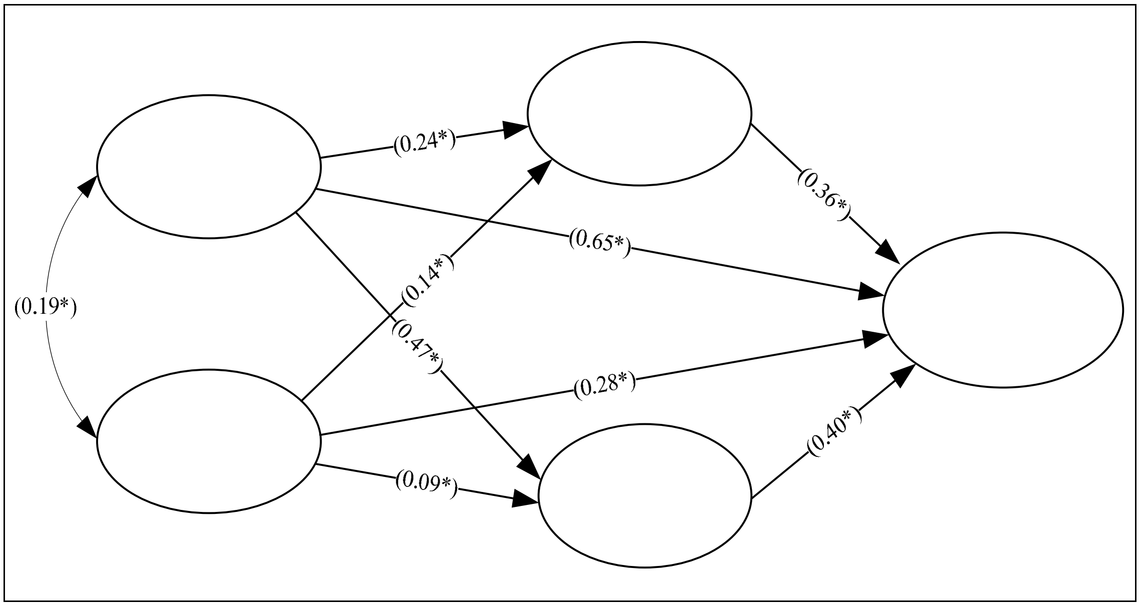


Figure 16. Effect of Motivation on the Retention of Estimating Competencies

4.4.5.2.Recommendations to Improve Motivation Practices in the Construction Industry

This study concluded that intrinsic and extrinsic motivations have significant effects on the development and retention of the cost estimating profession. Employees maybe motivated either intrinsically or extrinsically or both. Table 15 summarizes the best practices employed to motivate employees that can be as a guide to improve the motivational practices provided for the estimating profession. It is noteworthy, that the successfulness employing motivational practices may differ from one company to another and also between individuals.

Table 15. Best Practices to Advance Motivation Practices

Motivation	Best Practices	Source
Intrinsic Motivation	– **Performance Profiling** • Is a performance assessment technique that asks the athlete (individually/group) to identify the qualities essential to their performance and then rate themselves on those qualities. • The completed profile provides the athlete, the coach, and psychologist with a visual representation of the athlete's perception of his/her performance. Also it can be used to set goals and structure future training. • The results of using performance profiling helped in improving athletes' intrinsic motivation at three levels: ➢ Athlete involvement in the performance assessment (positively affected his perceived autonomy) ➢ Over time, profiling helped in improving athletes competence ➢ The group nature of profiling helped in facilitating athletes' communication, interaction, and discussion performance related issues with teammates.	Weston et al., 2011
Extrinsic Motivation	– **Performance-Based Compensation** • ING Baring Bank used the performance-based compensation to reward and motivate their employees on their performance. Using this method, employees were able to link their bonuses to the profit made, and how their performance can be chance to double their basic income. – **Professional Development and Training** • ING Baring Bank used the two-way process to help their employees career planning and develop their professional skills by customizing the training based on the employee needs and link it to the career plan to the promotion system.	Frey and Osterloh (2002)

4.5. Chapter Summary

Retention of experienced employees knowledge and competence has gained high attention from researchers and knowledge management practitioners especially after the increasing retirement rate of experienced employees. In addition, previous studies emphasized that the selection of the capture and transfer methods needs to be linked to the type of knowledge and skills required for performing job tasks efficiently. In addition, Recently organizational and knowledge management research found that adapting healthy learning environment and motivation plays critical role on the knowledge retention practices, job performance improvement, and sustaining the organization competiveness. Many studies aimed to identify the characteristics of the healthy learning environment and link it to the financial performance of the organization and knowledge development. Thus it is important to customize and determine the effective capture and transfer methods, learning environment, and motivations that will facilitate the retention of the specific knowledge and skills required for the estimating profession.

In this study, among different capture and transfer methods, ten capture and transfer methods were selected for further investigation on their capability to retain estimating knowledge and skills. "Mentoring from experienced estimators," "on-the-job training," "lectures and workshops," "documents and manuals," and "online courses" are classified as the traditional management practices employed in the construction industry. "Communities of practice," "peer mentoring," "virtual communities of practice," "audiovisuals," and "simulation" are classified as advanced capture and transfer methods. Structural equation modeling methodology is used to investigate the inherent effect of the traditional and advanced capture and transfer methods in retaining the estimating competencies. The result shows that advanced capture and transfer methods have greater effect on the development of estimating competencies than traditional capture and transfer methods by 27%. The result also shows that traditional and advanced capture and transfer methods have significant relation (0.18*) between them, indicating that by employing both traditional and advanced capture and transfer methods, companies can escalate the development of their estimating workforce competencies.

As a result models to capture and transfer knowledge and skills for the estimating profession were developed. For each factor of the estimating competencies the effective capture and transfer methods were determined. The results shows that "mentoring from experienced estimators," "on-the-job training," "COP," "VCOP," and "Simulation" plays vital role in capturing and transferring most of the estimating competencies factors especially the top three most significant factors in developing competent estimators; "Factor 2: basic knowledge required by an estimators," "Factor 1: estimator's communication and work behavior," and "Factor 4: estimator's ability to analyze project scope and deal with the profession pressure" which count for more than 65% of the estimating competencies. These models will help human resources development in designing and customizing training programs based on individuals and groups needs. In addition, these models will change how mangers and human resources development in the construction industry envisions the effectiveness of advanced capture and transfer methods and how to efficiently employ these methods rather than depending on mentoring and on-the-job training which sometime are infeasible to be implemented.

In this study, the current learning environment provided to cost estimators was measured and its impact on the effectiveness of the retention practices and development of estimating profession were assessed. The results shows that adapting healthy learning environment will escalate the retention of estismating profession competencies and will advance the effectiveness of the capture and transfer methods used for developing the estimating competencies. Transforming the current learning environment into the ideal and healthy learning environment is a very difficult and costly task, thus it is important to identify the most effective way to gradually transform the environment and reach ideality. To help companies facilitate a healthy learning environment for their estimating workforce and transforming their environment, the gap in the current learning environment are assessed. The gap analysis results show that the widest gaps in the current learning environment exist in "embedded system dimension," "team learning dimension," and "empowerment dimension." In order to help companies in prioritizing their efforts to adapt healthy environment, the significant effect of the gaps in the learning environment is assessed using SEM. The results show that gaps in "continuous learning dimension," "team learning dimension," and "strategic leadership dimension" requires immediate development due to their significant effect on sustaining the retention and development of the estimating profession.

This chapter also provided the results of the effect of intrinsic and extrinsic motivators on the development of the estimating profession competencies and on the effectiveness of knowledge capture and transfer practices. The results of this analysis emphasized the importance of intrinsic motivation on sustaining the development of the cost estimating profession, and on boosting the effectiveness of both the traditional and advanced capture and transfer methods employed to retain estimators' knowledge and skills. The analysis also signifies the effect of the intrinsic motivation in facilitating the retention of estimators' knowledge and skills by two times over the extrinsic motivators. These results will help companies in adapting effective motivators to their estimating workforce.

CHAPTER V

INTEGRATIVE FRAMEWORK FOR SUSTAINING THE DEVELOPMENT OF THE ESTIMATING PROFESSION

5.1. Introduction

Companies are reeling from discontinuities and survival resulted from the intense and global competition, explosion in information technology, demographic changes, and the emergence of the knowledge-based economy. These threats are facing companies with an immediate need to develop and adapt effective management practices to survive and enhance performance. Researchers and practitioners found out that a company's ability to learn and innovate has a direct relation to enhancing the company's operating efficiencies, increase profits, and maintain the knowledge assets within the company (Nonaka, 1995; Chawla and Renesch, 1995; Song, 2008). There has been little systematic, theory based research on the effect of learning environment and motivation on the development of competent engineers in the construction industry. In addition, recent studies aimed to evaluate the effect of learning and motivation at the organization level while ignoring the differences between the professionals' needs and characteristics within the single organization in the construction industry.

Recent studies show that the retirement rate of engineers in the construction industry is escalating, at the same time the educational outcomes cannot meet the demand for civil engineers (ASCE, 2003) which creates a gap in supply and demand of quality civil engineers. This shortage of qualified civil engineers is threatening companies of the loss of their experienced engineers' knowledge and wisdom they have acquired over their years of experience as the retirement rate keeps increasing. As a result, there is a clear need for companies in the construction industry to develop strategies for developing the knowledge and skills of their workforce.

Furthermore, there exist many studies in the literature which investigated the current practices of organization learning and effect of motivation on training outcomes in the construction industry. However, it is rare to find any study that ties all the factors affecting the knowledge retention and development together in one framework, and evaluated the impact or outcomes of adapting the learning organization culture on the organizational performance or knowledge retention. In addition, in the construction industry the concept of the learning organization environment is considered optional (Chinowsky et al., 2007) when actually it is a necessity to maintain the organization's performance and competiveness.

To efficiently retain experts' engineers' knowledge and experience within the construction industry, new and advanced approach need to be adapted. Companies need to realize that uni-dimension and temporary solutions are ineffective to sustain the development and retention of their employees' competencies. The only way to adapt to the rapidly changing industry and the evolving knowledge era is account for all factors affecting the knowledge retention process in a comprehensive multi-dimensional approach. This multi-dimensional approach must be customized to consider the individual and professional differences to effectively sustain the development of employee competence. This study aims in developing a multi-dimension framework to sustain the development of the cost estimating profession (refer to Figure 17). In designing the proposed framework (Figure 17), an extensive review of the literature related to factors affecting the knowledge development and retention are reviewed. The synthesis of the literature determines that the knowledge retention practices are highly affected by the methods used to retain that knowledge, the environment in which the retention process took place, and motivators provided to facilitate the knowledge retention process. The existing literature also highlighted that although these are affected by each other, currently each of these factors is studied by its own. This indicates that the level by which each factor is affecting other practices is not evaluated. Furthermore, to enhance the knowledge retention process, all these factors must be customized and linked to specific professional competencies. To effectively maximize the benefits of this framework, the current and desired levels for each dimension must be assessed and evaluated. In addition, the relationships between these factors must be evaluated. The uniqueness of this framework relies in the methodology used to customize all management practices affecting the knowledge retention process at the competency level for the estimating profession.

The first dimension (D1) in the framework, aims to identify and classify the core estimating competencies required for developing competent cost estimators. Estimating competencies can be defined as a cluster of interrelated skills, knowledge and personal attributes required to properly perform an estimating job. A total of 23 competencies have been identified as required competencies of cost estimators through a two day workshop with senior estimators and research team members. The 23 estimating competencies were classified into skills, knowledge, and personal attributes. Furthermore, skills and knowledge are divided into "soft" skill or knowledge that is difficult to be taught or developed and requires more experience and training, versus "hard" skill or knowledge that is relatively easy to be taught, developed, and learned. Expanded definition of each competency based on its classification and further discussions on analysis results related to gaps in the estimating competencies, criticality assessment of the competencies using the Euclidian distance concept, and grouping those core competencies based on the embedded relationships among them using factor analysis can be found in Chapter 3.

In the second dimension (D2), among various methods available in the literature to capture and transfer knowledge and skills, ten captures and transfer methods were selected for evaluating their effectiveness to capture and transfer the estimating competencies. "Mentoring from experienced estimators," "on-the-job training," "lectures and workshops," "documents and manuals," and "online courses" are classified as the traditional management practices employed in the construction industry. "Communities of practice," "peer mentoring," "virtual communities of practice," "audiovisuals," and "simulation" are classified as advanced capture and transfer methods. Using Structural Equation Modeling analysis, for each competency the effective capture and transfer methods to retain the estimating knowledge and skills was assessed and resulted in developing a capture and transfer model for the estimating profession. Descriptions and Details about the capture and transfer methods and their effectiveness can be found in Chapter 4.

The third dimension (D3) is concerned about evaluating the current level of learning organization environment provided to cost estimators in the construction industry, and its impact on the development of estimating competencies and effectiveness of the capture and transfer methods. The SEM analysis results shows that adapting healthier learning environment has significant effect in enhancing the retention practices for the estimating profession and directly increasing the effectiveness of both traditional and advanced capture and transfer methods. In addition, the gaps in the seven dimension of the learning environment were evaluated and the significant effect of each gap on the development of the estimating competencies was assessed using SEM. Details about the gap analysis results and their significance can be found in Chapter 4.

Finally, the fourth dimension (D4) considered in this framework is motivation. In this dimension the effect of intrinsic and extrinsic motivators on the development of the estimating competencies and effectiveness of the traditional and advanced capture and transfer methods was assessed using SEM method. The results indicate that companies need to employ harmoniously both intrinsic and extrinsic motivators to facilitate the knowledge retention and development process for their estimating workforce. Details about the different motivation aspects and their effectiveness can be found in Chapter 5.

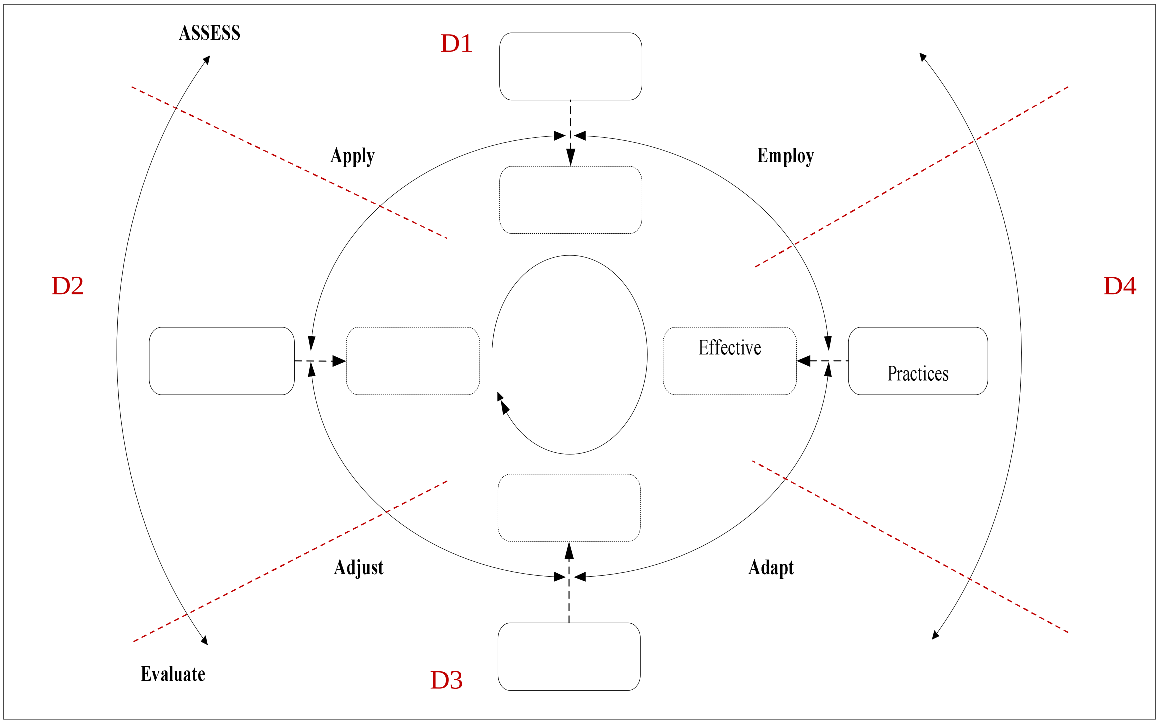


Figure 17. Integrated Multi-dimension Framework

5.2. Integrative Effect of Learning Environment and Motivation on Retaining the Cost Estimating Competencies

The assessment of the combined effect of the learning environment and motivation on the effectiveness of the retention practices and the development of the estimating profession underwent three main steps. In the first step, the reliability and validity of the scale used and the constructs developed were assessed as explained in the previous chapters 4. After validating the reliability and validity of the variables, two comparison scenarios were examined to determine the appropriate users for the developed model. The comparison analysis results discussed in Chapter 4 revealed that there are no significant differences in the management practices between owners and non-owners companies within the process/manufacturing industry sector and the building sector in the construction industry. Finally, SEM analysis technique is used to; 1) assess the significant effects of the learning environment and motivation on the development and retention of the estimating profession competencies, and 2) develop best practices guide to help companies in the industry advance and customize their management practices to efficiently sustain the development of estimators' capabilities and knowledge. The SEM analysis method is extensively explained in Chapter 4.

SEM analysis is performed using LISREL 8.8 to determine the combined effect of the management practices on the development of the cost estimators' capabilities and the effectiveness of the capture and transfer methods used. The SEM analysis results are summarized in Figure 18. The resulted model (Figure 18) is an adequate fit to the data with χ^2 = 1.12 (df = 1, p-value = 0.290). All of the fit indices provide acceptable results RMSEA = 0.039, CFI = 0.98, and SRMR = 0.025. Table 16 the SEM analysis results for the integrative effect of management practices on the development of the estimating profession.

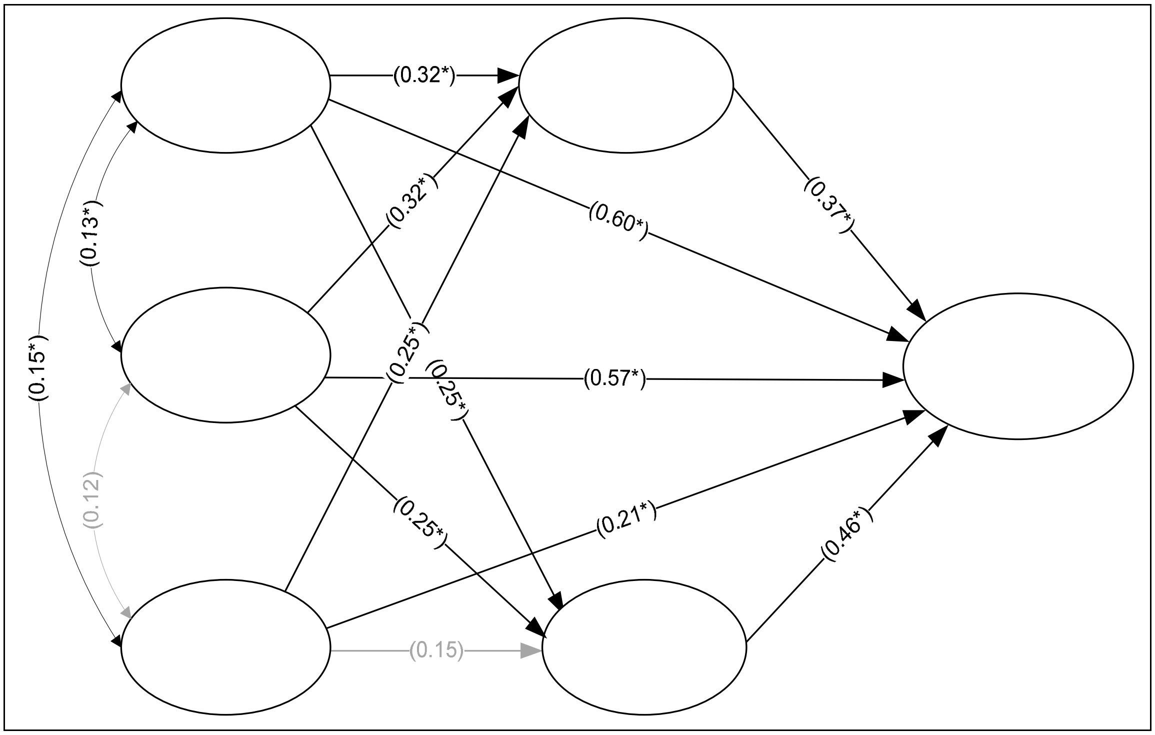


Figure 18. Integrative Effect of Management Practices on the Development of the Estimating Profession

Table 16. Summary Results of Integrative Management Practices Model

Paths	Parameter Estimates	Significance
Learning Environment ➔ Estimating Competencies	0.60*	Significant
Learning Environment ➔ Traditional C&T Methods	0.32*	Significant
Learning Environment ➔ Advanced C&T Methods	0.25*	Significant
Intrinsic Motivation ➔ Estimating Competencies	0.57*	Significant
Intrinsic Motivation ➔ Traditional C&T Methods	0.32*	Significant
Intrinsic Motivation ➔ Advanced C&T Methods	0.25*	Significant
Extrinsic Motivation ➔ Estimating Competencies	0.21*	Significant
Extrinsic Motivation ➔ Traditional C&T Methods	0.25*	Significant
Extrinsic Motivation ➔ Advanced C&T Methods	0.15	Not Significant
Learning Environment ↔ Intrinsic Motivation	0.13*	Significant
Learning Environment ↔ Extrinsic Motivation	0.15*	Significant
Intrinsic Motivation ↔ Extrinsic Motivation	0.12	Not Significant

The results show that the learning environment factor has a significant direct effect on the development of the estimating competencies the learning with parameter estimate 0.60*. The learning environment also has a significant direct effect on the effectiveness of the traditional and advanced capture and transfer methods with parameter estimates 0.32* and 0.25*, respectively. This result indicates that by improving and adapting a healthier learning environment, companies can enhance the effectiveness of the capture and transfer methods used and sustain the development and knowledge transfer between junior and experienced estimators generation even post training.

The analysis results also show that intrinsic motivation has greater direct effect on the development of estimators' capabilities than extrinsic motivation with parameter estimates 0.57* and 0.21*, respectively. The results also show that intrinsic motivation has a greater significant effect than extrinsic motivation on increasing the effectiveness of the traditional capture and transfer methods used to retain estimators' knowledge and skills with parameter estimates 0.32* and 0.25*, respectively. The results show that both intrinsic motivation and learning environment have equal significant effect in increasing the effectiveness of the advanced capture and transfer methods with parameter estimates 0.25* and 0.25, respectively, while extrinsic motivation has insignificant effect in advancing the effectiveness of the advanced capture and transfer methods. Furthermore, the results show that there is a significant relationship between the learning environment and both motivation practices (intrinsic and extrinsic). This indicates that to efficiently sustain the development of estimators', management efforts in facilitating the learning environment and providing motivations need to consider all three aspects together, not to advance one aspect over the others.

The results of the developed framework will change how the top management envisions and behaviors toward the importance of adapting a healthy learning environment that will facilitate the continuity of learning to advance their estimators' capabilities and retain estimators in the estimating profession. In addition, the framework developed will help companies realize the importance of intrinsic motivators in sustaining the development of their estimating workforce. The results of this framework are considered very significant in developing and retaining the estimating profession, practitioners may wonder how these results can be customized and applied to develop the different estimators' knowledge and skills requirements.

5.3. Integrative Management Practices Matrix

To facilitate the usability of the achieved results to help practitioners benefit and adapt the effective management practices for their estimating workforce, an integrative management practices matrix is developed (Figure 19). In developing this matrix, 84 saturated SEM models (discussed in Chapter 4) are analyzed. Saturated SEM models are perfect fit SEM models with Chi-square value $\chi^2 = 0.00$ and df = 0 (kline, 2011). For each cell in this matrix, three saturated SEM models are analyzed to; 1) determine the most effective methods to capture and transfer each of the estimating factors or combination, 2) critical gaps in the learning environment to be closed, and 3) the effective motivations to be used for developing the specific competencies. As shown in Figure 19, the top row and left column represents the seven factors of the cost estimating profession. At the matrix diagonal, each cell shows the top two effective methods to capture and transfer each factor along with the top two critical gaps in the learning environment, and the top two motivations aspects effective to develop the respective sets of knowledge and skills. The lower off-diagonal cells shows the top two effective methods to capture and transfer any combination of the estimating factors along with the top two critical gaps in the learning environment, and the top two motivations aspects effective to develop the both estimating factors at a time.

Factors	EF1: &	EF2: estimator	EF3:	EF4: & deal	EF5: &	EF6: &	EF7:
EF1: skills & work Behavior	•On-The- • • • • •						
EF2: Basic	•On-The- • • • • •	• • • • • •					
EF3: tasks for	• • • • •Outward •	• • • • • •	•On-The- • • • • •Outward				
EF4: scope & deal with pressure	• • • • • •	• •VCOP • Dialogue • • •	• •On-The- • • Dialogue • •	•VCOP •On-The- • • • •			
EF5: pieces & make decision	• • • • • •	• • • • System • •	• •Lectures & • • • •Outward	• •COP • • • •	•On-The- • • • • •		
EF6: &	• •VCOP • • • •	•On-The- • • • • •	•VCOP • • • • •	• • • • • •Outward	• • • • • •	•On-The- • • • • •	
EF7: estimate	•VCOP •On-The- • • Dialogue • •	•VCOP •COP • Dialogue • • •	•VCOP •COP • Dialogue • • •	• •Lecture & • • • •	•VCOP •On-The- • Dialogue • • •Outward	•VCOP •On-The- • • Dialogue • •	• • • • • •Outward

Figure 19. Integrative Management Practices Matrix to Sustain the Development of the Cost Estimating Profession

The integrative management practices matrix to sustain the development for the estimating profession is considered a practical tool or a guide to help companies customize their efforts when developing their learning environment and advancing their motivation practices based on their estimating workforce needs. This tool will help companies save the time and efforts when developing training methods for their estimating workforce, retain estimators', and transform their environment to a healthy learning environment that facilitate learning and knowledge transfer. For example, if company X realized that their cost estimating workforce lacks mainly the competencies represented in "factor 2 basic knowledge required by an estimator" and "factor 3 preliminary tasks for developing quantity of work" and wanted to efficiently develop these competencies. Using the integrative management practices matrix, the intersection cell between the column of EF2 "basic knowledge required by an estimator" and the row of EF3 "factor 3 preliminary tasks for developing quantity of work" represent the summary cell for the most effective capture and transfer methods to develop both factors of estimating competencies (see Figure 20), the gaps in learning environment affecting the development of these competency factors, and effective motivators affecting the development of these factors. Using the information in the intersection cell the company will find that using "mentoring from experienced estimators" and "online courses" are the most effective capture and transfer methods to be used to develop these sets of competencies. Also using the matrix, the company will recognize that they need to close the gaps in "continuous learning dimension" and "inquiry dialogue dimension" to improve their learning environment and advance the effectiveness of their training methods. In addition, to motivate their estimating workforce and enhance the training transfer, they need to provide challenge motivators and compensations to effectively retain and develop their estimating workforce capabilities.

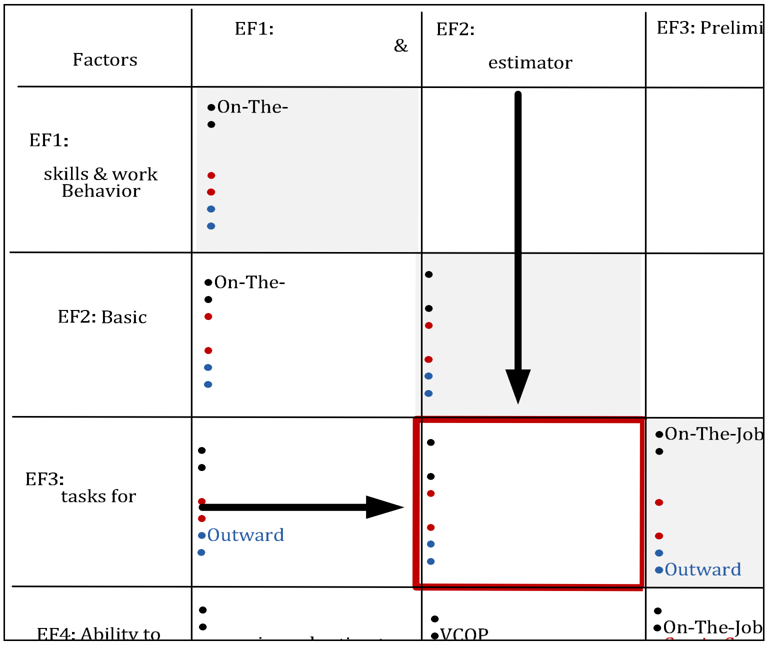
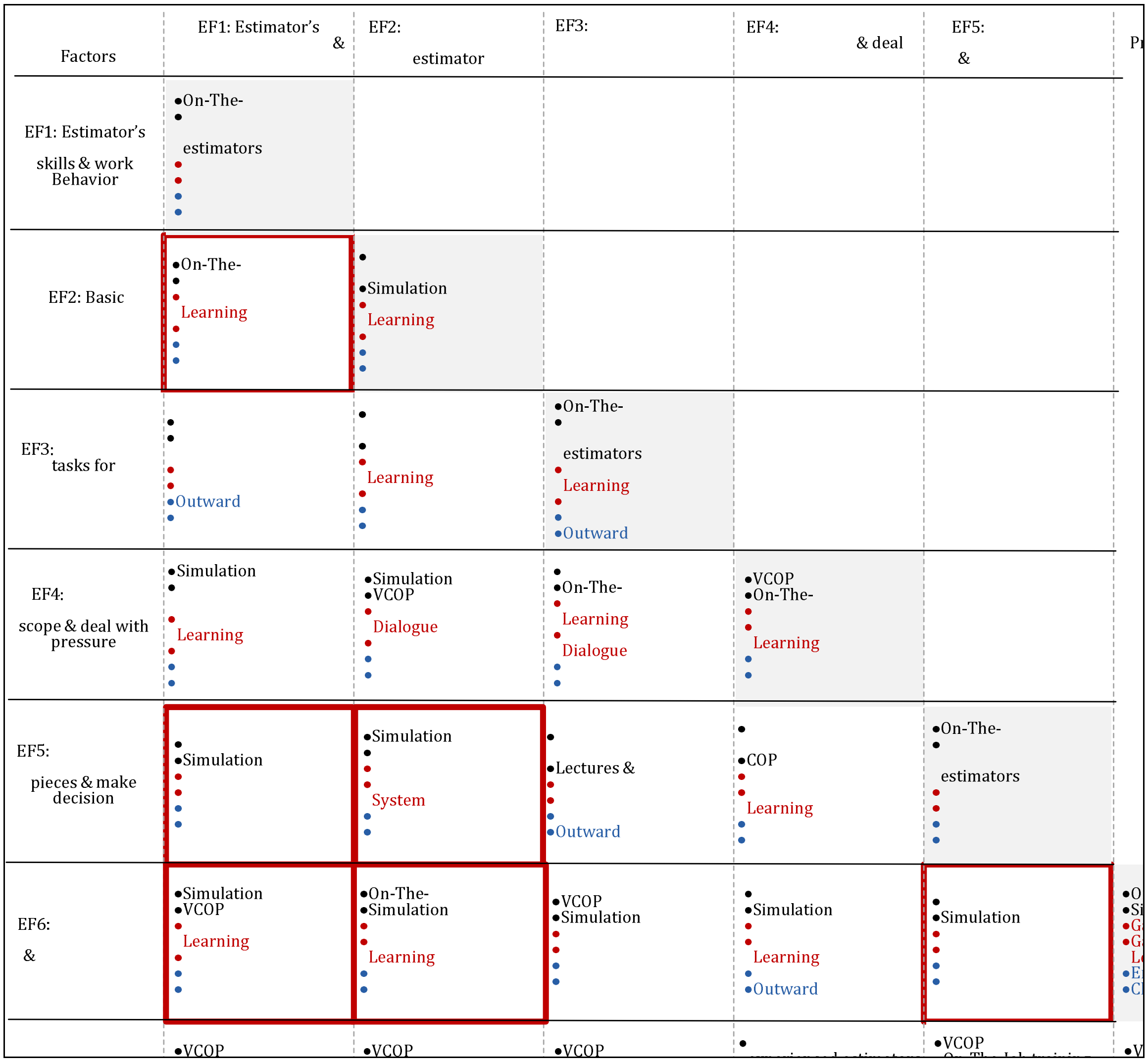


Figure 20. Uses of the Integrative Management Practices Matrix - Example 1

The previous example shows that the integrative management practices matrix is very easy to use in providing effective training and motivation practices and adapt healthier learning environment. Is the integrative management practices matrix to sustain the development for the estimating profession considered a practical and beneficial when the estimating work force lacks in one or two factors of the estimating competencies? The answer is No. The benefits of the integrative management practices matrix developed are extended to help companies develop effective training programs and customize their efforts when developing their learning environment and advancing their motivation practices when their estimating workforce lacks in one factors of the estimating competencies factors or more. For example, if company Y realized that their cost estimating workforce lacks competencies scattered between four factors of the estimating competencies represented in “factor 1 estimator’s communication skills and work behavior,” “factor 2 basic knowledge required by an estimators,” “factor 5 ability to put together project pieces and make decision,” and “factor 6 construction process knowledge and judgment skills” and they wanted to develop the best training program and adapt the best management practices to effectively develop those competencies. The best and easiest way to identify the best management practices to develop those competencies is to compare the practices in the integrative management practices matrix for all the combinations of these factors (see Figure 21). As shown in the Figure 21, the intersection cells between the column of EF1 and the rows of EF2, EF5 and EF6, the column of EF2 and the rows of EF5 and EF6, and the column of EF5 and the row of EF6 are highlighted for comparison. By comparing the six highlighted cells, the most effective capture and transfer methods to be used to develop the lacking estimating competencies are “simulation,” “audiovisuals,” and “on-the-job training.” The comparison results also show that the gaps in learning environment affecting the development of these competency factors and need immediate attention to improve their learning environment and advance the effectiveness of their training methods are gaps in “empowerment dimension,” “continuous learning dimension,” and “team learning dimension”. In addition, to efficiently motivate their estimating workforce and enhance the training transfer, they need to provide mainly intrinsic motivators “enjoyment” and “challenge” motivators and “compensations” to effectively retain and develop their estimating workforce capabilities.



Factors	EF1: Estimator’s &	EF2: estimator	EF3:	EF4: & deal	EF5: &	Pr
EF1: Estimator’s skills & work Behavior	•On-The- • estimators • • • •					
EF2: Basic	•On-The- • • Learning • • •	• •Simulation • Learning • • •				
EF3: tasks for	• • • • •Outward •	• • • Learning • • •	•On-The- • estimators • Learning • • •Outward			
EF4: scope & deal with pressure	•Simulation • • Learning • • •	•Simulation •VCOP • Dialogue • • •	• •On-The- • Learning • Dialogue • •	•VCOP •On-The- • • Learning • •		
EF5: pieces & make decision	• •Simulation • • • •	•Simulation • • • System • •	• •Lectures & • • • •Outward	• •COP • • Learning • •	•On-The- • estimators • • • •	
EF6: &	•Simulation •VCOP • Learning • • •	•On-The- •Simulation • • Learning • •	•VCOP •Simulation • • • •	• •Simulation • • Learning • •Outward	• •Simulation • • • •	•O •Si •G •G L •E •C
	•VCOP	•VCOP	•VCOP	•	•VCOP	•V

Figure 21. Uses of the Integrative Management Practices Matrix - Example 2

5.4. Chapter Summary

The current challenges reside in global competition, information technology explosion, demographic changes, and escalated retirement rate are facing organizations with an imminent need to adapt effective practices to sustain their performance and remain their competiveness. To survive these threats, developing and adapting a healthy learning environment is found to be the most effective solution. Transforming to a learning environment organization is very challenging and requires employing effective knowledge retention and motivation practices to ensure the successful transformation.

This chapter developed an integrated framework that assesses the significant effect of the adapting effective management practices in providing learning environment, motivation, and trainings on the development and retention of the cost estimating knowledge and skills. Using SEM technique, the underlying relation between the practices and their effects on the development of the estimating profession were determined. The results show that learning environment has a significant direct effect on developing estimating competencies and enhancing the effectiveness of the traditional and advanced capture and transfer methods to retain estimating profession knowledge and experience. The result shows that intrinsic motivation and learning environment have equal effect on enhancing the effectiveness of the advanced capture and transfer method. The results also show that learning environment and intrinsic motivation have greater direct effect on the development of the estimating profession competencies than extrinsic motivation. However, the result indicates that the success in sustaining the development and retention of the estimating profession can only be achieved by harmoniously employing intrinsic and extrinsic motivation and adapting healthier environment due to the significant relation among them.

Due to data limitation, the framework developed is more effective for development of estimators' working for owner and construction/engineering companies within the process/manufacturing industry and building sectors. Future studies should be directed toward identifying the effective practices on developing learning environment for other professionals within the construction industry.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The knowledge retention and development is considered very critical and challenging. There are many factors affecting the success of the knowledge retention practices such as the effectiveness of the methods used to capture and transfer knowledge, the climate in which the knowledge transfer takes place, and motivators used to facilitate the knowledge transfer process. Previous efforts aimed to investigate and evaluate the effectiveness of each factor or practice individually without considering the effect of other factors on the knowledge development.

This study developed a multi-dimensional integrated learning framework for management practices that affect the development and retention of the cost estimators' competencies. This framework incorporates all factors affecting the knowledge development and retention practices such as; the capture and transfer methods used, the learning environment provided, and motivation practices into one structure that will help in analyzing the relationships between these factors and assess the combined effect of these factors on the development of the estimating profession competencies. The study also developed a competency map for the estimating profession that can help companies assess their estimating workforce capabilities and also used as a guide when recruiting for estimating positions. Furthermore, this study developed a customized capture and transfer models for the estimating profession that determine the effective capture and transfer methods to develop each of the estimating competency factors. These models will help companies customize and design effective training programs for their estimating workforce based on their estimators needs.

This study has identified 23 core estimating competencies for developing qualified cost estimators. The competencies were classified into skills, knowledge, and personal attributes and were further classified into soft and hard subcategories. The gap analysis results show that new estimators lack the main estimating capabilities especially for the soft skills and knowledge that are considered very difficult to capture and transfer and cannot be taught by using simple training methods. The concept of the estimating core competency criticality matrix was used to prioritize the estimating competencies based on their criticality score. The study has found that most critical competencies are soft skills or knowledge which are difficult to be transferred.

Using factor analysis, the 23 competencies were grouped into seven different factors. They are; 1) estimator's communication and work behavior, 2) basic knowledge required by an estimator, 3) preliminary tasks for developing quantity of work, 4) estimator's ability to analyze project scope and deal with the profession pressure, 5) ability to put together the project pieces and make decision, 6) construction process knowledge and judgment skill, and 7) ability to produce a clear and organized estimates. Among these factors, factors 2, 1, and 4 are the most significant factors which require immediate attention when developing training and education programs for cost estimators.

There are many capture and transfer methods available, however, the selection of the capture and transfer methods need to be linked to the type of knowledge and skills required for performing job tasks efficiently. Among different capture and transfer methods, ten capture and transfer methods were selected for further investigation on their capability to retain estimating knowledge and skills. "Mentoring from experienced estimators," "on-the-job training," "lectures and workshops," "documents and manuals," and "online courses" are classified as the traditional management practices employed in the construction industry. "Communities of practice," "peer mentoring," "virtual communities of practice," "audiovisuals," and "simulation" are classified as advanced capture and transfer methods. Using SEM analysis, advanced capture and transfer methods are identified to have greater impact on the development of the estimating capabilities. SEM analysis was also employed to evaluate the effectiveness of the capture and transfer methods on developing each factor of the estimating competencies; as a result models to capture and transfer knowledge and skills for the estimating profession were developed. The results show that "mentoring from experienced estimators," "on-the-job training," "COP," "VCOP," and "Simulation" plays vital role in capturing and transferring most of the estimating competencies factors especially the top three most significant factors in developing competent estimators; "Factor 2: basic knowledge required by an estimators," "Factor 1: estimator's communication and work behavior," and "Factor 4: estimator's ability to analyze project scope and deal with the profession pressure" which count for more than 65% of the estimating competencies. These models will help designing and customizing training programs based on individuals and groups needs. Also, these models will change how managers and human resources development in the construction industry envision the effectiveness of advanced capture and transfer methods and how to efficiently employ these methods rather than depending on mentoring and on-the-job training which sometimes are infeasible to be adapted or employed.

There exist many studies in the literature which investigated the current practices of organization learning in the construction industry. However, it is rare to find any study that evaluates the effect of adapting learning environment on the development and retention practices of professional competencies. In this study, the effect of the learning environment on the effectiveness of the retention practices and development of estimating profession were assessed. The results show that adapting healthy learning environment will escalate the retention of estimating profession competencies and will advance the effectiveness of the capture and transfer methods used for developing the estimating competencies. To help companies facilitate a healthy learning environment for their estimating workforce and transforming their environment, the gaps in the current learning environment were assessed. The gap analysis results show that the widest gaps in the current learning environment exist in “embedded system dimension,” “team learning dimension,” and “empowerment dimension.” The significant effect of the gaps in the learning environment was assessed using SEM. The results show that gaps in “continuous learning dimension,” “team learning dimension,” and “strategic leadership dimension” requires immediate development due to their significant effect on sustaining the retention and development of the estimating profession.

The effect of intrinsic and extrinsic motivators on the development of the estimating profession competencies and on the effectiveness of knowledge capture and transfer practices were evaluated. The results of this analysis emphasized the importance of intrinsic motivation on sustaining the development of the cost estimating profession, and on boosting the effectiveness of both the traditional and advanced capture and transfer methods employed to retain estimators’ knowledge and skills. The analysis result shows that intrinsic motivation is two times more effective over the extrinsic motivators in facilitating the retention of estimators’ knowledge and skills. These results will help companies in adapting effective motivators to their estimating workforce.

An integrated framework to sustain the development of estimators working for owner and construction/engineering companies within the process/manufacturing industry and building sectors was developed. The integrated framework was structured to assess the significant effect of the adapting effective management practices in providing learning environment, motivation, and trainings on the development and retention of the cost estimating knowledge and skills. Using SEM technique, the underlying relation between the practices and their effects on the development of the estimating profession were determined. The results show that learning environment has a significant direct effect on developing estimating competencies and enhancing the effectiveness of the traditional and advanced capture and transfer methods to retain the estimating profession knowledge and experience. The result shows that intrinsic motivation and learning environment have equal effect on enhancing the effectiveness of the advanced capture and transfer method. The results also show that learning environment and intrinsic motivation have greater direct effect on the development of the estimating profession competencies than extrinsic motivation. However, the result indicates that the success in sustaining the development and retention of the estimating profession can only be achieved by harmoniously employing intrinsic and extrinsic motivation and adapting healthier environment due to the significant relation among them.

6.2. Recommendations

This study has shown the significant effect of incorporating companies' management practices in order to effectively retain estimators' knowledge and skills and sustain the development of the estimating profession. While this study provides a good tool for developing effective management practices and transform to adapt healthier learning environment for their estimating workforce, there are still open areas for improvement. Future research can be directed to address the listed below issues:

- **Incorporate job satisfaction dimension in the integrated framework**

  The existing literature shows that providing effective motivation, climate, and training can increase the job satisfaction (Kozlowski and Salas, 2010). However, due to the limited scope of the study the effect of the integrated management practices on estimators' job satisfaction was not evaluated. In the future, job satisfaction dimension need to be incorporated to the integrated framework to develop more comprehensive framework.

- **Relate Intrinsic Motivations to Estimating Tasks**

  It is shown that intrinsic motivation plays vital role in the competency development and retention practices. Enhancing the retention of estimators will require evaluation of different intrinsic motivation practices and their relation to the estimating tasks, to make estimating profession enjoyable and enhance the retention process.

- **Develop integrated frameworks for other professionals in the construction industry**

  It is shown that customizing and integrating management practices in one framework is very critical in developing competencies and knowledge retention practices. However, due to data limitation, the developed framework is more effective for the development of estimators' working for owner and construction/engineering companies within the process/manufacturing industry and building sectors. In the future, studies should be directed toward developing integrated management practices frameworks for other professionals within the construction industry.

REFERENCES

Amabile, T. M., Hill, K. G., Hennessey, B. A., and Tighe, E. M. (1994). "The Work Preference Inventory: Assessing intrinsic and extrinsic motivational orientations." *Journal of Personality and Social Psychology*, 66(5), 950-967.

Aik, C. T. (2005). "The synergies of the learning organization, visual factory management, and on-the-job training." *Performance Improvement*, 44(7), 15.

Akintoye, A. (2000). "Analysis of factors influencing project cost estimating practice." *Construction Management and Economics*, 18(1), 77-89.

Akintoye, A., and Fitzgerald, E. (2000). "A survey of current cost estimating practices in the UK." *Construction Management & Economics*, Routledge, 161-172.

Ardichvili, A., Page, V., and Wentling, T. (2003). "Motivation and barriers to participation in virtual knowledge-sharing communities of practice." *Journal of Knowledge Management*, 7(1), 64-64-77.

Argyris, C. (1977). "double loop learning in organizations" *Harvard Business Review*, 55(5), 115.

Armstrong, A., and Foley, P. (2003). "*Foundations for a learning organization: Organization learning mechanisms.*" The Learning Organization, 10(2/3), 74-82.

Arthur, D. (2001). The employee recruitment and retention handbook AMACOM, New York.

Austin, R. D. (1996). "Measuring and managing performance in organizations." Dorset House Publishing, New York, xxi, 216 p.

Bakewell, R. D. (1985). "Theoretical and Practical Aspects of Conceptual Estimating." *Cost Engineering*, 27(2), 18.

Behrendt, V. (2005). "Surviving the Perfect Storm." *Cost Engineering*, 47(2), 8.

Brozova, H., and Subrt, T. (2008). "Competency mapping and modelling in system design." Scientia Agriculturae Bohemica, 39(2), 125-131.

Bryant, S. E. (2005). "The Impact of Peer Mentoring on Organizational Knowledge Creation and Sharing." *Group & Organization Management*, 30(3), 319-338.

Bui, H., and Baruch, Y. (2010). "Creating learning organizations: A system perspective." *The Learning Organization*, 17(3), 208-227.

Carr, R. I. (1989). "Cost-Estimating Principles." *Journal of Construction Engineering and Management*, 115(4), 545-551.

Chawla, S., and Renesch, J. (1995). "Learning organizations: developing cultures for tomorrow's workplace." Productivity Press, Portland, Or., xxiii, 547 p.

Calder, B. J., and Staw, B. M. (1975). "Self-perception of intrinsic and extrinsic motivation." *Journal of Personality and Social Psychology,* 31(4), 599-605.

Chinowsky, P., and Carrillo, P. (2007). "Knowledge Management to Learning Organization Connection." Journal of Management in Engineering, American Society of Civil Engineers, 122-130.

Chinowsky, P., Molenaar, K., and Realph, A. (2007). "Learning organizations in construction." *Journal of Management in Engineering*, 23(1), 27-34.

Chiu, C.-M., Hsu, M.-H., and Wang, E. T. G. (2006). "Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories" *Decision Support Systems*, 42(3), 1872-1888.

Davis, J. R., and Davis, A. B. (1998). "*Effective training strategies: A comprehensive guide to maximizing learning in organizations*" A publication in the Berrett-Koehler organizational performance series, Berrett-Koehler Publishers, San Francisco, ix, 521 p.

Eby, L. T. (1997). "Alternative Forms of Mentoring in Changing Organizational Environments: A Conceptual Extension of the Mentoring Literature." *Journal of Vocational Behavior*, 51(1), 125-144.

Field, A. (2005). Discovering Statistics Using SPSS, SAGE, London; Thousand Oaks; New Delhi.

Fornell, C., and Larcker, D. (1981). "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error" *Journal of Marketing Research*, 18(1), 39-39.

Frey, B. S., and Osterloh, M. (2002). "*Successful management by motivation : balancing intrinsic and extrinsic incentives*" Organization and management innovation, Springer, Berlin ;New York, xvi, 299 p.

Garavan, T. N. (1997). "Training, developmetn, education and learning: Different or the same?" *Journal of European Industrial Training*, 21(2), 39-50.

Garvin, D. A. (1993). "Building a learning organization." Harvard Business Review, Harvard Business School Publication Corp., 78-91.

Gushgari, S. K., Francis, P. A., and Saklou, J. H. (1997). "Skills Critical to Long-Term Profitability of Engineering Firms." *Journal of Management in Engineering*, 13(2), 46-56.

Hollmann, J. K., and Elliott, B. G. (2006). "Core Competencies, Expectations and Career Path for an Estimating Professional." *AACE International Transactions*, DE11.

Houseman, O. W., Coley, F., and Roy, R. (2006). "Capturing How Cost Engineers Think." *AACE International Transactions*, 5.1-5.8.

Jensen, P. E. (2005). "A contextual theory of learning and the learning organization." *Knowledge and Process Management*, 12(1), 53-53-64.

Jeong, H. S., Oberlender, G. D., Alroomi, A., Chong, W., and Liu, L. (2010). "Estimating as a Competency in Capital Projects." Construction Industry Institute.

Joo, B., and Lim, T. (2009). "The Effects of Organizational Learning Culture, Perceived Job Complexity, and Proactive Personality on Organizational Commitment and Intrinsic Motivation." 48.

Jöreskog, K. G., and Sörbom, D. (1993). "*LISREL 8: structural equation modeling with the SIMPLIS command language.*" Scientific Software International ;Distributed by L. Erlbaum Associates, Chicago, Ill. :Hillsdale, N.J., xxvi, 226 p.

Kivrak, S., Arslan, G., Dikmen, I., and Birgonul, M. T. (2008). "Capturing Knowledge in Construction Projects: Knowledge Platform for Contractors." *Journal of Management in Engineering*, 24(2), 87-95.

Kline, R. B. (2011). "Principles and practice of structural equation modeling." Guilford Press, New York, xvi, 427 p.

Ko, D.-G., Kirsch, L. J., and King, W. R. (2005). "Antecedents of Knowledge Transfer from Consultants to Clients in Enterprise System Implementation." *MIS Quarterly*, 29(1), 59.

Kogut, B., and Zander, U. (1992). "knowledge of the firm, combinative capabilities, and the replication of technology" Organization Science, INFORMS: Institute for Operations Research, 383-397.

Kozlowski, S. W. J., and Farr, J. L. (1988). "An Integrative Model of Updating and Performance." *Human Performance*, 1(1), 5.

Kozlowski, S. W. J., and Hults, B. M. (1987). "An Exploration of Climates for Technical Updating and Performance." *Personnel Psychology*, 40(3), 539-539.

Kozlowski, S. W. J., and Salas, E. (2010). "Learning, training, and development in organizations." Routledge, New York, xxvii, 517 p.

Kram, K. E., and Isabella, L. A. (1985). "Mentoring Alternatives: The Role of Peer Relationships in Career Development." *The Academy of Management Journal*, 28(1), 110-132.

Lien, B. Y.-H., Hung, R. Y.-Y., Yang, B., and Li, M. (2006). "Is the learning organization a valid concept in the Taiwanese context?" *International Journal of Manpower*, 27(2), 189-189-203.

Love, P. E. D., Li, H., Irani, Z., and Faniran, O. (2000). "Total quality management and the learning organization: a dialogue for change in construction." *Construction Management & Economics*, Routledge, 321-331.

Lowe, D., and Skitmore, M. (1994). "Experiential learning in cost estimating." *Construction Management and Economics*, 12(5), 423.

Marsick, V. J., and Watkins, K. E. (1999). "Facilitating learning organizations : making learning count." Gower, Aldershot, Hampshire, England ;Brookfield, Vt., USA, xii, 222 p.

Marsick, V. J., and Watkins, K. E. (2003). "Demonstrating the Value of an Organization's Learning Culture: The Dimensions of the Learning Organization Questionnaire." *Advances in Developing Human Resources*, 5(2), 132-151.

McQuillen, J. L. (1986). Motivating the Civil Engineer, *ASCE*.

Merrow, E. W., and Schroeder, B. R. (1991). "Understanding the Costs and Schedule of Hydroelectric Projects." American Association of Cost Engineers. *Transactions of the American Association of Cost Engineers*, I3(1).

Myatt, G. J. (2007c). Making sense of data: a practical guide to exploratory data analysis and data mining, Wiley-Interscience, Hoboken, N.J.

Noe, R. A. (2008). "*Employee training and development*" McGraw-Hill/Irwin, New York, NY, xv, 536 p.

Nonaka, I. (1994). "A Dynamic Theory of Organizational Knowledge Creation." Organization Science, INFORMS: Institute for Operations Research, 14-37.

Nonaka, I., and Takeuchi, H. (1995). "The knowledge-creating company : how Japanese companies create the dynamics of innovation." Oxford University Press, New York, xii, 284 p.

Nunnally, J. C. (1978). "*Psychometric theory."* McGraw-Hill, New York, xv, 701 p.

O'Dell, C., and Grayson, C. J. (1998). "If only we knew what we know: Identification and transfer of internal best practices." *California Management Review*, 40(3), 154.

Ogunlana, O. (1991). "Learning from Experience in Design Cost Estimating." *Construction Management and Economics*, 9(2), 133.

Oliver, R. W. (2001). "The return on human capital." *The Journal of Business Strategy*, 22(4), 7.

Osterloh, M., and Frey, B. S. (2000). "Motivation, knowledge transfer, and organizational forms." *Organization Science*, 11(5), 538.

Pasher, E., and Ronen, T. (2011). "*The complete guide to knowledge management: A strategic plan to leverage your company's intellectual capital*" John Wiley, Hoboken, N.J., xvii, 204 p.

Pedler, M., Burgoyne, J., and Boydell, T. (1991). "The learning company : a strategy for sustainable development." McGraw-Hill, London ;New York, x, 213 p.

Russell, R. J. (2003c). Guide to hiring and retaining great civil engineers (No. 103), American Society of Civil Engineers.

Rencher, A. C. (2002). Methods of Multivariate Analysis, Wiley, New York.

Ryan, R. M., and Deci, E. L. (2000). "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions." *Contemporary Educational Psychology*, 25(1), 54-67.

Skitmore, M. (1988). "Factors Affecting Accuracy Of Engineers' Estimates." *Cost Engineering*, 30(10), 16.

Senge, P. M. (1990). "The fifth discipline : the art and practice of the learning organization." Doubleday/Currency, New York, viii, 424 p.

Senge, P. M. (2006). "*The fifth discipline: the art and practice of the learning organization."* Currency Doubleday, New York, N.Y. ;London, xviii, 445 p.

Skitmore, M. (1988). "Factors Affecting Accuracy Of Engineers' Estimates." *Cost Engineering*, 30(10), 16.

Snyder, W. M. (1996). "Organization learning and performance: An exploration of the linkages between organization learning, knowledge, and performance," Ph.D., University of Southern California, United States -- California.

Song, J. (2008). "The integrative determinants of organizational performance improvement: The impacts of dimensions of learning organization and dynamic knowledge creation." The Pennsylvania State University, United States -- Pennsylvania, 183.

Styhre, A., Josephson, P.-E., and Knauseder, I. (2004). "Learning capabilities in organizational networks: case studies of six construction projects." Construction Management & Economics, Routledge, 957-966.

Tabassi, A. A., Ramli, M., and Bakar, A. H. A. (2011). "Effects of training and motivation practices on teamwork improvement and task efficiency: The case of construction firms." *International Journal of Project Management*, 30(2), 213-224.

Tierney, P., Farmer, S. M., and Graen, G. B. (1999). "An examination of leadership and employee creativity: The relevance of traits and relationships." *Personnel Psychology*, 52(3), 591.

Trost, S. M., and Oberlender, G. D. (2003). "Predicting accuracy of early cost estimates using factor analysis and multivariate regression." *Journal of Construction Engineering and Management-ASCE*, 129(2), 198-204.

Vestal, W. (2006). "Sustaining: communities of practice." KM World, 15(3), 8-40.

Watkins, K. E., and Marsick, V. J. (1993). "Sculpting the learning organization : lessons in the art and science of systemic change." Jossey-Bass management series, Jossey-Bass, San Francisco, Calif., xxiv, 298 p.

Weston, N. J. V., Greenlees, I. A., and Thelwell, R. C. "*The Impact of a Performance Profiling Intervention on Athletes' Intrinsic Motivation"* Research Quarterly for Exercise and Sport, 82(1), 151-5.

Wong, P. S. P., Cheung, S. O., and Leung, K. Y. (2008). "Moderating Effect of Organizational Learning Type on Performance Improvement." *Journal of Management in Engineering, American Society of Civil Engineers*, 162-172.

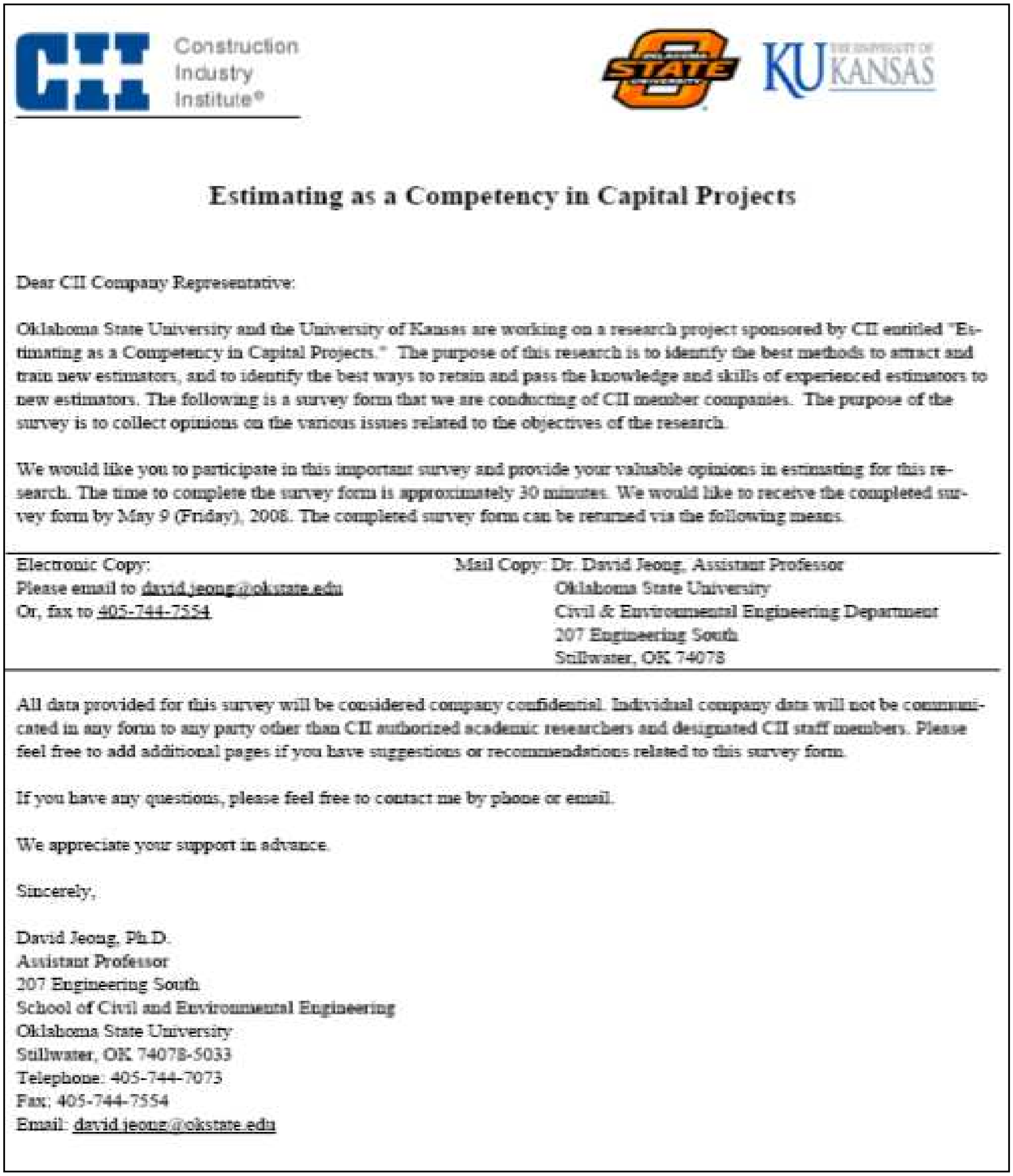
Yang, B., Watkins, K. E., and Marsick, V. J. (2004). "The construct of the learning organization: Dimensions, measurement, and validation." *Human Resource Development Quarterly*, 15(1), 31-55.

Zack, J. G. (2007). "Cost Estimating - A Dying Art?" Cost Engineering, 49(1), 3.

Zhang, D., Zhen, Z., and Baiyin, Y. (2004). "*Learning organization in mainland China: empirical research on its application to Chinese state-owned enterprises."* International Journal of Training & Development, Wiley-Blackwell, 258-273.

APPENDIX A

“ESTIMATING AS A COMPETENCY IN CAPITAL PROJECTS” SURVEY



Construction
Industry
Institute®

Estimating as a Competency in Capital Projects

Dear CII Company Representative:

Oklahoma State University and the University of Kansas are working on a research project sponsored by CII entitled "Estimating as a Competency in Capital Projects." The purpose of this research is to identify the best methods to attract and train new estimators, and to identify the best ways to retain and pass the knowledge and skills of experienced estimators to new estimators. The following is a survey form that we are conducting of CII member companies. The purpose of the survey is to collect opinions on the various issues related to the objectives of the research.

We would like you to participate in this important survey and provide your valuable opinions in estimating for this research. The time to complete the survey form is approximately 30 minutes. We would like to receive the completed survey form by May 9 (Friday), 2008. The completed survey form can be returned via the following means.

Electronic Copy:
Please email to david.jeong@okstate.edu
Or, fax to 405-744-7554

Mail Copy: Dr. David Jeong, Assistant Professor
Oklahoma State University
Civil & Environmental Engineering Department
207 Engineering South
Stillwater, OK 74078

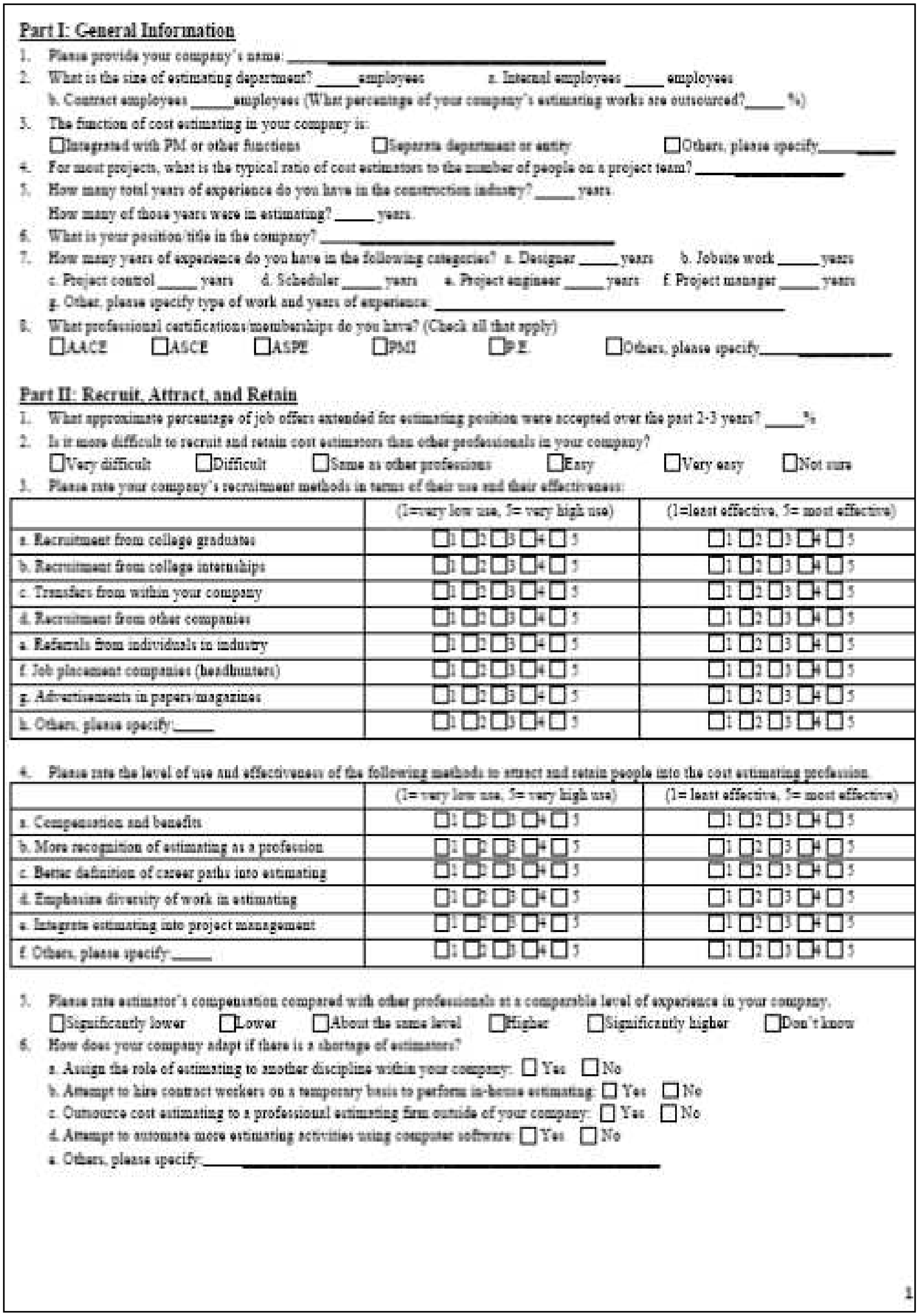
All data provided for this survey will be considered company confidential. Individual company data will not be communicated in any form to any party other than CII authorized academic researchers and designated CII staff members. Please feel free to add additional pages if you have suggestions or recommendations related to this survey form.

If you have any questions, please feel free to contact me by phone or email.

We appreciate your support in advance.

Sincerely,

David Jeong, Ph.D.
Assistant Professor
207 Engineering South
School of Civil and Environmental Engineering
Oklahoma State University
Stillwater, OK 74078-5033
Telephone: 405-744-7073
Fax: 405-744-7554
Email: david.jeong@okstate.edu



Part I: General Information

1. Please provide your company's name: ______________________

2. What is the size of estimating department? _____employees a. Internal employees _____ employees
b. Contract employees _____employees (What percentage of your company's estimating works are outsourced?_____ %)

3. The function of cost estimating in your company is:
☐Integrated with PM or other functions ☐Separate department or entity ☐Others, please specify__________

4. For most projects, what is the typical ratio of cost estimators to the number of people on a project team? __________

5. How many total years of experience do you have in the construction industry? _____ years.
How many of those years were in estimating? _____ years.

6. What is your position/title in the company? ______________________

7. How many years of experience do you have in the following categories? a. Designer _____ years b. Jobsite work _____ years
c. Project control _____ years d. Scheduler _____ years e. Project engineer _____ years f. Project manager _____ years
g. Other, please specify type of work and years of experience: ______________________

8. What professional certifications/memberships do you have? (Check all that apply)
☐AACE ☐ASCE ☐ASPE ☐PMI ☐P.E. ☐Others, please specify__________

Part II: Recruit, Attract, and Retain

1. What approximate percentage of job offers extended for estimating position were accepted over the past 2-3 years? _____%

2. Is it more difficult to recruit and retain cost estimators than other professionals in your company?
☐Very difficult ☐Difficult ☐Same as other professions ☐Easy ☐Very easy ☐Not sure

3. Please rate your company's recruitment methods in terms of their use and their effectiveness:

	(1=very low use, 5= very high use)	(1=least effective, 5= most effective)
a. Recruitment from college graduates	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
b. Recruitment from college internships	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
c. Transfers from within your company	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
d. Recruitment from other companies	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
e. Referrals from individuals in industry	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
f. Job placement companies (headhunters)	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
g. Advertisements in papers/magazines	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
h. Others, please specify:_____	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5

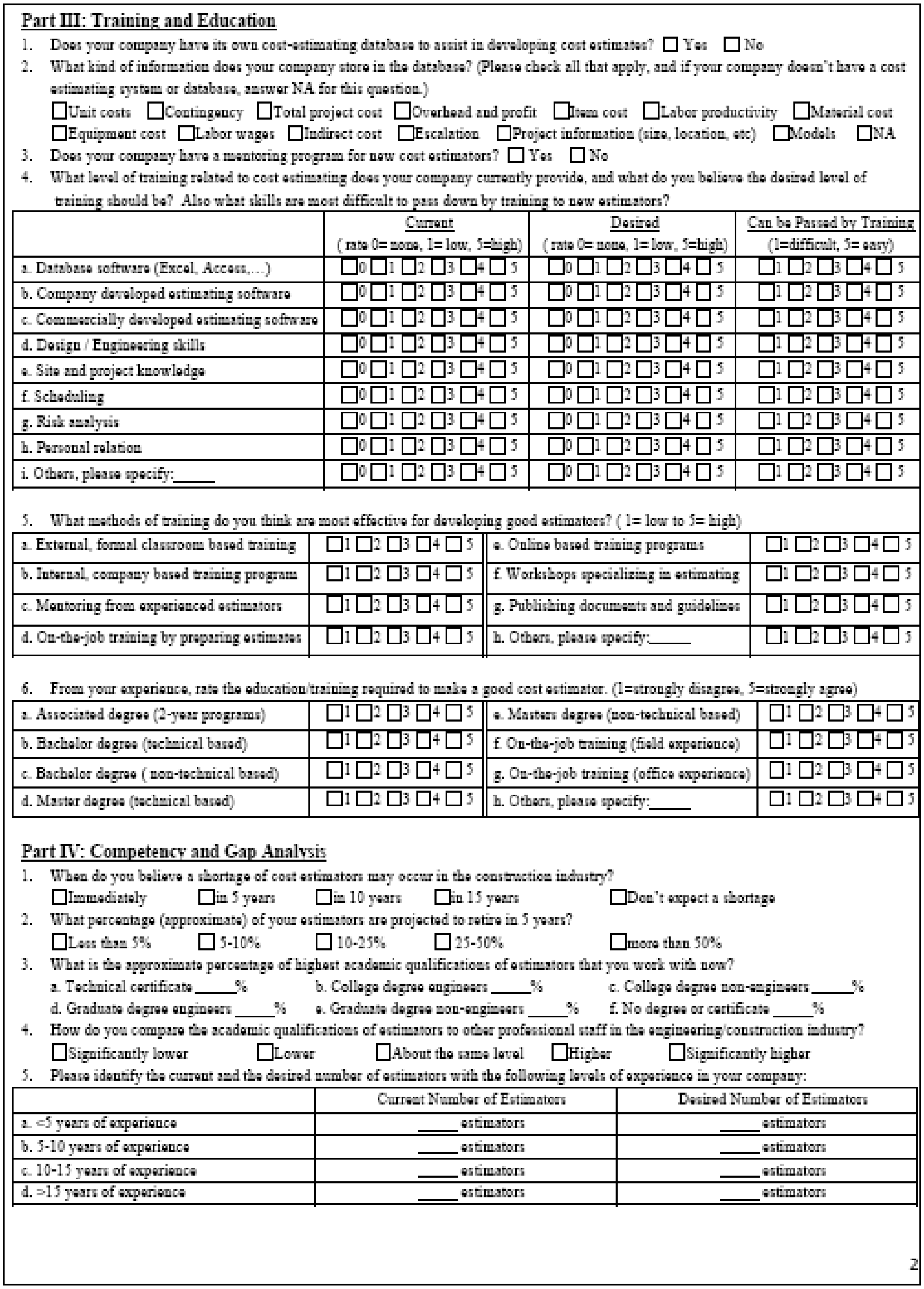
4. Please rate the level of use and effectiveness of the following methods to attract and retain people into the cost estimating profession.

	(1= very low use, 5= very high use)	(1= least effective, 5= most effective)
a. Compensation and benefits	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
b. More recognition of estimating as a profession	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
c. Better definition of career paths into estimating	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
d. Emphasize diversity of work in estimating	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
e. Integrate estimating into project management	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
f. Others, please specify:_____	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5

5. Please rate estimator's compensation compared with other professionals at a comparable level of experience in your company.
☐Significantly lower ☐Lower ☐About the same level ☐Higher ☐Significantly higher ☐Don't know

6. How does your company adapt if there is a shortage of estimators?
a. Assign the role of estimating to another discipline within your company: ☐ Yes ☐ No
b. Attempt to hire contract workers on a temporary basis to perform in-house estimating: ☐ Yes ☐ No
c. Outsource cost estimating to a professional estimating firm outside of your company: ☐ Yes ☐ No
d. Attempt to automate more estimating activities using computer software: ☐ Yes ☐ No
e. Others, please specify:______________________

1



Part III: Training and Education

1. Does your company have its own cost-estimating database to assist in developing cost estimates? ☐ Yes ☐ No
2. What kind of information does your company store in the database? (Please check all that apply, and if your company doesn't have a cost estimating system or database, answer NA for this question.)
   ☐Unit costs ☐Contingency ☐Total project cost ☐Overhead and profit ☐Item cost ☐Labor productivity ☐Material cost
   ☐Equipment cost ☐Labor wages ☐Indirect cost ☐Escalation ☐Project information (size, location, etc) ☐Models ☐NA
3. Does your company have a mentoring program for new cost estimators? ☐ Yes ☐ No
4. What level of training related to cost estimating does your company currently provide, and what do you believe the desired level of training should be? Also what skills are most difficult to pass down by training to new estimators?

	Current (rate 0= none, 1= low, 5=high)	Desired (rate 0= none, 1= low, 5=high)	Can be Passed by Training (1=difficult, 5= easy)
a. Database software (Excel, Access,…)	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
b. Company developed estimating software	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
c. Commercially developed estimating software	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
d. Design / Engineering skills	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
e. Site and project knowledge	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
f. Scheduling	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
g. Risk analysis	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
h. Personal relation	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
i. Others, please specify:_____	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐0 ☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5

5. What methods of training do you think are most effective for developing good estimators? (1= low to 5= high)

a. External, formal classroom based training	☐1 ☐2 ☐3 ☐4 ☐ 5	e. Online based training programs	☐1 ☐2 ☐3 ☐4 ☐ 5
b. Internal, company based training program	☐1 ☐2 ☐3 ☐4 ☐ 5	f. Workshops specializing in estimating	☐1 ☐2 ☐3 ☐4 ☐ 5
c. Mentoring from experienced estimators	☐1 ☐2 ☐3 ☐4 ☐ 5	g. Publishing documents and guidelines	☐1 ☐2 ☐3 ☐4 ☐ 5
d. On-the-job training by preparing estimates	☐1 ☐2 ☐3 ☐4 ☐ 5	h. Others, please specify:_____	☐1 ☐2 ☐3 ☐4 ☐ 5

6. From your experience, rate the education/training required to make a good cost estimator. (1=strongly disagree, 5=strongly agree)

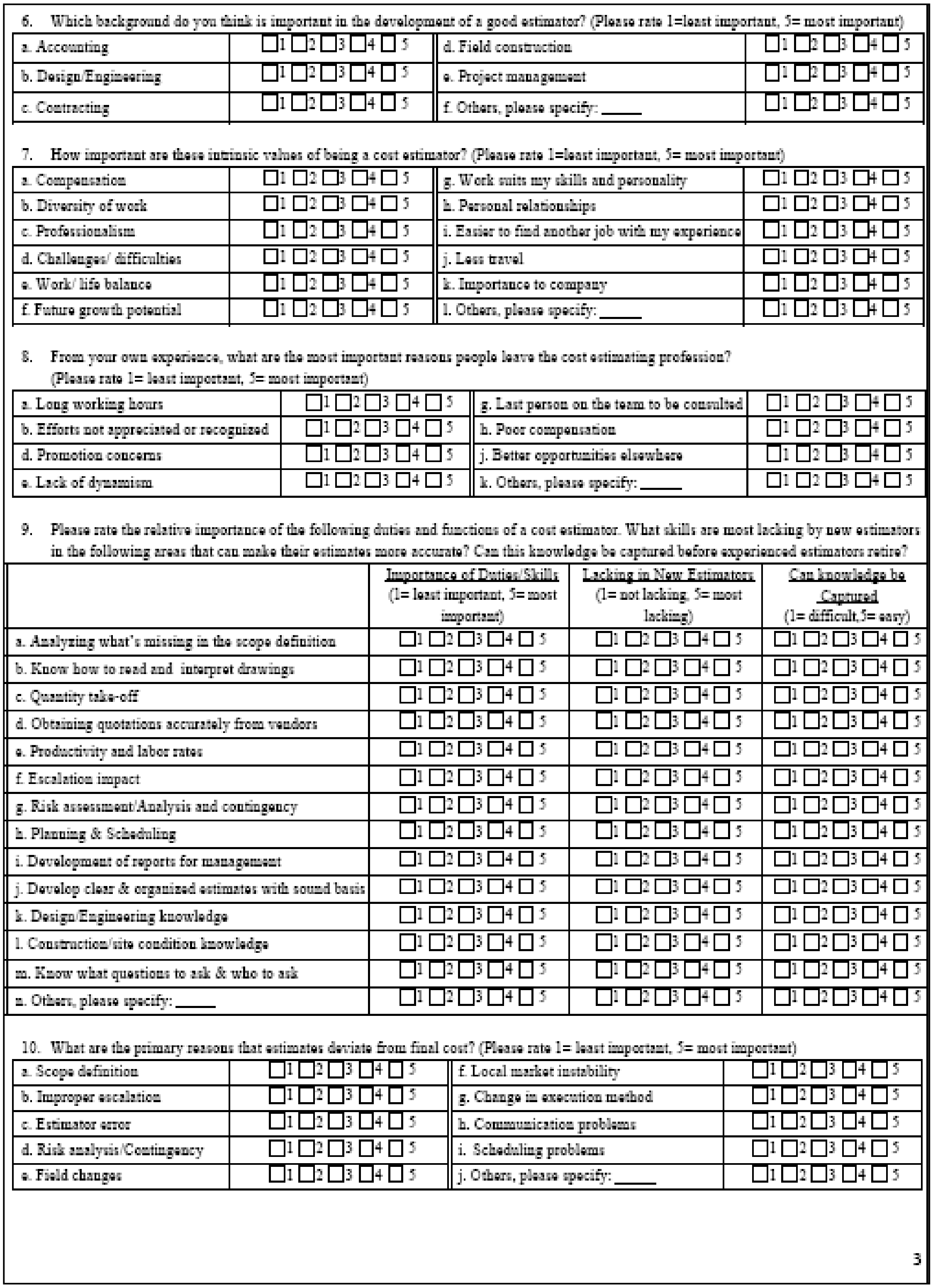
a. Associated degree (2-year programs)	☐1 ☐2 ☐3 ☐4 ☐ 5	e. Masters degree (non-technical based)	☐1 ☐2 ☐3 ☐4 ☐ 5
b. Bachelor degree (technical based)	☐1 ☐2 ☐3 ☐4 ☐ 5	f. On-the-job training (field experience)	☐1 ☐2 ☐3 ☐4 ☐ 5
c. Bachelor degree (non-technical based)	☐1 ☐2 ☐3 ☐4 ☐ 5	g. On-the-job training (office experience)	☐1 ☐2 ☐3 ☐4 ☐ 5
d. Master degree (technical based)	☐1 ☐2 ☐3 ☐4 ☐ 5	h. Others, please specify:_____	☐1 ☐2 ☐3 ☐4 ☐ 5

Part IV: Competency and Gap Analysis

1. When do you believe a shortage of cost estimators may occur in the construction industry?
   ☐Immediately ☐in 5 years ☐in 10 years ☐in 15 years ☐Don't expect a shortage
2. What percentage (approximate) of your estimators are projected to retire in 5 years?
   ☐Less than 5% ☐ 5-10% ☐ 10-25% ☐ 25-50% ☐more than 50%
3. What is the approximate percentage of highest academic qualifications of estimators that you work with now?
   a. Technical certificate _____% b. College degree engineers _____% c. College degree non-engineers _____%
   d. Graduate degree engineers _____% e. Graduate degree non-engineers _____% f. No degree or certificate _____%
4. How do you compare the academic qualifications of estimators to other professional staff in the engineering/construction industry?
   ☐Significantly lower ☐Lower ☐About the same level ☐Higher ☐Significantly higher
5. Please identify the current and the desired number of estimators with the following levels of experience in your company:

	Current Number of Estimators	Desired Number of Estimators
a. <5 years of experience	_____ estimators	_____ estimators
b. 5-10 years of experience	_____ estimators	_____ estimators
c. 10-15 years of experience	_____ estimators	_____ estimators
d. >15 years of experience	_____ estimators	_____ estimators

2



6. Which background do you think is important in the development of a good estimator? (Please rate 1=least important, 5= most important)

a. Accounting	☐1 ☐2 ☐3 ☐4 ☐5	d. Field construction	☐1 ☐2 ☐3 ☐4 ☐5
b. Design/Engineering	☐1 ☐2 ☐3 ☐4 ☐5	e. Project management	☐1 ☐2 ☐3 ☐4 ☐5
c. Contracting	☐1 ☐2 ☐3 ☐4 ☐5	f. Others, please specify: _____	☐1 ☐2 ☐3 ☐4 ☐5

7. How important are these intrinsic values of being a cost estimator? (Please rate 1=least important, 5= most important)

a. Compensation	☐1 ☐2 ☐3 ☐4 ☐5	g. Work suits my skills and personality	☐1 ☐2 ☐3 ☐4 ☐5
b. Diversity of work	☐1 ☐2 ☐3 ☐4 ☐5	h. Personal relationships	☐1 ☐2 ☐3 ☐4 ☐5
c. Professionalism	☐1 ☐2 ☐3 ☐4 ☐5	i. Easier to find another job with my experience	☐1 ☐2 ☐3 ☐4 ☐5
d. Challenges/ difficulties	☐1 ☐2 ☐3 ☐4 ☐5	j. Less travel	☐1 ☐2 ☐3 ☐4 ☐5
e. Work/ life balance	☐1 ☐2 ☐3 ☐4 ☐5	k. Importance to company	☐1 ☐2 ☐3 ☐4 ☐5
f. Future growth potential	☐1 ☐2 ☐3 ☐4 ☐5	l. Others, please specify: _____	☐1 ☐2 ☐3 ☐4 ☐5

8. From your own experience, what are the most important reasons people leave the cost estimating profession? (Please rate 1= least important, 5= most important)

a. Long working hours	☐1 ☐2 ☐3 ☐4 ☐5	g. Last person on the team to be consulted	☐1 ☐2 ☐3 ☐4 ☐5
b. Efforts not appreciated or recognized	☐1 ☐2 ☐3 ☐4 ☐5	h. Poor compensation	☐1 ☐2 ☐3 ☐4 ☐5
d. Promotion concerns	☐1 ☐2 ☐3 ☐4 ☐5	j. Better opportunities elsewhere	☐1 ☐2 ☐3 ☐4 ☐5
e. Lack of dynamism	☐1 ☐2 ☐3 ☐4 ☐5	k. Others, please specify: _____	☐1 ☐2 ☐3 ☐4 ☐5

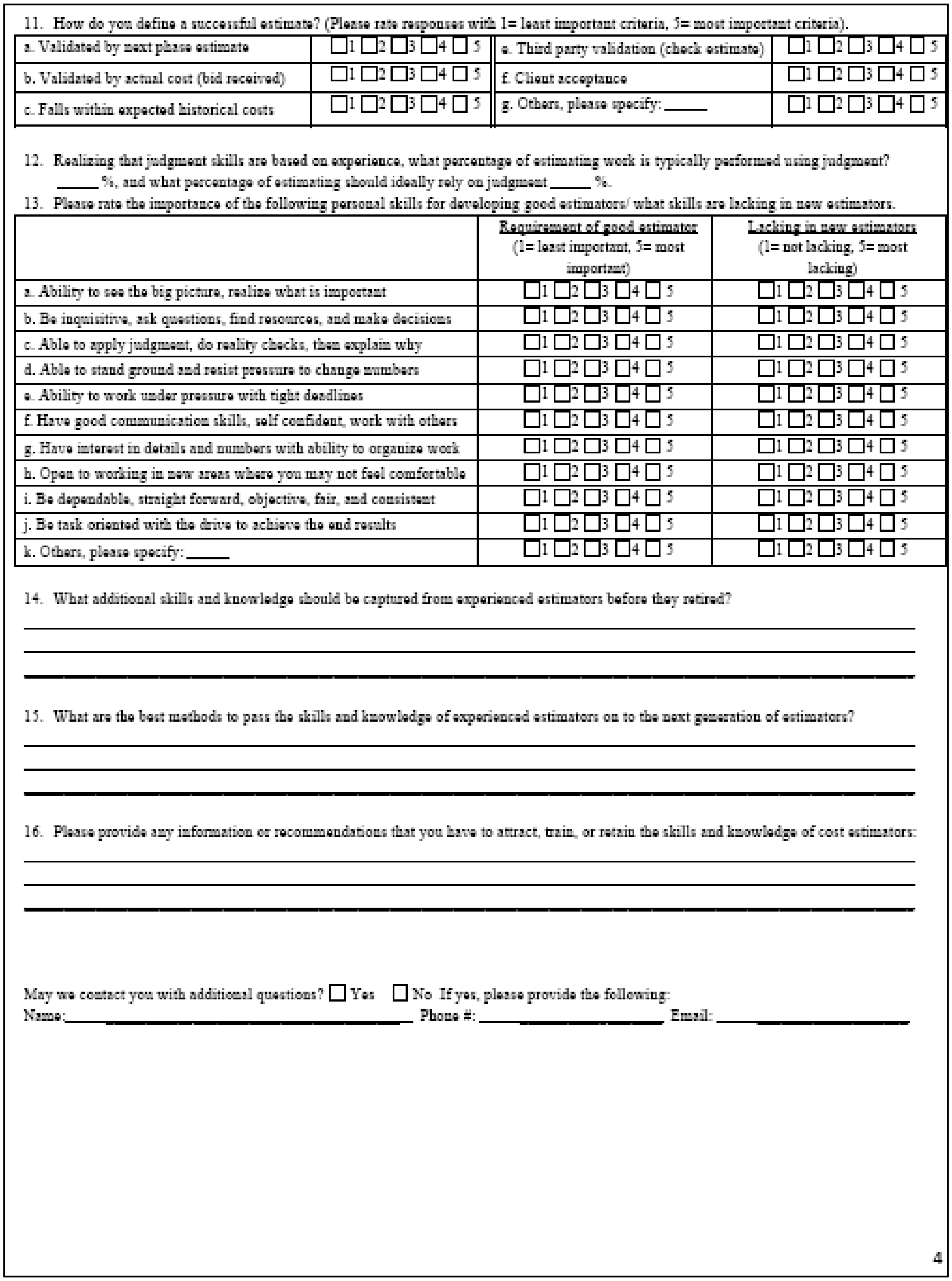
9. Please rate the relative importance of the following duties and functions of a cost estimator. What skills are most lacking by new estimators in the following areas that can make their estimates more accurate? Can this knowledge be captured before experienced estimators retire?

	Importance of Duties/Skills (1= least important, 5= most important)	Lacking in New Estimators (1= not lacking, 5= most lacking)	Can knowledge be Captured (1= difficult, 5= easy)
a. Analyzing what's missing in the scope definition	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
b. Know how to read and interpret drawings	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
c. Quantity take-off	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
d. Obtaining quotations accurately from vendors	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
e. Productivity and labor rates	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
f. Escalation impact	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
g. Risk assessment/Analysis and contingency	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
h. Planning & Scheduling	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
i. Development of reports for management	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
j. Develop clear & organized estimates with sound basis	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
k. Design/Engineering knowledge	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
l. Construction/site condition knowledge	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
m. Know what questions to ask & who to ask	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
n. Others, please specify: _____	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5

10. What are the primary reasons that estimates deviate from final cost? (Please rate 1= least important, 5= most important)

a. Scope definition	☐1 ☐2 ☐3 ☐4 ☐5	f. Local market instability	☐1 ☐2 ☐3 ☐4 ☐5
b. Improper escalation	☐1 ☐2 ☐3 ☐4 ☐5	g. Change in execution method	☐1 ☐2 ☐3 ☐4 ☐5
c. Estimator error	☐1 ☐2 ☐3 ☐4 ☐5	h. Communication problems	☐1 ☐2 ☐3 ☐4 ☐5
d. Risk analysis/Contingency	☐1 ☐2 ☐3 ☐4 ☐5	i. Scheduling problems	☐1 ☐2 ☐3 ☐4 ☐5
e. Field changes	☐1 ☐2 ☐3 ☐4 ☐5	j. Others, please specify: _____	☐1 ☐2 ☐3 ☐4 ☐5

3



11. How do you define a successful estimate? (Please rate responses with 1= least important criteria, 5= most important criteria).

a. Validated by next phase estimate	☐1 ☐2 ☐3 ☐4 ☐ 5	e. Third party validation (check estimate)	☐1 ☐2 ☐3 ☐4 ☐ 5
b. Validated by actual cost (bid received)	☐1 ☐2 ☐3 ☐4 ☐ 5	f. Client acceptance	☐1 ☐2 ☐3 ☐4 ☐ 5
c. Falls within expected historical costs	☐1 ☐2 ☐3 ☐4 ☐ 5	g. Others, please specify: ______	☐1 ☐2 ☐3 ☐4 ☐ 5

12. Realizing that judgment skills are based on experience, what percentage of estimating work is typically performed using judgment? ______ %, and what percentage of estimating should ideally rely on judgment ______ %.

13. Please rate the importance of the following personal skills for developing good estimators/ what skills are lacking in new estimators.

	Requirement of good estimator (1= least important, 5= most important)	Lacking in new estimators (1= not lacking, 5= most lacking)
a. Ability to see the big picture, realize what is important	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
b. Be inquisitive, ask questions, find resources, and make decisions	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
c. Able to apply judgment, do reality checks, then explain why	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
d. Able to stand ground and resist pressure to change numbers	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
e. Ability to work under pressure with tight deadlines	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
f. Have good communication skills, self confident, work with others	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
g. Have interest in details and numbers with ability to organize work	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
h. Open to working in new areas where you may not feel comfortable	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
i. Be dependable, straight forward, objective, fair, and consistent	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
j. Be task oriented with the drive to achieve the end results	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5
k. Others, please specify: ______	☐1 ☐2 ☐3 ☐4 ☐ 5	☐1 ☐2 ☐3 ☐4 ☐ 5

14. What additional skills and knowledge should be captured from experienced estimators before they retired?

15. What are the best methods to pass the skills and knowledge of experienced estimators on to the next generation of estimators?

16. Please provide any information or recommendations that you have to attract, train, or retain the skills and knowledge of cost estimators:

May we contact you with additional questions? ☐ Yes ☐ No If yes, please provide the following:
Name:______ Phone #: ______ Email: ______

4

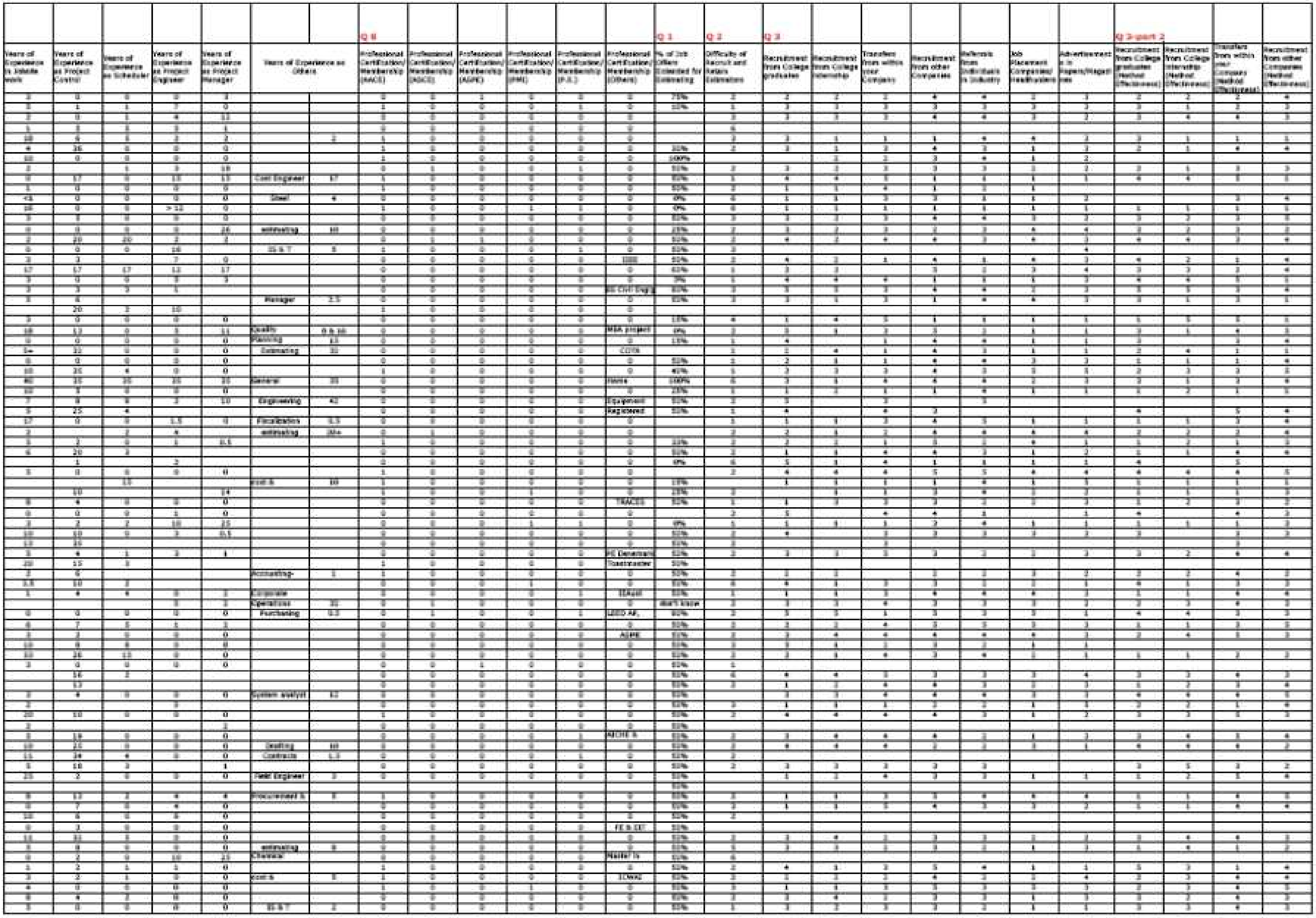
APPENDIX B

““ESTIMATING AS A COMPETENCY IN CAPITAL PROJECTS” RAW DATA

Follow-up Survey Data				Q1-2	Q 2				Q 3			Q 4	Q 5		Q 6	Q 7
What industry sector your company involved in	Q2	Q3	Q4	What industry sector your company involved in	Size of Estimating Department	Internal Employees	Contract Employees	% of Estimating Work Outsourced	Function of Cost Estimating (Integrated with PM or other function)	Function of Cost Estimating (Separate department or entity)	Function of Cost Estimating (Others)	Ratio of Estimators to Project Team	Years of Experience in Construction	Years of Experience in Estimating	Position/Title	Years of Experience as Designer
1	1	1	3		8	8	0	0	0	1		1/5	23	17	Vice President of	0
					25	25	10		1	0	part of technology	1/25	26	10	Cost Engineering	1
					<100	100	0	0	0	1	0	1/5	20	2	Vice President	0
					1	1		0	1	0	0	1/40	5	1	Project Engineer	1
					31	30	1		0	1	0	1/15	25	1	Project Controls Manager	0
					30	30	0	0	0	1	0	1/50	40	36	Chief Estimator	0
3	3	2	3		2	2			1	0	0	1/10	31	15	Senior Estimator	0
					4	4		0	0	1	0	1/40	27	5	Project Manager	3
3	2	2	3			70%	30%	<1	1	1	0	1/12	40+	40+	Global Cost Engineering	0
3	1	2	1		9	7	2	5	0	1	0	3/20	36	20	Supervisor Construction	16
3	1	2	3		7		2		0	1	0	1/7 or 3/10	29	29	Supervisor	5
					0	0	0	20	0	0	programming/ Asset	0	28	0	Senior Project Engineer	0
3	2	1	3		24	24	0	0	0	1		4-8%	16	10	Regional Estimating	0
5	2	1	2		15	15	0	0	0	1		1:as needed	26	10	Civil Project Estimator –	0
5	2	2	2		15	13	0	0	1	0			34	24	Managing Estimator	3
5	2	1	2		200	180	20	0	0	0	Integrated with project	most projects don't have	34	13	Lead Discipline Estimator	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	26	10	Estimator	3
3	1	2	3		100	100	0	0	1	1		10%	27	10	Director of Estimating	
					10	10	0	0	0	1	0	1/10	29	19	Estimating Manager	0
					31	23	1	0	0	1	0	1/10	30	30	Senior Estimator	
					31	30	1	0	0	1	0	1/15	26	25	Manager of Estimating	
					3	3	0	0	0	1	0	1/12	32	20	Senior Estimator	
3	1	2	3		7	7	0	0	0	1	0	10%	27	24	Manager of Estimating	0
					78	41	37	0	0	1	0	5	37	20	Consultant	0
					78	41	37	0	1	1	0	5	1.5	1.5	Data Bank Coordinator	0
5	2	2	3		5	4	1	30	0	1	0		32	32	Architect/Senior Estimator	0
3	2	2	3		4	4	0	0	0	1	0	1 or 2	43	43	Manager of Estimating	0
					26	26	0	0	1	0	0		38	30	Manager of Estimating	0
					1	1	0	10	1	1	0	1/3	40	35	Estimator	35
					5	4	1	25	0	1	0	1/4	30	16	Engineering Technician	0
					72	42	30	41.6	0	1	0	6	35	20	Estimation Coordinator for	15
					200	180	20	0	0	0	Integrated with project	most projects don't have	30	10	Project Estimating	6
					78	41	37	0	0	1	0	3%	19	2	Coordinator	0.5
					9	9	0	0	0	1	0	5-10%	28	20+	Estimating Department	
					10	9	1	0	0	1	0	1/11	18	12.5	Estimating Manager	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	40	7	Manager of Estimating	6
					78	41	37	0	0	1	0	5	1	1	Mechanical Engineering	2
5	1	1	2		12	12	0	0	1	0	0		30	25	Estimating Manager	0
					78	41	37	0	0	1	0	5	29	15	Cost & Schedule Manager	
3		2	1		2	45	23	100	1	0	0	10%	24	0	President	
1	1	1	1		5	4	1	10	0	1	0	1/6	12	4	Senior Cost	0
					80	40	40	0	0	1	0		1	0.3	Equipment Engineer	0
					2	35	1	6	1	0	0		25	0	Vice President	2
					200	180	20	0	0	0	Integrated with project	most projects don't have	25	22	Chief Estimator	3
					200	180	20	0	0	0	Integrated with project	most projects don't have	25	5	Project Controls Manager	
					200	180	20	0	0	0	Integrated with project	most projects don't have	34	18	Project Estimator	3
					200	180	20	0	0	0	Integrated with project	most projects don't have	39	21	Senior Estimator	
					200	180	20	0	0	0	Integrated with project	most projects don't have	5	3	Estimator	
					200	180	20	0	0	0	Integrated with project	most projects don't have	10	5	Project Estimator	1.5
					200	180	20	0	0	0	Integrated with project	most projects don't have	19	10	Senior Estimator	2
3	2	2	2		10	10	0	0	0	1	0	1/4	39	37	Regional Manager	
1	1	2	3		9	9	1	10	0	1	0	1/2	10	9.5	Senior Project Estimator	0
3	1	2	3		1	1	0	25	0	0	Project Controls	We currently only have	9.5	3 to 5	Lead Estimator	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	7	2	Mechanical Startup	2
					200	180	20	0	0	0	Integrated with project	most projects don't have	18	8	Senior Estimator I	0
2	2	1	3		200	180	20	0	0	0	Integrated with project	most projects don't have	33	4	Joint Venture Estimatin	0
5	2	2	3		200	180	20	0	0	0	Integrated with project	most projects don't have	38	38	Senior Estimator	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	18	1	Project Estimator	
					200	180	20	0	0	0	Integrated with project	most projects don't have	27	13	Chief Estimator	14
					200	180	20	0	0	0	Integrated with project	most projects don't have	4	4	Piping Estimator	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	16	9	Estimator	
					200	180	20	0	0	0	Integrated with project	most projects don't have	30	15	Project Controls Manager	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	34	30	Senior Project Estimator	
					200	180	20	0	0	0	Integrated with project	most projects don't have	39	20	Estimating Manager	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	30	15	Change Control &	5
					200	180	20	0	0	0	Integrated with project	most projects don't have	36	6	Project Estimator	0
2	1	1	2		200	180	20	0	0	0	Integrated with project	most projects don't have	28	3	Chief Estimator	1
					200	180	20	0	0	0	Integrated with project	most projects don't have	30	16	Estimating Manager for	0
					200	180	20	0	0	0	Integrated with project	most projects don't have				
					200	180	20	0	0	0	Integrated with project	most projects don't have	28	26	Senior Estimator	5
					200	180	20	0	0	0	Integrated with project	most projects don't have	30	30	Senior Estimator	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	38	16	Senior Estimator	0
2	1	2	2		200	180	20	0	0	0	Integrated with project	most projects don't have	2	2	Mechanical Estimator	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	37	8	Project Estimator/	0
					45	3	0	25	0	0	Integrated with project	most projects don't have	10	0	Discipline Estimator	20
					200	180	20	0	0	0	Integrated with project	most projects don't have	25	25	Senior Project Estimator	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	6	4	Associate Project	0
					200	180	20	0	0	0	Integrated with project	most projects don't have		16	Chief Estimator	0
3	1	2	3		200	180	20	0	0	0	Integrated with project	most projects don't have	18	12	Senior Estimator	0
5	1	1	3		200	180	20	0	0	0	Integrated with project	most projects don't have	30	16	Project Estimating	0
					200	180	20	0	0	0	Integrated with project	most projects don't have	18	10	Chief Estimator	10

Follow-up Survey Data				Q1-2	Q 2				Q 3			Q 4	Q 5		Q 6	Q 7
What industry sector your company involved in	Q2	Q3	Q4	What industry sector your company involved in	Size of Estimating Department	Internal Employees	Contract Employees	% of Estimating Work Outsourced	Function of Cost Estimating (Integrated with PM or other function)	Function of Cost Estimating (Separate department or entity)	Function of Cost Estimating (Others)	Ratio of Estimators to Project Team	Years of Experience in Construction	Years of Experience in Estimating	Position/Title	Years of Experience as Designer
					300	180	20	0	0	0	Integrated with project	most projects don't have	40	15	Senior Estimator	0
5	4	1	3		3	150	0	0	1	0	0	1/10	35	15+	Project Director &	0
					300	180	20	0	0	0	Integrated with project	most projects don't have	38	32	Estimating Department	4
5	4	2	3		300	180	20	0	0	0	Integrated with project	most projects don't have	35	15	Senior Estimator	0
					14	14	0	25	0	1	0	1/9	30	22	Chief, Civil Works Cost	1
1	4	2	2		13	13	0	50	0	1	0	1/13	28	2	Cost Engineering	10
					5	5	0	1	0	1	0	1/5	30	1	civil engineer	1
1	4	1	3		5	5	0	80	0	1	0	1/20	12	7	Mechanical Engineering	0
						4	0	10	0	1	0	10%	15	8	Cost Engineering	
2	4	2	2		8	100	0		0	1	0	1/20		2	Civil engineer	2
					1	1	0	0	0	1	0	0	30	20	Regional Cost Engineer	15
					300	30	0	10	1	0	0	1/5	24	20	civil engineer/ cost	5
						15	0	15	0	1	0	1/10	8	20	chief civil engineering	8
3	4	2	3		7	7	0	10	0	1	0	1/9	24	12	Senior Cost Estimator	0
3	4	2	3		10	10	1	0	0	1	0	0.10	35	30	Manager of Estimating	0
					300	180	20	0	0	0	Integrated with project	most projects don't have	40	33	Estimating Supervisor	0
					300	180	20	0	0	0	Integrated with project	most projects don't have	36	10	Civil Discipline Estimating	26
					300	180	20	0	0	0	Integrated with project	most projects don't have	22	18	Estimating Manager	6
					3	3	0	10	0	1	0	1/10	30	17	chief, construction and	18
5	4	1	3		3	3	0	25	0	0	Design Branch	1/7 or 1/10	38	30	chief cost engineering	1
					7	7	0	0	0	1	0	1/20 or 1/50	33	16	Manager of Estimating	0
					8	7	1	0	1	0	0	1/20	30	10	Senior Cost Estimator	10
					3	3	0	0	1	0	0	UNK	6	8.5		0
5	4	1	2		6	114	0	0	0	1	0		30	12	cost estimator	0
					1	1	0	5	1	0	0	1/5	37	10	Estimating Manager	0
					13	13	0	0	1	0	0	1	20	10	Cost Engineering	0
3	4	1	3		80	10	70	80	0	1	0	1/20	31	10	Manager project control	0
1	4	1	3		300	300	10	70	0	1	0	1	36	13	Tri-Service Certified Cost	8
3	3	2	1		3	3	0	70	1	0	0	don't know	30	1	Director	0
3	4	2	3		10		0	50	1	0	0	1/15	23	5	Manager engineering best	7
					3			80	1	0	0	1/30	35	15	Senior Estimator/scheduler	0
						3	0	70	1	0	0	1/5	38	3	Manager Project	0
					4	4	0	25	1	0	0	1/10	5	14	lead cost engineer	0
					15	14	1	10	0	1	0	1/10	30	5	Estimating Manager	0
3	4	1	1		17	2	15	95	0	1	0	3%	35	15	Manager project control	0
					2	165	2	0	1	0	0	1/15	36	6	Senior Assoc.	3
					10	10		0	1	1	0	1/8	35	23	project controls, material	0
					6	6	0	20	0	1	0	1/5	34	1	cost estimator	28
					9	9	0		0	1	0	7/12	8	8	civil engineer/ cost	7
1				Building Construction	50	80	5	5	1	0	0	N/A	36	30	Chief Executive Officer	0
1				Building Construction	26	26	0	0	0	1	0	1/3	18	7	Preconstruction Director	0
5	4	2	2	Building Construction	1				0	0	cost consulting	1/1	33	15	President	0
1				Building Construction	16	16	0	0	0	1	0	3%	29	24	Chief Estimator	0
3				Building Construction -	2	1	2	15	0	1	0	33%	19	19	owner	
				Architect	2	2	0	80	0	1	0		43	40	senior estimator	0
1				Building Construction	12			0	0	1	0		30	20	senior mechanical	0
5	4	1	3	Building construction	5	5	0	0	0	1	0	1/10	33	23	chief estimator	0
1	3	2	3	Building construction	3	3			0	1	0	1	29	6	project lead estimator	15
1	3	1	3	Building construction	3		1		1	0	0	1/4	30	15	senior estimator	3
1				Building construction	1	1			0	1	0	100%	13	10	Estimator/Owner	0.25
5		1	1	Building construction	8	8			0	1	0	1/4	34	22	Director of Preconstruction	0
1	4	2	3	Building construction	3	3	0	0	0	1	0	1	38	31	Senior Preconstruction	0
1	4	1	3	Consultant					1	0	0		30	25	cost consultant	0
1	4	2	3	Building construction	3		4		1	0	provide estimating to architect	100%	31	16	president	0
3	4	2	3	Building Construction -	2	4	1	0	1	0	0		36	31	estimator	0
3				Process Industry					0	1	0		39	20	retired consulting	18
				Others	20	15	5	5	0	1	0	2%	25	20	Chief project control	0
3				Industrial/Manufacturing	80	80	0	0	1	0	0	1%	13	7	Estimator	0
5	4	1	3	Process Industry	75	72	0	0	0	1	0	3%	60	40	principal estimator	0
5				All	75	75	0	0	1	0	0	1%	1.5	1.5	Associate Project	0
3	4	1	2	Building/Infra/Process	75	74	1		0	1	0	1:15	11	8	estimator	0
3	2	2	3	Process Industry	75	0	0	0	0	1	0	1-3%	30	25	principal estimator	1
3	4	1	2	Process Industry	80	80	80	0	0	1	0	2%	29	29	estimating director	0
3	4	1	2	EPC	73	73			0	1	0	1%	27	22	assistant manager	0
1				Building Construction	76				1	0	0	3%	28	11	estimator	0
1	4	2	3	Building Construction	1				1	0	0	1:20	33	20	construction estimator	10
3	4	2	3	Infrastructure/ process/	20	20	0	10	0	1	0	1/25	27	16	senior estimator	0
1				Building Construction	50	26	24	0	1	0	0	1/5	28	8	assistant estimator	0
3	4	1	2	Process Industry	76	70	0	0	0	1	0	1/30	33	24	senior estimator	0
3				Industrial/Manufacturing	75	0	0	0	1	0	0	1/50	27	21	senior estimator	0
				power generation		23			0	1	0		40	35	Manager of Estimating	0
5	4	1	2										30	18		10
3				Process Industry					0	1	0		30	20	principal estimator	0
1				Building construction	14	8	10	25	0	1	0		37	36	Chief Estimator	0
1				Building Construction	14	14	0	0	0	0	1	don't know	13	13	ceo/president/chief estima	0
3	4	2	2	Process Industry	80			0	0	1	0	1/20	13	13	estimating director	
1				Building Construction	150	150		5	1	0	0	1/3	18	8	project consultant	0
5				Industrial/Infra/Process	76			0	0	1	0	1/20	16	14	principal estimator	1
5	4	1	3	Process Industry	75				0	1	0	1/10	13	10	estimator	0
				oil production	3	2	1	0	1	0	0	1/40	28	25	Lead Estimator	0
3				Industrial/Manufacturing	76								5	5	Tech	

Follow-up Survey Data				Q1-2	Q 2				Q 3			Q 4	Q 5		Q 6	Q 7
What industry sector your company involved in	Q2	Q3	Q4	What industry sector your company involved in	Size of Estimating Department	Internal Employees	Contract Employees	% of Estimating Work Outsourced	Function of Cost Estimating (Integrated with PM or other function)	Function of Cost Estimating (Separate department or entity)	Function of Cost Estimating (Others)	Ratio of Estimators to Project Team	Years of Experience in Construction	Years of Experience in Estimating	Position/Title	Years of Experience as Designer
3				Process Industry	75	75			0	1	0	1/20	6	0.5	Associate Project Estimator	0
5				Building/Infra/Process	60	60			0	1	0		31	27	senior estimator	0
1				Building construction	80				0	1	0	1/60	19	9	estimator	0
1	1	1	1	Building construction	75	60			1	0	0		1	1	associate Project Estimator	0
5				Industrial/manufacturing	10	8	2	20	1	0	0	1/20	11	11	Lead Estimator	
3	1	1	2	EPC	70									2	Associate Project Estimator	0
3	1	2	2		10	10	0	0	0	1	0	5%	19	0	Project Manager	0
					9	9	0	0	0	1	0	1/8	10	8	estimating manager	0
3	1	2	1		100				0	1	0	1/10	22	20	senior estimator	0
3	1	2	2		3	2	1	0	0	1	0		34	23	estimating manager	0
3	1	1	3		25	25	0	0	0	1	0	1/100	32	15	or of project controls & esti	0
					10	10		0	0	1	0		35	17	Lead Estimator	0
1	2	2	3		2	1	1	99	1	0	0		35	35	chief estimator	0
					10	9	1	0	0	1	0	1/5	29	27	estimator	0.5
					19			0	0	1	0	1/4	26	10	estimator	0
					2	2	0	0	0	1	0		35	23	estimator	0
5	1	2	2		2	450	0	0	0	1	0	1/3	35	20	estimating manager	2
					118	118	0	0	0	1	0	1/2	20	5	vice president of estimating	1
3	1	2	3		3	2	1	0	0	1	0	1/3	34	8	estimator	1
					80	75	5	0	0	1	0	1%	30	25	Director of Estimating	4
5	1	2	3		150	150	0	0	1	0	0	1/5	42	29	Director of Estimating	2
									1	0	0	5%	20	8	estimator	6
								20	1	0	0	1/20	30	2	mgr	0
					2	2	0	10	0	1	0	1/5	28	12	region manager	0
					15	10	5	0	0	1	0		33	0	comemrcial director	0
					15	13	2	0	1	0	0	1/4	35	7	estimating manager	12
						24			0	1	0		32	5	estimator	8
					10	9	1	0	0	1	0	1/2	43	8	special structure estimator	2
					50	50	0	0	0	1	0		33	0	Dir Eng	5
					0			100	1	0	0		30	10	project advisor	0
3	1	1	3		9	6	3		1	0	0		21	10	estimating team leader	0
					19	19	0	0	0	1	0	1/3	33	5	general estimator	10
					4	1	3	50	1	0	0	1/10	28	1	Associate Project Estimator	0
					0			90	1	0	0		40	20	cost consultant	30
3	1	2	1		6	6	2	20	0	1	0	1/10	35	25	senior estimator	0
3	2	2	3		0	0	0	0	1	0	0		22	20	sr project development	2
					9	25	75	0	1	0	0	1	10	10	Project Manager	0
					8	5	3	25	0	1	0	1/10	24	18	estimating Manager	0
3	1	1	3		20	20	0	0	0	1	0	1/20	28	25	Director of Estimating	0
									0	1	0		33	16	senior estimator	9
					5	5	0	0	0	1	0	1/25	30	12	estimating manager	0
					1	1	3	100	0	1	0	1/10	30	0	manager PMO	5
2	1	1	1		15	15	0	0	0	1	0	1/20	22	0	director process innovation	0
					2	1	1	85	0	1	0		33	8	Project Controls Manager	0
5	2	2	2		2	0	2	60	1	0	0	1/6	38	18	Project Controls Manager	6
					7	7	0	0	1	1	I have always believed that	Bid phase around	25	25	principal estimator	0
					51	11	40	80	1	0	0	1/25	30	15	technical director	0
					30	10	15	10	0	0	ENGINEERING	1/15	5	1	sr estimator	15
					23	23		10	0	1	0	1/10	30	27	sr estimator	0
3	1	2	3		25	20	5	0	0	1	0	10%	35	35	Manager of Estimating	0
3	2	2	2		1	1	5	100	0	1	0	1/20	25	0	Project Manager	5
3	1	1	2	Process Industry	75	75	0	0	0	1	0	5%	28	28	Manager of Estimating	0
									0	0	business development team		20	2	project manager	0
5	2	1	2		110	105	5	0	0	1	0		3	25	vice president of estimating	0
5	2	2	2		6	1	5	60	1	0	0	1/4	30	24	sr estimator	0
					50	10000	500	0	0	1	0	1/10	20	8	Chief Estimator	0
1	1	1	1		16	14	2	0	0	1	0	1/10	28	18	Manager of Estimating	0
3	1	1	3		3	3	0	0	0	1	0	1/4	35	10	sr estimator	0
					27	24	3	7	0	1	0	1/10	14	11	Manager of Estimating	0
3	1	1	2		13	12	1	0	1	0	0	50%	36	32	Manager of Estimating	0
3	1	2	3	Process Industry	2		0	90	1	0	0		33	30	Manager of Estimating	0
						32	0	0	1	0	0	5%	31	11	pervisor of civil & infrastruct	26
					8	3	5		0	1	0	1/4	40	20	project control manager	0
2	1	1	3		14	14			0	1	0		28	22	vice president of estimating	0
					75	75	0		0	1	0	0	26	15	anager Project Developmer	0
				Hydro electric	0	0	0	70	0	0	1		14	0	project services head	0



							Q 8						Q 1	Q 2	Q 3							Q 3-part 2			
Years of Experience in Jobsite work	Years of Experience as Project Control	Years of Experience as Scheduler	Years of Experience as Project Engineer	Years of Experience as Project Manager	Years of Experience as Others		Professional Certification/ Membership (AACE)	Professional Certification/ Membership (ASCE)	Professional Certification/ Membership (ASPE)	Professional Certification/ Membership (PMI)	Professional Certification/ Membership (P.E.)	Professional Certification/ Membership (Others)	% of Job Offers Extended for Estimating	Difficulty of Recruit and Retain Estimators	Recruitment from College graduates	Recruitment from College Internship	Transfers from within your Company	Recruitment from other Companies	Referrals from Individuals in Industry	Job Placement Companies/ Headhunters	Advertisements in Papers/Magazines	Recruitment from College graduates (Method Effectiveness)	Recruitment from College Internship (Method Effectiveness)	Transfers from within your Company (Method Effectiveness)	Recruitment from other Companies (Method Effectiveness)

							Q 8						Q 1	Q 2	Q 3							Q 3-part 2			
Years of Experience in Jobsite work	Years of Experience as Project Control	Years of Experience as Scheduler	Years of Experience as Project Engineer	Years of Experience as Project Manager	Years of Experience as Others		Professional Certification/ Membership (AACE)	Professional Certification/ Membership (ASCE)	Professional Certification/ Membership (ASPE)	Professional Certification/ Membership (PMI)	Professional Certification/ Membership (P.E.)	Professional Certification/ Membership (Others)	% of Job Offers Extended for Estimating	Difficulty of Recruit and Retain Estimators	Recruitment from College graduates	Recruitment from College Internship	Transfers from within your Company	Recruitment from other Companies	Referrals from Individuals in Industry	Job Placement Companies/ Headhunters	Advertisements in Papers/Magazines	Recruitment from College graduates (Method Effectiveness)	Recruitment from College Internship (Method Effectiveness)	Transfers from within your Company (Method Effectiveness)	Recruitment from other Companies (Method Effectiveness)
15	15	0	0	0			0	1	0	0	0	0	50%	6	3	3	3	2	3	3	3	2	3	4	3
10	25	15	3	20			0	0	0	0	0	0	100%	3	5	5	4	2	2	3	4	3	5	3	3
6	32	0	0	0	Draughtsman /	9	1	0	0	0	0	CEP	50%	2	1	4	1	3	3	3	2	1	1	1	4
5	15	0	0	0	Engineering &	5	1	0	0	0	1	AICNE	50%	2	2	2	4	4	3	2	4	3	3	3	3
3	21	10	0	10			0	0	0	0	1	USACE	75%	2	3	4	3	3	2	1	1	4	4	4	3
0	0	0	0	0			0	0	0	0	0	0	don't know	2	3	3	3	3	3	3	3	3	3	3	3
15	0	0	1	1			0	0	0	0	0	EIT	3%	1	1	4	3	3	2	1	2	3	2	4	3
0	0	0	0	3			0	0	0	0	0	CCC	65%	2	3	5	3	3	3	1	1	3	5	3	3
							0	0	0	0	0	Certified	100%	2	1	1	3	1	1	1	1			5	
3	0	0	4	8			0	1	0	0	1	SAME		2	1	1	2	3	1	1	1	1	1	3	3
2	2	2	2	10			0	0	0	0	1	0	0%	1											
10	5	2	10	2	environmental		0	0	0	0	0	0	3%	1	3	2	3	3	2	2	2	3	2	2	3
5	0	0	0	0			0	1	0	0	1	0		1	1	1	3	2	3	1	1	1	1	1	2
12	3	2	0	3	own business	8	0	0	0	0	0	CCEIT	50%	1	1	1	1	1	1	1	2	1	1	1	1
5	0	1	0	0			0	0	0	0	0	0	12%	1	1	2	1	3	5	2	2	1	1	3	4
6	3	2	2	0			0	0	0	0	0	0	50%	2											
3	10	0	0	0			0	0	0	0	0	0	50%	2	3	3	2	1	1	1	1	2	3	3	2
6	10	0	0	0			0	0	0	0	0	0	50%	2	1	1	1	4	4	3	3	3	3	3	4
2	0	0	0	0	Estimating	17	0	0	0	0	1	TRACES	N/A	3	5		4					5		5	
1	0	0	1	5	regulatory	10	0	0	0	0	0	TRACES-CCC	10%	1	1	2	5	1	1	1	1		4	3	
0	0	0	7	0	process	3-May	1	0	0	0	0	AICNE	15%	1	1	1	1	4	3	3	2	2	2	2	3
10	12	0	12	6			1	0	0	0	1	0			2	2	4	3	3	3	3	1	1	3	3
0	0	10	0	6			0	0	0	0	1	0	0%	2											
0	11	0	0	2			0	0	0	0	0	Licence ARCH	0%	1	1	1	3	5	4	1	3	1	1	3	4
10	1	0	0	10	Estate &	10	0	0	0	0	1	0	0%	1	4	2	4	3	3	3	3	3	2	3	3
3	0	0	0	7	branch manager	5	0	0	0	0	0	0													
3	32	0	0	0			0	0	0	0	0	0	50%	1											
8	0	0	0	0	Surveying/	5	0	0	0	0	0	0	0%	1	3	3	3	3	3	1	1	2	2	2	2
1	3	1	3	4	Director	8	0	0	0	0	1	0		3	3	3	4	2	2	1	1	3	5	4	3
0	0	0	10	5			0	0	0	0	0	Licence ARCH	0%	6	4	4	3	2	2	1	1	4	4	3	4
10	7	20	0	0			0	0	0	0	0	0	0%	1	1	1	1	1	2	1	1	1	1	1	1
8	3	2	0	3	Engineering	10	0	0	0	0	1	0	0%	3	4	5	4	2	2	2	2	4	5	4	3
0	0	0	0	0			0	0	0	0	1	Certified	0%	1	5	3		1	1	1	1	4	1	1	1
10	0	0	0	0	Sales	15	0	0	0	0	1	ASHRAE	50%	3	1	1	4	3	2	2	2	1	1	3	3
0	25	10	0	0	Cost Engineer	10	1	0	0	0	0	0	100%	3	1	1	3	3	3	1	3	1	1	3	3
30	15	3	10	12			0	1	0	0	1	ACI, AISC,	N/A		5	5	5	3	3	1	1	5	5	5	
20	30	3	0	0			0	0	0	0	0	0	100%	2	1	1	5	1	1	1	1			5	
3	2	1	38	1			0	0	0	0	1	0	0%	3	1	3	4	3	2	2	2	1	3	4	1
0	0	0	1	0	government		0	0	0	0	1	0	0%	6											
6	8	2	0	0			1	0	1	1	0	0	50%	1	2	4	2	5	5	2	4	3	3	1	4
8	1	0	1	6			0	0	1	0	0	0	60%	3	3	4	4	3		4	1	4	4	4	4
0	0	0	0	0			0	0	1	0	0	0	0%	6											
25	20	5	0	20			0	0	0	0	0	ED AP CSI, C	75%	2		4	1	3	1	2	1	4	4	5	3
							0	0	1	0	0	0	50%	2	1	1	1	5	3	1	1	1	1		
5	5	0	0	10	conceptual estimating		0	0	1	0	0	LEED	0%	1	5	4	1	4	4	3	1	4	4	1	4
10	5	0	0	5			0	0	1	0	0	0		2	4	4	3	3	3	4	3	5	3	3	3
15	15	10	0	5			1	0	1	1	1	0	0%	2	1	3	3	4	4	1	3	2	2	3	4
28	29	15		8			0	0	1	0	0	0	10%	1	1	1	4	3	3	1	3	1	1	3	3
0	4	0	0	6			0	0	1	0	0	LEED	100%	1	2	1	3	3	3	4	2	1	1	3	3
1				1.75			0	0	1	0	0	CPE	N/A	2	4	4	4	3	2	4	1	4	4	4	3
4	0	8	4	4			0	0	1	0	0	LEED	50%	1	4	2	2	2	2	4	4	4	4	4	3
3	0	0	0	17			0	0	1	0	0	LEED	100%	3	4	4	1	4	3	1	1	4	4	2	4
3	0	0	0	0			1	0	0	0	0	0		1	2	4	2	3	3	4	3	1	1	3	4
4	0	0	0	1			0	0	1	0	0	0	0%	1	4	4	1	4	3	1	1	3	3	4	3
10	0	0	0	1			0	0	1	0	0	0		4	1	1	1	3	3	1	1				
0	4	0	20	11			1	0	0	0	1	0													
10	10	3	0	0			1	0	0	1	0	SCEA	40%	1	2	3	1	3	2	3	1	2	3	3	4
8	0	0	0	0			0	0	0	0	0	0	0%	4	3	3	3	3	3	3	3	3	3	3	3
0	10	0	0	0			0	0	0	0	0	oject team m	don't know	6	3	3	3	4	4	3	3	3	3	3	4
0	2	1	0	0			0	0	0	0	0	0	don't know	3	1	2	2	5	4	1		3	3	3	3
0	0	0	0	0	IT automation	11	0	0	0	0	0	0		3	4	3	4	4	3	3	3	4	3	4	4
10	0.5	0.5	0	0			0	0	0	0	0	0	25%	2	3		3	4	3	3	2	4	3	4	3
3	0	0	0	0			0	0	0	0	0	0		3	2	2	2	4	3	3	4	3	2	3	3
1	3	0	0	0			0	0	0	0	0	0	25%	1	4	4	4	4	4	2	4	4	4	4	4
18	0	0	0	0			0	0	0	0	0	0		1	4		4	3	3	1	3	3	3	3	3
10	0	0	0	5			0	0	0	0	0	0													
6	11	3	2	0			1	0	0	0	0	0	50%	2	4	4	3	4	1	3	4	4	4	4	2
18	0	0	0	0			0	0	1	0	0	0	100%	6	3	3	3	4	3	2	1	4	1	3	4
20	22	10	20	4			0	0	0	0	0	0	0%	3	4	4	3	3	3	1	2	2	2	3	5
6	0	0	0	0			0	0	0	0	0	0	50%	4	2	2	3	4	4	1	1	2	2	3	4
0	10	0	0	0			0	0	0	0	1	0		2	3		2	4	4	3	2	2			
0	0	0	0	0			0	0	0	0	0	0													
8	11	0	0	0			0	0	0	0	0	0													
3	3	0	0	3			1	0	1	0	0	0	10%	2	3	3	2	3	1	4	1	4	2	4	4
0	0	0	0	4			0	0	0	0	0	0	100%	1	1	1	1	1	4	1	5	1	1		
							1	0	0	0	0	0		1	4	3	4	5	4	2	1	2	1	2	3
0	0	0	2.5	0			0	0	1	0	0	0	10%	2	1	1	2	3	3	4	2	3	3	5	4
12	8	5	8	6			0	0	0	0	0	0		3	5	4	3	5		3	3	4	4	3	3
4	2	2	0	0			0	0	0	0	0	0		2	4	3	3	4	3	3	3	4	3	2	3
0	25	0	0	0			1	0	0	0	0	0	10%	2	1	1	1	5	4	5	1	1	1	1	5
							0	0	0	0	0	0		6	3	3	4	4	4	1	4	3	2	3	3

							Q 8						Q 1	Q 2	Q 3							Q 3-part 2			
Years of Experience in Jobsite work	Years of Experience as Project Control	Years of Experience as Scheduler	Years of Experience as Project Engineer	Years of Experience as Project Manager	Years of Experience as Others		Professional Certification/ Membership (AACE)	Professional Certification/ Membership (ASCE)	Professional Certification/ Membership (AGPE)	Professional Certification/ Membership (PMI)	Professional Certification/ Membership (P.E.)	Professional Certification/ Membership (Others)	% of Job Offers Extended for Estimating	Difficulty of Recruit and Retain Estimators	Recruitment from College graduates	Recruitment from College internship	Transfers from within your Company	Recruitment from other Companies	Referrals from Individuals in Industry	Job Placement Companies/ Headhunters	Advertisement s in Papers/Magazines	Recruitment from College graduates (Method Effectiveness)	Recruitment from College internship (Method Effectiveness)	Transfers from within your Company (Method Effectiveness)	Recruitment from other Companies (Method Effectiveness)
2	4	0	0	0			0	0	0	0	0	0		2	4	4	3	3	4	1	1	4	4	3	3
4	27	0	0	0			0	0	1	0	0	0		6											
10	2	0	0	0			0	0	0	0	0	0	3%	6	3	3	3	3	4	2	3	3	3	4	4
0	0	0	0	0			0	0	0	0	0	0		2	5	3	3	3	3	1	1	3	4	4	4
							1	0	0	0	0	0		6											
0	0	0	0	0			0	0	0	0	0	0		6	4	4	4	3	3	2	2	4	4	4	3
4	0	0	16	3			0	0	0	1	0	AICHE		3	3	1	3	5	5	3	5	3	3	4	5
0	0	0	2	0			0	0	0	0	1	0	80%	3	4		4	4	4	4	4	4	4	5	3
20	2	0	2	0			0	0	0	0	0	0		1	2	2	3	4	3	4	1	3	2	4	4
0	0	0	0	11			0	0	0	0	0	0	100%	3	4	1	4	3	3	1	2	4	1	3	3
0	32	0	0	0			0	0	0	1	0	0	50%	3	3	1	2	3	3	1	4	4		3	
18	17	0	0	0			0	0	0	0	0	0	10%	3	1	1	1	3	3	2	2	1	2	1	3
35	30	10	30	30			0	0	0	0	0	ASPE	5%	1	1	1	2	3	1	1	2		1	1	3
1	0	0	0	0			0	0	0	0	0	0		2	1	1	4	2	1	1	1	1	1	4	2
16	0	0	0	0			0	0	0	0	0	0		6	1	1	3	3	4	3	3	3	3	3	3
10	10	10	10	10			0	0	0	0	0	0		2	1	1	1	2	2	1	1				2
2	0	0	3	2			0	0	0	0	0	0	5%	2			5							4	
2	0	0	1	0			0	0	0	0	0	0	50%	1	2	1	4	4	3	3	1	2	1	4	4
2.5	0	0	0	0			0	0	0	0	1	0	100%	3	1	1	3	3	3	1	2	2	1	3	3
0	2	1	0	0			0	0	0	0	0	0	60%	2			4	4	4		4		4	4	4
0	0	0	6	5			0	0	0	0	0	0	50%	1	2	1	3	4	4	3	3	2	1	2	5
4	0	0	0	0	sales developm	10	0	0	0	0	0	0		2	3	3	4	3	2	2	3	3	2	4	3
30	20	3	0	4			1	0	0	0	0	0	20%	1	1	1	3	3	3	1	1	1	1	1	3
0	0	0	0	0			0	1	0	0	1	LAWWA, SEAOSC		3											
5	0	0	5	10			0	0	0	0	1	A eng stand	10%		1	1	2	3	4	3	1	1	1	4	4
0	0	0	2	0			0	0	0	0	1	ASME	60%	2	3	3	4	3	4	4	2	4	2	3	4
20	2	20	0	4			0	0	0	0	0	0	5%	2	3	3	4	4	3	2	2	4	4	4	4
2	0	0	3	25			0	0	0	0	0	0	0%	6	1	1	4	1	1	1	3	1	1	4	1
12	0	0	0	0	eng.	33	0	0	0	0	1	0		3											
3	10	0	5	2			1	0	0	0	0	0	0%												
7	0	0	4	0			0	0	0	0	0	0	100%	1			4	4						4	3
0	0	0	0	10			0	0	0	0	0	ASME													
12	1	0	0	3			1	1	0	0	0	0	100%	6	5	5	5	3	2	2	3	3	5	3	4
20	0	0	20	0			1	0	0	0	0	FDSAGE		2	3	3	3	3	4	2	3	3	3	4	3
0	10	0	0	0			0	0	0	0	0	0	100%	1	1	1	3	3	2	1	3	1	1	3	3
10	20	0	0	20			0	0	0	0	1	0			4	3	3	3	1	3	4	3	3	4	4
2	2	0	3	2			0	0	0	0	0	0	75%	1	3	1	1	1	2	1	1	3	1	3	1
5	0	0	0	1			1	0	0	0	0	0	67%	6	3	4	3	3	4	2	2	3	4	3	3
5	0	0	0	0			0	0	0	0	0	0	60%	6	2	3	3	4	3	3	3	3	2	3	4
2	0	0	0	1			0	0	0	0	0	0													
15	2	0	2	12			0	0	0	0	0	0	10%	2	2	3	3	4	3	4	2	2	2	2	4
10	15	0	0	0			0	0	0	0	1	0	100%	3	3	3	5	3	2	1	3	5	3	3	5
0	0	0	0	3			0	0	0	0	0	0	100%	3			4		2					2	
22	25	2	0	6			0	0	0	0	0	0		2	3	1	1	4	2	3	4	4	4	2	2
25	2	2	15	15			0	0	0	1	0	0	100%	3	1	1	3	2	4	4	2	1	1	2	2
3	3	0	1	0	organic chemist	5	0	1	0	0	0	0		1	3		1	4	4	4	3	3		2	4
10	30	6	0	3			1	0	0	0	0	MBA	30%	1	1	1	2	4	4	2	3	1	1	2	4
2	1	0	0	0			0	0	0	0	0	0	60%	3	3	1	4	3	3	4	3	3	1	4	3
3	0	0	0	0			0	0	0	0	0	0	50%	1	1	3		3	3	1	4	1	1	4	3
7	0	0	0	0			0	0	0	0	0	[illegible]	50%	1	1	1	1	3	4	1	3	3	1	3	4
25	0	0	7	18			0	0	0	1	0	0	100%	3		3	2	4	3	3	4	4	3	4	3
1	0	0	0	0			1	0	0	0	0	0	77%	3	3	3	3	4	4	1	3	4	3	4	3
0	4	3	4	4			0	0	0	0	0	0	0%	6	1	2	3	3	3	4	1	1	2	2	3
8	0	2	2	2			1	0	0	0	1	CCE	60%	2	2	3	4	1	4	1	3	2	4	3	2
3	2	0	0	3	safety manager	2	0	0	0	0	0	0	20%	2	1	2	4	4	4	3	4	2	2	4	4
8	4	0	0	6			0	0	0	0	0	0	70%	2	3	4	1	5	4	1	2	3	3	2	5
15	0	0	10	20			0	1	0	0	1	0		1	1	1	3	1	4	4	1	1	1	3	1
10	4	4	2	5			1	0	0	0	0	0	50%	3	4	3	3	4	4	3	3	4	3	4	3
0	0	0	0	0			0	0	0	0	0	MBA	60%	2	4	3	2	4	4	3	3	4	4	4	4
0	0	0	2	4			0	0	0	0	0	0	100%	2	3	3	4	4	4	2	3	3	3	4	4
10	0	0	0	0			1	0	0	1	0	0		1	4	4	4	2	2	4	3	4	4	4	2
5	0	0	0	0			0	0	0	0	0	0	40-50%	1	2	2	3	1	1	4	4				
0	20	0	0	0			1	0	0	1	0	0	50%	1	3	4	1	1	4	3	3	2	2	2	2
2	4	0	0	0			1	0	0	0	0	0	30%	2	3	1	1	4	4	4	3	1	1	1	4
1	0	0	5	6			1	0	0	0	0	0	75%	3	3	4	3	3	1	1	1	4	4	2	3
2	0	0	3	6			0	0	0	0	1	0		6	4	3	4	3	3	1	2	3	2	4	3

			Q 4					Q 4-part 2					Q 5	Q 6					Q 1	Q2	
Referrals from Individuals in Industry (Method Effectiveness)	Job Placement Companies/ Headhunters (Method Effectiveness)	Advertisements in Papers/ Magazines (Method Effectiveness)	Compensation & Benefits	More Recognition of Estimating as a Profession	Better Definition of Career Paths into Estimating	Emphasize Diversity of Work in Estimating	Integrate Estimating into Project Management	Attract & Retain using Compensation & Benefits (Method Effectiveness)	Attract & Retain using More Recognition of Estimating as a Profession (Method Effectiveness)	Attract & Retain using Better Definition of Career Paths into Estimating (Method Effectiveness)	Attract & Retain using Emphasize Diversity of Work in Estimation	Attract & Retain using Integrate Estimating into Project Management (Method	Estimator Compensation Related to Others	Assign the Role of Estimating to another Discipline within your Company	Attempt to Hire Contract Workers on a Temporary basis to perform a	Outsource Cost Estimating to a professional Estimating firm outside of	Attempt to automate more estimating activities using computer	Others	Your Company have its own Database	Type of Database Information (Unit Costs)	Type of Database Information (Contingency)
4	3	4	3	3	3	3	2	5	4	4	4	2	3	YES	NO	NO	YES	hired home office	YES	1	0
2	1	1	3	2	4	3	4	3	4	3	3	3	3	YES	YES	NO	NO		NO	0	0
3	2	2	4	3	4	4	2	2	3	4	4	4	3	YES	NO	NO	NO		YES	1	1
													6					source an	NO	1	1
4	4	3	4	2	3	3	3	4	2	2	3	2	3	NO	YES	NO	YES		NO		
3	1	2	3	3	1	4	4	3	3	1	4	4	2	NO	NO	NO	YES		YES	1	0
				1	1	1	1						1	NO	NO	NO	NO	overtime	NO		
3	3	2	3	3	2	3	3	3	3	2	2	2	3	YES	NO	NO	YES		YES	1	1
1	1	1					4					4	3	YES	YES	NO	YES		YES	1	1
			4	4		3	3						3	NO	YES	NO	YES		NO	0	0
		3	4	1	1	3	1	4	2	2	4	2	4	NO	YES	NO	YES	We have had the	YES	1	0
1	1	1	1	1	1	1	1	1	1	1	1	1	6	YES	NO	NO	NO	outsource	NO	0	0
4	4	3	4	2	3	3	1	4	2	3	4	1	4	NO	NO	NO	NO	reduce the	YES	1	0
3	4	4	4	2	3	3	4	4	2	3	3	4	3	NO	NO	NO	YES		YES	0	1
4	3	2	3	2	2	3	3	5	2	2	3	3	4	YES	NO	NO	NO		YES	0	0
													2	NO	NO	NO	YES	overtime	YES	1	1
1	4	3	4	4	3	3	2	4	4	3	3	2	4	NO	YES	NO	YES		YES	1	1
2	3	4	4	1	1	1	2	5	5	3	3	3	2	YES	YES	YES	NO		YES	0	0
1	1	1	4	4	4	4	3	4	4	4	3	3	4	YES	NO	NO	YES		YES	1	1
3	2	3	5	4	4	4	5	5	4	4	4	5	6	NO	NO	NO	NO	just pitched in and	YES	0	0
4	4	3	4	3	4	4	4	4	3	4	4	4	3	NO	YES	NO	YES		NO	0	0
																			YES	1	1
1	1	1	2	1	3	1	4	2	1	3	3	4	3	NO	NO	YES	NO		YES	1	1
4	1	1	1	1	1	1	1	1		1	3	1	3	NO	YES	NO	YES		YES	1	1
	1	1	4	3	2	4	1	5	3	3	4	1	3	NO	YES	NO	YES		YES	1	0
2	1	1	4	2	2	3	2	3	2	2	3	2	4	NO	YES	YES	YES		YES	1	1
4	3	3	3	2	3	3	1	5	4	2	2	2	4	YES	NO	NO	YES	with regards to lie	YES	1	0
4	3	1	1	2	3	4	3	5	5	3	4	5	4	NO	NO	NO	YES	approve overtime	YES	1	1
4	4	3	4	2	2	3	4	4	2	2	3	4	3	YES	NO	NO	NO		NO	1	1
3	1	1	4	2	2	2	1	4	3	3	3	3	3	NO	YES	YES	NO		NO	0	0
			5	5	3		3									YES	YES		YES	1	1
			2	2	2	2	2		1	1			6	NO	NO	NO	NO		YES	1	1
3	1	1	1	1	1	2	1	1	1	1	3	1	3	NO	YES	NO	YES		YES	1	1
1	2	1	1	1	1	3	3	4	2	1	3	4	3	NO	NO	NO	NO	A workshare betwe	YES	1	0
1	3	1	1	2	2	1	1	1	1	3	1	1	3	YES	YES	NO	YES	negotiate more time	YES	1	0
3	1	3	1	2	3	4	1	2	1	3	2	1	3		NO	NO	YES	from projects contr	NO	0	0
			3	3	2	3	3	5	4	3	3	3	3	NO	YES	NO	YES		YES	1	1
5	4	4	4	4	4	3	3	4	4	4	3	3	3	NO	NO	NO	YES		YES	1	0
3	1	3	1	3	1	4	1	1	3	1	3	1	3	NO	YES	NO	YES		YES	1	1
4	3	2	4	3	3	4	3	4	3	3	4	3	4	NO	YES	YES	NO		YES	1	1
1	3	1	2	2	1	2	1	5	4	3	3	1	4	NO	YES	YES	NO		YES	1	1
		1	4	3	3	4	4	4	3	3	4	3	3	YES	YES	NO	YES		YES	1	1
4	1	1											3	YES	YES	YES	NO		YES	1	1
3	3	3	3	3	3	3	4	3	3	2	2	3	3	NO	YES	NO	YES		YES	1	0
														YES	YES	NO	NO		YES	1	1
3	3	3	4	2	3	4	3	5	3	3	2	4	4	YES	NO	NO	YES		YES	1	1
2	3	3	1	1	1	1	1	1	1	1	3	1	2	NO	YES	NO	NO	require fewer	NO	0	0
2	2		4	4	4	2	3	4	4	4	2	3	3	NO	NO	NO	NO	increase	YES	1	1
4	4	3	3	5	4	4	3	3	5	4	4	3	4	NO	YES	NO	YES		YES	1	1
3	3	2	3	3	2	3	2	3	4	3	4		3	YES	NO	NO	YES		YES	0	0
3	4	1	3	4	4	4	3	4	5	4	3	2	3	NO	NO	YES	NO		YES	1	0
5	3	3	1	3	3	3	2	2	3	3	3	2	4	YES	YES	YES	NO		YES	1	1
4	2	3	4	2	2	1	2	3	1	2	2	4	3	NO	NO	NO	NO		YES	1	1
			3	2	2	2	3						3	NO	YES	NO	YES		YES	1	1
3	3	1	3	2	3	1	1	3	2	1	1	1	3	YES	YES	NO	NO		NO	1	1
			3	3	1	4	4	4		3	4	4	3	NO	YES	NO	NO		YES	0	0
3	3	4	4	3	4	3	3	4	3	4	4	3	3	NO	YES	NO	YES		YES	1	0
3	3	4	2	2	2	3	3	4	2	3	3	3	3	NO	YES	NO	NO		NO	0	0
4	3	3	3	5	4	4	3	5	5	4	4	3	3	YES	NO	NO	YES		YES	1	1
5	4	3	5	5	5	5	5	5	5	5	5	5	6	NO	YES	NO	YES		YES	1	1
3	1	3	5	5	5	5	5	5	5	5	3	5	3	YES	YES	NO	NO		YES	1	0
																			YES	0	0
2	3	3	4	4	4	4	4	4	4	4	4	4	3	YES	YES	NO	NO		YES	1	1
1	3	1	3	3	2	3	2	4	4	3	3	3	6	YES	YES	NO	NO	College hire/ interns	YES	1	0
																			YES	1	0
3			3	1	1	4	1	4	3	1	4	1	3	NO	YES	YES	YES		YES	1	0
4	1	1	4	2	3	2	1	4	3	3	1	1	4	NO	YES	NO	YES		NO	0	0
																			YES	1	0
4	4	4	3	4	4	3	3	4	4	3	4	4	3	NO	YES	NO	NO	need is greater than	YES	1	0
3	3	3	4	4	3	3	4	4	4	3	3	4	3	NO	YES	NO	YES		YES	1	1
													2		YES	YES			NO		
																			YES	1	0
3	3	3	3	3	3	3	2	3	4	3	3	3	3	NO	NO	NO	YES	work more hours	YES	1	1
2	3	3	4	4	4	3	4	4	3	4	3	4	3	YES	NO	YES	NO	to/in estimating	YES	1	0
			5	5	5	5	5	5	5	5	5	5	3	YES	NO	NO	NO		YES	1	1
5	1	1	5	4	1	4	5	5	3	1	4	3	3	NO	NO	NO	YES	Promote internal	YES	1	1
4	2	3	4	2	3	3	2	4	2	3	3	2	3	YES	NO	NO	YES		YES	1	1
3	4	3	3	2	2	3	2	5	4	4	3	4	3	NO	YES	NO	YES		YES	1	1
3	3	3		2	2	3	2	4	4	2	4	3	3	NO	NO	NO		overtime and	YES	1	1
3	3	3	3	2	3	3	2	1	5				2				YES	Double tie	YES	1	1

			Q 4					Q 4-part 2					Q 5	Q 6					Q 1	Q2	
Referrals from Individuals in Industry (Method Effectiveness)	Job Placement Companies/ Headhunters (Method Effectiveness)	Advertisements in Papers/ Magazines (Method Effectiveness)	Compensation & Benefits	More Recognition of Estimating as a Profession	Better Difinition of Career Paths into Estimating	Emphasize Diversity of Work in Estimating	Integrate Estimating into Project Management	Attract & Retain using Compensation & Benefits (Method Effectiveness	Attract & Retain using More Recognition of Estimating as a Profession (Method Effectiveness)	Attract & Retain using Better Difinition of Career Paths into Estimating (Method Effectiveness)	Attract & Retain using Emphasize Diversity of Work in Estimating	Attract & Retain using Integrate Estimating into Project Management (Method	Estimator Compensation Related to Others	Assign the Role of Estimating to another Descipline withing your Company	Attempt to Hire Contract Workers on a Temporary basis to perform in	Outsource Cost Estimating to a professional Estimating firm outside of	Attempt to automate more estimating activities using computer	Others	Your Company have its own Database	Type of Database Information (Unit Costs)	Type of Database Information (Contingency)
4	4	3	3	3	3	3	3	4	4		4	4	3	NO	YES	NO	YES		YES	1	0
3	3	4	3	3	3	3	3	3	3	3	3	3	3	YES	NO	NO	YES		YES	0	0
4	4	2	5	4	1		2	5	3	1	1	2	4	NO	YES	NO	YES	overtime	YES	1	0
2	2	2	4	1	2	1	1	4	2	3	2	3	3	YES	YES	NO	YES	s, schedule loger wo	YES	1	1
5	1	2	3	4	4	4	4	4	4	4	4	4	2	NO	NO	YES	YES	e of retired annuitan	YES	1	0
3	3	3	3	3	3	3	3	3	3	3	3	3	3	NO	NO	YES	YES		YES	1	0
2	1	2	3	1	1	1	2		2	2	2	2	2	YES	YES	YES	YES		YES	1	1
3	3	3	3	3	3	3	3	3	3	3	3	3	3	YES	YES	YES	YES		YES	1	0
			2	2	1	1	1						3	NO	NO	YES	NO			1	1
1	1	1	1	1	1	1	1	4	4	4	3	3	3	NO	NO	YES	NO		YES		
													2					do nothing we are overs	YES	1	1
2	2	2	2	1	2	1	1	2	2	2	2	3	1	NO	NO	YES			YES	1	1
3	1	1	4	3	2	5	1	5	5	5	5	1	3	NO	YES	YES	NO	the cost engineering	YES	1	0
1	1	2	5	3	2	1	2	5	3	2	1	2	2	NO	NO	YES		use of parametric cost estimati	YES	1	1
5	3	4	4	3	3	3	2	4	4	4	4	3	4	NO	YES	NO	YES		YES	1	0
													3	NO	YES	NO	NO		YES	0	0
1	1	1	1	1	3	2	3	1	1	1	2	3	3	YES	NO	NO	YES		YES	1	0
4	2	3	4	4	4	3	4	4	4	4	3	3	3						NO	1	0
			3	3	3	3	1	5	4	3	4	1	3	NO	YES	YES	NO	of other Corps of En	YES	1	0
			5	2	1	1	1	3	3	4		4	3	NO	NO	YES	YES	Use of IDIQ - AE	YES	1	1
3	3	1	4	3	2	2	1	2	2	1	1	1	4	NO	YES	NO	YES	Transfer work to	NO	0	0
5	1	1	4	3	2	5	5	3	3	2	3	5	3	YES	NO	YES	YES		YES	1	1
																			YES	1	0
4	1	5	5	5	5	5	3	5	4	4	3	3	4	NO	YES	YES	YES		YES	1	1
3	3	4	3	3	3	4	3	5	4	4	4	4	3	YES	YES	YES	YES		YES	1	0
														YES	NO	YES	NO		YES	1	1
			2	4	4	5	4	2	4	4	5	4	3	NO	YES	YES	YES		NO		
2	2	2	4	4	2	2	2	3	3	3	1	1	1	NO	YES	YES	NO	ourcing is other distr	YES	1	1
4	1	1	2	2	2	2	4	2	2	2	2	4	3	YES	NO	YES	NO		YES	1	1
4	3	2	4	4	4	5	4	4	4	4	5	4	3	YES	NO	YES	NO		NO	0	0
1	1	1	1	1	1	2	2	1	1	1	1	1	3	YES	YES	YES	NO		NO	0	0
3	2	2	4	2	2	2	4	4	2	2	2	4	3	YES	NO	YES	YES		YES	0	1
1	1	1	2	1	1	5	4	3	1	1	5	4	3	YES	NO	YES	YES		YES	1	0
2	2	2	2	2	2	2	2	3	3	3	3	3	3	YES	YES	NO	YES		YES	1	0
5	1	3	5	5	4	4	1	5	5	4	4	1	2	NO	YES	NO	YES		YES	1	0
1	1	1											4	YES	NO	NO	NO		NO	0	0
			4	4		1	3	5	4	3	1	1	4	NO	NO	NO	YES	Estimating training	YES	1	1
1	1	1	3	3	3	4	3	3	3	3	3	3	2	NO	NO	YES	NO		YES	1	1
													3	NO	NO	NO	NO	pensatory time for o	YES	1	0
5	3	3	4	4	4	5	5	4	4	4	4	4	3	YES	YES	YES	YES		YES	1	1
4	4	1	5	4	4	4	4	4	4	4	4	3	4	NO	NO	NO	NO	overtime	YES	1	1
																			NO		
3	4		4	2	1		1	4	2	4	3	1	4	YES	NO	NO	YES		YES	1	
			3	4	4	5	1						3	NO	YES	NO			YES	1	
4	1	1	3	4	4	4	3	4	4	4	5	3	2	NO	YES	YES	NO		YES		
3	4	3	5	3	3	3	4	4	3	3	3	4	4	YES	YES	NO	YES		YES	1	1
4	1	5	5	4	4	3	3	5	4	4	3	3	2	YES	NO	NO	YES		YES	1	
3	1	3	2	2	2	2	1	3	2	2	2	2	3	NO	YES	YES	YES		YES	1	1
2	2	2	4	2	2	2	3	4	3	2	2	3	4	YES	NO	NO	NO	work harder	YES		
2	4	1	4	4	4	4	3	3	5	4	5	3	4	YES	YES	YES	YES		YES		
4	3	3											4	YES	NO	NO	YES	work longer hours	YES	1	
5	1	1	5	3	3	3	4	4	3	3	3	4	3	YES	NO	NO	YES		YES	1	
4	5	1	5	4	1	1	1	5	2	1	1	1	6	YES	NO	NO	NO		YES	1	1
5	1	1	5	5	4	4	1	5	5	4	4	1	4	NO	YES	YES	YES		YES	1	1
			5	5	5	5	3						6						NO		
													2	YES	YES	YES	YES				
3	3	2	2	2	4	4	4	3	4	4	4	4	4	NO	YES	YES	NO		NO		
3	3	3	4	3	4	3	3	4	3	4	3	3	3	NO	NO	NO	YES	working longer hours	YES	1	1
4	3	3	3	4	4	4	2	3	3	4	4	3	6	YES	NO	NO	YES	overtime	YES	1	
4	1	4	2	2	2	2	4	3	3	3		4	6	NO	NO	NO	YES	overtime	YES	1	1
3	3	3	4	4	4	4	4	4	4	4	4	4	3	NO	NO	NO	YES	hiring and recruiting	YES	1	1
1	3	3	5	3	4	3		4	3	4	5		6	YES			YES	work longer hours	YES		1
3	2	3	3	4	3	4	3	4	4	4	4	3	3	NO	NO	NO	YES	overtime	YES		
4	1	3	4	4	4	4	3	4	4	4	4	2	4	NO	YES	NO	YES		YES	1	1
3	3	3		5	4	3	4	3	4	3	4	4	4	YES	NO	NO	YES		YES	1	1
																			NO		
2	2	1	4	3	2	4	4	3	4	2	3	2	3	NO	NO	NO	YES		YES	1	
3	2	1	4	4	4	5	4	5	4	4	5	4	6	NO	NO	NO	NO	ork faster and hard	YES	1	1
5	1	2	3	2	1	2	1	3	2	2	2	1	2	NO	NO	NO	YES		YES		1
4	1	1	5	3	1	3	3	5	3	1	3	3	3	NO	NO	NO	YES		YES	1	1
	3	2	4		2	2	4	3		2	2	2	3	NO	NO	NO	YES		YES	1	
																			YES		
1	4	1	3	4	4	4	5	3	4	4	4	5	2	NO	YES	NO	YES		YES	1	
4	1	5	5	3	3	3	3	5	3	3	3	3	2	YES	NO	NO	YES		YES	1	
3	2	1	3	1	1	2	1	4	2	2	3	1	2	NO	NO	NO	YES	overtime	YES		
2	2	2	5	2	2	5	5	5	1	4	5	5	6	YES	NO	NO	NO		YES	1	
4	2	3	3	3	3	3	2	3	5	4	4	4	3	YES	YES	NO	YES		YES		
3	2	2	4	3	3	4	3	4	3	3	4	3	3	NO	NO	NO	YES	longer hours	NO		
4	5	4	4	2	1	1	2	5	3	2	2	2	3	NO	YES	NO	NO		NO	1	
5		3	5	5	5	5	4	5		5	5	4	3	YES					YES	1	1

			Q 4					Q 4-part 2					Q 5	Q 6					Q 1	Q2	
Referrals from Individuals in Industry (Method Effectiveness)	Job Placement Companies/ Headhunters (Method Effectiveness)	Advertisement in Papers/ Magazines (Method Effectiveness)	Compensation & Benefits	More Recognition of Estimating as a Profession	Better Definition of Career Paths into Estimating	Emphasize Diversity of Work in Estimating	Integrate Estimating into Project Management	Attract & Retain using Compensation & Benefits (Method Effectiveness)	Attract & Retain using More Recognition of Estimating as a Profession (Method Effectiveness)	Attract & Retain using Better Definition of Career Paths into Estimating (Method Effectiveness)	Attract & Retain using Emphasize Diversity of Work in Estimating	Attract & Retain using Integrate Estimating into Project Management (Method	Estimator Compensation Related to Others	Assign the Role of Estimating to another Discipline within your Company	Attempt to Hire Contract Workers on a Temporary basis to perform as	Outsource Cost Estimating to a professional Estimating firm outside of	Attempt to automate more estimating activities using computer	Others	Your Company have its own Database	Type of Database Information (Unit Costs)	Type of Database Information (Contingency)
4	3	1	3	4	4	2	3	3	4	4	3	3	2	NO	NO	NO	NO	Hire new estimators	YES	1	1
			3	3	3	3	3	5	4	3	3	3	3						YES	1	1
5	3	2	4	4	4	4	4	5	4	4	4	4	3	NO	YES	YES	YES		YES	1	1
4	2	1	3	4	5	3	4	4	4	3	3	4	2	YES	NO	NO	YES		YES	1	1
			5	3	4	3	3	5	5	4	3	3	6	NO	YES	NO	YES		YES		
3	2	2	4	4	4	4	4	4	4	4	4	3	6	NO	NO	NO	YES		YES		
5	4	3	3	2	3	4	3	5	4	3	3	2	3				YES	overtime	YES	1	1
5	4	4	5	5	5	5	5	5	5	5	5	5	3	YES	NO	NO	YES		YES	1	1
5	3	1	4	3	2	3	1	4	2	3	4	2	4	YES	YES	NO	YES		YES	1	
3	1	2	4	3	2	3	2	5	3	1	3	2	3	NO	YES	NO	YES		YES	1	1
4	2	3	5	4	3	4		5	4	4	4		3	YES	YES	NO	NO		NO		
3	3	3	3	3	2	2	3	3	3	2	2	2	2	YES	NO	NO	YES	overtime	YES	1	
3	1	3	3	1	1	1	1	3		4	4	5	3	YES	YES	YES	NO		NO	1	
1	1	1	4	3	2	2	2	4	3	2	2	2	3	YES	YES	NO	YES		YES	1	
5	2	3	3	3	3	3	3	5	3	2	3	3	6						YES	1	1
2			4	3	3	3	3	4	3	3	3	3	2	YES	NO	NO	NO		YES		
			2	2	1	3	1	4	4	3	4	3	1	NO	NO	NO	NO	Hold existing estima	YES	1	
5	3	1	4	3	3	4	3	4	3	3	4	4	3	YES	YES	NO	YES		YES	1	
3	1	2	4	3	2	3	2	5	3	1	3	2	6	NO	YES	NO	YES		YES	1	1
4	4	3	5	5	5	3	4	5	5	5	5	5	4	NO	YES	NO	YES		YES	1	
5	3	3	5	3	4	3	3	5	1	4	3	1	3	YES	NO	NO	YES		YES	1	1
2	3	3	2	3	3	2	3	4	3	3	3	3	2	YES	NO	NO	YES		YES		
3	1	1	2	3	1	1	1	2	2	1	1	1	4	NO	YES	YES	YES		YES	1	1
			4	2	2	3		4	2	2	3		3	YES	NO	NO			YES	1	
4	3	3	3	2	2	2	1	5	3	4	1	3	3	NO	YES	NO	NO	overtime	YES	1	1
3		1	4	3	3	4	4	4	3	3	4	4	2	NO	YES	NO	YES		YES	1	
4	2	3	4	4	3	4	4	4	2	2	3	4			YES				YES	1	1
1	1	1	3	3	3	3	3	5	3	3	3	3	3	YES	YES	NO	NO		NO		
																			YES		
																			NO		
			4	4	3	4	2	3	4	3	3	3	2	NO	YES	YES	NO		YES	1	1
													2	NO	YES	NO	NO		YES	1	1
4	4	4	4	3	2	3	5	5	2	2	2	3	3	NO	YES	YES	YES		NO		
4	2	2	4	4	4	3	3	5	3	4	3	4	3	YES	YES	YES	YES		YES	1	1
2	1	3	3	3	3	2	2	3	3	3	2	2	3	NO	YES	NO	YES		YES	1	1
2	3	2												YES	NO	NO	NO		NO		
3	1	1	3	5	1	5	5	3	5	3	3	5	4	NO	NO	NO	YES		YES	1	
4	3	3	3	3	2	4	3	3	2	2	3	3	2	NO	YES	YES	YES		NO	1	1
5	3	2	4	3	3	2	4	4	4	3	3	4	4	YES	YES	NO	YES		YES	1	
													1	YES	YES	NO	YES		YES	1	
3	3	2	3		1	3	3	4	4	4	3	4	3	NO	NO	NO	YES		YES	1	
4	4	3	4	4	4	4	4	4	4	4	4	4	2	YES	NO	YES	YES		NO		
3													3				YES	overtime	YES	1	1
3	3	3	4	1	1	1	2	3	1	1	2	2	3	NO	YES	YES	NO		YES	1	1
5	4	2	2	3	1	1	2	2	2	1	1	3	3	NO	YES	YES	NO		YES	1	
4	4	3	4	3	4	3	3	4	3	4	3	3	3	NO	YES	NO	YES	For D above !!	YES	1	1
3	2	2	5	1	1	3	1	2	1	1	3	1	3	NO	YES	YES	NO				
2	1	1	3	1	4	3	2	3	3	4	3	2	2	NO	YES	YES	YES		YES	1	1
2	1	3	3	3	4	3	4	2	3	4	3	4	2	NO	YES	NO	YES		YES	1	1
5	3	2	5	1	1	3	4	5	2	2	4	3	3	NO	YES	NO	YES	overtime	YES	1	
2	3	4	4	2	2		3	5	3	3	3	2	3	NO	YES	YES	YES		YES	1	1
3	2	3	5	4	4	5	1	3	3	4	4	1	3	NO	NO	NO	NO		YES		
2	4	3											6	YES	NO	YES	NO		YES	1	
4	1	2	4	4	3	2	4	4	5	3	2	4	4	NO	NO	NO	NO	Augment the	YES	1	
5	3	3	5	3	3	4	4	5	3	3	4	4	3	YES	YES	YES	YES		YES	1	1
3	1	1	4	2	3	3	4	4	2	2	3	4	4	NO	NO	NO	YES		YES	1	1
4	4	1	4	2	1	3	3	4	2	1	3	3	2	YES	NO	NO	NO		YES	1	
5	3	2	4	3	4	4	4	4	3	4	4	4	3	NO					YES		
4	3	3	5	4	4	4	5	5	4	4	4	5	4	NO	YES	NO	YES		YES	1	
4	3	3	4	3	2	3	3	4	2	2	3	3	4	YES	NO	NO	YES		YES		
2	4	3	3	3	1	2	3	5	2	1	2	3	3		YES	YES	YES		YES	1	1
			5	3	3	3	4						3	NO	YES	NO	YES		YES	1	1
4	3	5	4	3	3	3	3	4	3	3	3	2	2		YES	YES	YES		YES	1	
4	4	2	5	2	2	5	3	5	2	2	5	3	3	YES	NO	NO	YES		YES	1	
			3	1	1	1	1	3					3	YES	YES	NO	NO		YES	1	1
3	1	2	2	2	1	1	2	3	2	1	1	1	6	YES	NO	YES	NO		NO		

												Q 3	Q4-a								Q4-b				
Type of Database Information (Total Project Cost)	Type of Database Information (Overhead & Profit)	Type of Database Information (Item Cost)	Type of Database Information (Labor Productivity)	Type of Database Information (Material Cost)	Type of Database Information (Equipment Cost)	Type of Database Information (Labor Wages)	Type of Database Information (Indirect Cost)	Type of Database Information (Escalation)	Type of Database Information (Project Information)	Type of Database Information (Models)	Type of Database Information (NA)	Mentoring Program	Database Software	Company developed estimating software	Commercially developed estimating software	Design / Engineering Skills	Site & Project Knowledge	Scheduling	Risk Analysis	Personal Relation	Database Software (Desired Training)	Company developed estimating software (Desired Training)	Commercially developed estimating software (Desired Training)	Design / Engineering Skills (Desired Training)	Site & Project Knowledge (Desired Training)
1	1	1	1	1	1	1	1	0	1	1	0	NO	2	0	4	0	4	4	4	3	2	0	4	3	5
1	0	1	0	1	1	0	1	0	1	0	0	YES	3	0	4	3	3	2	2	4	5	2	5	5	5
1	1	1	1	1	1	1	1	0	1	1	0	NO	3	3	1	1	4	3	3	0	4	4	1	1	4
1	1	1	1	1	1	1	1	1	1	0	0		3	4	2	3	4	3	4	3	4	5	3	3	4
												YES	5	0	5	3	2	4	3	4	5	0	5	3	3
0	0	1	1	1	1	1	0	0	0	0	0	YES	5	5	4	3	4	2	3	3	5	5	4	3	4
												YES	1		0	0	0		1	1	1	3	5	0	
1	1	1	1	1	1	1	1	1	1	0	0	YES	1	2	0	2	2	2	3	2	4	3	0	3	3
1	0	1	1	1	1	1	1	1	1	1	0	NO	4	5	3	2	4	3	4	3	4	5	4	4	4
0	0	0	0	0	0	0	0	0	0	0	1		4	4	4	3	3	2	2	0	4	4	4	3	3
0	0	1	1	1	0	1	0	0	1	1	0	YES	0	3	3	0	2	0	0	0	4	4	4	3	5
0	0	0	0	0	0	0	0	0	0	0	1	NO	0	1	0	0	0	0	0	0					
1	0	1	1	1	1	1	1	0	1	0	0	YES	4	3	1	1	2	1	3	3	4	4	1	3	4
0	1	0	1	0	0	0	1	1	1	0	0	NO	5	0	5	3	3	4	4	5	5	0	5	3	3
1	1	0	1	0	1	1	0	0	1	0	0	YES	4	4	4	1	3	3	4	2	5	4	2	3	4
1	1	1	1	1	1	1	1	1	1	0	0	NO	0	1	0	1	1	0	1	2	4	4	0	3	2
1	1	1	1	1	1	1	1	1	1	0	0	NO	0	4	4	0	0	0	0	2	4	4	4	5	5
0	0	1	1	1	1	1	1	0	0	0	0	YES	3	3	3	3	3	2	2	2	4	4	4	4	4
1	1	0	1	1	1	1	1	1	1	0	0	NO	3	4	3	0	4	2	2	4	4	4	5	0	4
0	0	0	0	0	0	0	0	0	0	0	1	YES	5	0	5	3	2	4	3	4	5	0	5	3	3
0	0	0	0	0	0	0	0	0	0	0	1	YES	5	0	5	3	2	4	3	4	5	0	5	3	3
0	0	1	1	1	0	0	0	0	0	0	0	NO	0	3	0	0	0	2	2	0	4	5	3	3	3
1	1	1	1	1	1	1	1	1	1	1	0	NO	4	0	5	3	3	3	1	4	4	0	5	4	4
0	1	1	1	1	1	1	1	1	1	0	0	NO	3	3	3	4	2	3	4	0	5	5	5	5	5
0	1	0	1	1	1	1	1	1	1	1	0	YES	4	3	4	3	1	3	3	2	4	5	4	4	5
1	1	1	1	1	1	1	1	1	1	1	0	YES	3		4	0	0	0	1	0	5	4	4	3	3
1	0	1	1	1	1	1	1	0	0	0	0	NO	1	5	1	0	1	0	0	4	4	5	5	3	4
1	1	1	1	1	1	1	1	1	1	0	0	NO	3	3	3	2	0	0	2	0	5	5	4	3	4
1	0	1	0	1	1	0	1	0	1	0	0	NO	1	3	1	4	4	3	2	3	5	4	3	4	4
0	0	0	0	0	0	0	0	0	0	0	1	NO	1	0	1	0	0	0	0	0	5	5	3	3	3
1	1	1	0	1	1	1	1	1	1	0	0	YES	5	5	4	4	5	3	4	5					
1	1	1	1	1	1	1	1	1	1	1	0	YES	4	4	0	3	3	1	1	1	4	4	0	3	4
1	1	0	1	1	1	1	1	0	1	0	0	YES	5	3	4	3	2	4	2	3	5	5	5	5	5
0	0	0	1	0	0	0	0	0	0	0	0	YES	4	4	0	0	3	0	0	0	4	4	2	3	3
0	0	0	1	0	0	0	0	0	0	0	0	NO	1	0	2	0	0	0	1	1	2	2	4	4	4
0	0	0	0	0	0	0	0	0	0	0	1	YES	4	3	0	2	3		4		4	3	0	4	5
0	1	1	1	1	1	1	1	1	1	0	0	NO	3	3	3	4	3	3	4	0	5	5	5	5	5
0	0	0	1	1	0	0	0	0	0	0	0	YES	3		4	4	4	4	2	4	5		5	5	5
1	1	1	1	1	1	1	1	1	1	1	0	YES	4	4	3	2	3	1	2	3	5	5	5	3	5
1	1	1	1	1	1	1	1	1	1	0	0	NO	2	2	2	0	1	2	3	3	3	3	3	0	1
1	1	1	1	1	1	1	1	1	1	1	0	NO	0	0	1	0	0	0	0	1	4	3	4	3	2
1	1	1	1	1	1	1	1	1	1	0	0	YES	3	2	4	4	4	3	3	4	5	4	5	5	5
1	1	0	1	0	0	1	1	1	0	0	0	NO	0	0	0	0	0	0	0	0					
1	0	0	1	1	1	0	0	0	1	0	0	NO	3	3	3	2	2	2	3	2	4	4	4	3	4
0	1	1	1	1	1	1	1	1	1	1	0														
1	1	1	1	1	1	1	1	0	0	0	0	NO	4	4	4	5	4	5	5	4	4	4	4	5	5
0	0	0	0	0	0	0	0	0	0	0	1	NO	2	1	3	1	1	1	1	2	4	4	4	5	5
1	1	1	1	1	1	0	1	1	1	0	0	YES	4	4	1	2	3	3	1	1	4	4	2	3	4
1	0	1	1	1	1	1	1	0	1	0	0		3	4	0	4	3	4	3	5	3	5	0	5	5
0	0	1	1	1	1	1	1	0	0	0	0	NO	3	4	4	1	2	4	3		3	4	4	4	4
0	0	0	0	0	0	0	0	1	0	1	0	NO	3	2	2	1	1	1	1	1	4	4	4	4	4
1	1	1	1	1	1	1	1	1	1	0	0	NO	1	0	0	1	1	1	2	1	4	4	0	4	3
1	1	1	1	1	1	1	1	1	1	1	0	NO	1	1	0	0	0	0	0	0	4	4	0	0	0
0	1	0	0	0	0	0	1	1	1	0	0	NO	5	3	2	0	1	0	2	4	5	4	4	2	5
0	1	0	1	0	0	0	0	0	0	0	0	YES	3	3	0	1	1	1	1	3	5	4	5	4	5
1	1	0	1	0	0	1	1	1	0	0	0	NO	2	3	2	0		3	1	5	4	5	5	2	
1	1	1	1	1	0	1	1	1	1	1	0	NO	5	4	4	2	5	4	3	4	4	3	4	4	5
0	0	0	0	0	0	0	0	0	0	0	1	NO	0	0	0	0	0	2	2	0	0	3	3	3	3
1	0	1	1	1	1	1	1	1	1	0	0	YES	3	3	0	3	4	2	2	3	5	5	0	5	5
1	1	1	1	1	1	1	1	1	1	1	0	YES	5	5	5	5	5	3	5	5	5	5	5	5	5
1	1	1	1	1	1	1	1	0	1	0	0	YES	2	2	2	2	3	0	3	3	4	4	2	4	4
0	0	0	1	0	0	0	0	0	0	0	0	YES	1	1					5		4	5			
1	1	1	1	1	1	1	1	0	1	1	0	YES	4	4	1	3	3	3	4	3	5	5	3	4	4
0	0	1	1	1	1	1	0	0	0	0	0	NO	5	3	0	0	0	0	0	0	5	3	0	3	3
1	0	0	1	1	1	1	0	0	1	0	0		3	3		3	4	3		2	3	3		3	4
1	0	1	0	0	1	1	0	0	0	1	0	YES	2	2	3	1	1	0	3		3	3	4	3	4
0	0	0	0	0	0	0	0	0	0	0	1	NO	1	1	4	3	1	2	2	2	4	0	5	2	3
1	0	0	0	1	1	0	0	0	1	0	0	YES	3	3	3	3	3	3	3	3	4	4	4	4	4
0	0	1	0	0	0	0	0	0	1	0	0	NO	5	5	1	4	5	3	4	4	5	4	1	4	5
1	0	1	1	1	1	1	1	0	1	0	0	NO	5	5	1	3	4	2	4	4	5	5	1	3	4
													3	1	4	4	5	5	5	5	5	4	5	5	5
1	0	1	1	1	1	1	1	0	1	1	0	NO	4	3	0	2	2	1	3	2	4	4	0	4	4
1	1	1	1	1	1	1	1	1	1	0	0		3	4	2	2	2	3	2	2	4	4	4	3	3
1	0	1	0	1	1	0	0	1	1	0	0	YES	3	4	0		2	2	2	4	5	5	2		3
1	1	1	1	1	1	1	1	1	1	1	0	YES	5	5	5	5	5	5	5	5	5	5	5	5	5
1	1	1	1	1	1	1	1	1	1	1	0	YES	5	5	0	0	1	0	1	1	3	3	5	4	5
1	1	0	0	1	0	1	1	1	1	1	0	YES	2	4	1	2	2	1	2	3	4	4	4	3	4
1	0	1	1	1	1	1	1	1	1	1	0	NO	5	3	2	1	0	2	3	3	5	5	4	5	5
1	1	1	1	1	0	0	0	0	0	0	0	YES	3	4	1	0	1	3	2	3	3	4	2		
1	1	1	1	1	1	1	1	1	1	0	0	YES	1	2	0	2	1	0	2	2	5	5	0	4	4

												Q 3	Q4-a								Q4-b				
Type of Database Information (Total Project Cost)	Type of Database Information (Overhead & Profit)	Type of Database Information (Item Cost)	Type of Database Information (Labor Productivity)	Type of Database Information (Material Cost)	Type of Database Information (Equipment Cost)	Type of Database Information (Labor Wages)	Type of Database Information (Indirect Cost)	Type of Database Information (Escalation)	Type of Database Information (Project Information)	Type of Database Information (Models)	Type of Database Information (NA)	Mentoring Program	Database Software	Company developed estimating software	Commercially developed estimating software	Design / Engineering Skills	Site & Project Knowledge	Scheduling	Risk Analysis	Personal Relation	Database Software (Desired Training)	Company developed estimating software (Desired Training)	Commercially developed estimating software (Desired Training)	Design / Engineering Skills (Desired Training)	Site & Project Knowledge (Desired Training)
0	1	0	1	0	0	0	0	0	0	0	0	YES	2	0	2	2	2	2	2		4	4	4	4	5
0	0	0	1	0	0	1	0	0	1	0	0	YES	3	0	0	4	3	2	1	3	3	0	0	3	3
1	0	1	1	1	1	1	1	0	1	0	0	NO	2	4	2	0	3	0	4	0	3	3	3	0	3
1	0	1	1	1	1	1	1	1	1	0	0	NO	2	3	2	0	2	2	3	3	4	4	4	2	4
0	0	1	1	1	1	1	0	0	0	1	0	YES	3	3	4	2	3	3	3	4	3	3	4	2	3
0	0	1	1	1	1	1	0	0	0	0	0	NO	0	0	4	0	0	0	4	0	3	3	3	4	0
1	1	1	1	1	0	1	1	1	0	1	0	YES	4	4	4	3	4	2	1	1	3	3	3	3	3
0	0	0	1	1	1	0	0	1	1	0	0	NO	0	3	3	4	4	0	0	3	0	3	3	4	4
1	1	1	1	0	0	0	0	1	1	0	0	NO	0	3	0	0	3	0	3	3	3	0	3		5
												NO	3	2	2	1	1	1	1	1		4	4	4	4
1	1	1	1	1	1	1	1	1	1	1	0	NO	2	4	0	3	1	1	3	1	0	3	3	3	4
1	1	1	1	1	1	1	1	1	1	1	0	NO	3	3	2	3	2	2	2	1	2	3	3	2	2
1	0	1	0	1	1	0	0	0	1	0	0	NO	1	2	2	0	0	0	2	0	3	5	5	1	1
1	1	1	1	1	1	1	1	1	1	0	0	NO	1	1	2	0	1	0	1	3	3	3	4	2	4
0	0	0	0	1	0	0	0	0	0	0	0	YES	3		3	2	2	1	1	3	3	3	2	3	5
0	0	1	0	1	1	1	1	0	0	0	0	NO	1	0	1	0	1	0	1	1	3	3	4	3	4
1	0	1	1	1	1	1	1	0	1	1	0	YES	2	4	0	2	2	2	2	3	4	5	3	3	5
0	0	0	0	0	0	0	0	0	0	0	0	YES	3	1	2	2	4	3	2	3				3	3
0	1	0	1	1	1	1	0	1	0	0	0	NO	2	0	5	3	4	4	4	4	3	0	3	4	4
1	1	1	1	1	1	1	1	1	0	0	0	NO	2	5	4	1	0	0	4	3	3	5	4	3	5
0	0	0	0	0	0	0	0	0	0	0	1	YES	2	3	4	2	2	2	2	3	2	3	3	3	3
1	1	1	1	1	1	1	1	1	1	1	0	NO	3	3	3	2	2	2	2	3	3	3	3	3	3
0	0	0	0	1	1	1	0	0	0	0	0	NO	2	2	0	2					3	3	2	3	
1	1	1	0	1	0	1	0	1	0	0	0	NO	3	3	3	3	3	1	1	2	3	3	3	3	4
0	0	1	0	0	0	0	0	0	0	0	0	NO	2	4	4	2	2	2	2	2	4	4	4	2	2
1	1	1	1	1	1	1	1	1	1	1	0	NO	0	3	0	2	0	0	2	0					
												YES	1												
1	1	1	1	1	1	1	1	1	1	0	no	NO	0	3	4	1	1	2	1	3	3	3	3	3	3
1	1	1	1	1	1	1	1	1	1	0	0	NO	1		1	1	1	0	0	2	2		3	3	4
0	0	0	0	0	0	0	0	0	0	0	1	NO	0	0	0	0	0	0	0	0	3	0	3	3	3
1	0	0	0	0	1	0	1	0	0	0	0	NO	0	0	2	2	2	3	2	1	4	4	3	4	4
1	1	0	0	0	1	0	0	1	0	0	0	NO	3	0	2	4	4	3	3	2	4	0	3	4	4
0	0	0	0	1	1	1	0	0	0	1	0	NO	0	0	3	4	3	4	3	0	3	0	3	4	4
1	0	1	1	1	0	0	0	0	1	0	0	NO	2	3	3	4	2	1	1	1	2	4	4	2	3
1	0	1	1	1	0	1	1	0	1	1	0	YES	3	3	4	3	3	4	3	3	4	3	4	3	3
0	1	1	0	0	0	0	0	0	0	0	0	NO					3								
1	0	1	1	1	1	1	1	0	1	0	0	YES	3	3	0	1	3	3	2	3	2	3	0	1	3
1	1	1	0	1	1	1	1	1	1	1	0	YES	3	3	3	2	2	2	3	2	4	4	4	4	4
1	0	0	1	0	1	1	0	0	1	0	0	NO													
	1	1	1	1	1					1		YES	3	0	4	3	2	4	0	0	4		4	3	3
1	1	1	1	1	1	1	1		1	1		NO	4	4	4	2	2	1		3	4	4	4	4	4
											1	NO	0	0	0	0	5	3	3	0	3	3	3	0	3
		1		1	1		1		1			YES		5	2	0	3	0	1	0	1	5	4	2	5
			1									YES	5	2	2	5	3	1	3	2	5	4	4	5	3
1									1	1		YES	5	4	1	3	3	3	4	3	5	4	3	3	3
1	1	1	1	1	1	1	1	1	1			YES	3	3	4	4	4	3	5	4		3	4	3	4
1	1	1	1	1	1	1	1		1			NO	3	0	3	4	3	4	4	4	3	0	3	4	5
1	1	1	1	1								NO	3	4	2	3	3	3	2	3	3	4	3	4	4
1									1			NO	1	1	0	3	2	4	1	4	3	1	3	3	3
1		1	1	1	1	1	1		1			NO	4	4	3	2	4	2	1	3	4	4	4	3	3
	1	1	1	1	1	1			1	1		NO	1	0	3	1	2	1	1	2	3	0	4		
		1		1									4	3	3	0	3	3	3	3	4	3	3	1	3
1	1	1						1	1	1		YES	4		4		1	4	4	4	4		4		2
	1			1	1	1						NO	0	3	0	0	0	0	1	3	2	3	3	0	0
											1	NO													
													0	2	0	0	1	0	0	0	4	4	4		3
												NO	3	0	3	2	3	3	1	2	4	0	4	4	4
1	1	1	1	1	1	1	1	1	1	1		YES	3	4	4	3	2	3	3	3	3	4	4	3	4
				1	1					1		YES	3	3	3	2	4	1	4	4	3	3	3	4	4
1	1	1	1	1	1	1	1	1	1	1		YES	1	1	4	1	2	1		1	2	3	3	3	3
1	1	1	1	1	1	1	1		1	1		YES	4	4	4	3	3	3	3	3	4	4	4	4	4
	1		1			1	1	1				YES	3		3	1	1	0	1		4	3			
											1	YES	2	2	3	2	3	1	2	3	4	3	4	2	4
1		1	1	1	1	1	1	1	1	1		YES	3	4	2	2	2	1	2	4	4	4	3	3	
1	1	1	1	1	1	1	1	1	1	1		YES	2	4	2		4			4	4	3	4		4
1												NO	4		0	1	4	2	1	2	3		3	4	5
1		1	1	1					1			YES	1	3	1	2	1	1	1	2	4	1	3	5	4
1	1	1	1	1	1	1	1	1	1			YES	3	4	0	0	3	4	4	4	5	5	3	3	5
1		1	1	1		1	1	1				YES	2	2	4	3	3	2	3	3	4	4	3	3	4
1	1	1	1	1	1	1	1	1	1	1		YES	4	4	4	0	0	4	4	4	4	4	4	4	4
			1	1								YES	2							4	4	2			
			1					1				YES	4	3	4	2	2	3	1	4	5	3	3	4	4
				1		1						YES	4	4	0	0	4	0	0	4	4	4	0	0	4
1	1	1	1	1	1				1			YES	3	3	2	3	3	3	3	3	3	3	3	3	3
1					1				1			NO	0	2	4	0	0	0	1	3	2	2	4	3	3
1	1	1	1	1	1	1			1			YES	4	4	0	3	2	4	1	4	3	3	1	4	4
			1	1	1	1			1			YES	3	4	3	3	2	3	4	5	4	5	4	2	3
												YES	3	4	3	3	4	4	3	5	4	4	3	4	3
				1	1	1		1				NO	2	0	2	0	1	0	0	3	2	2	4	3	3
1	1	1	1	1	1	1	1	1	1	1		YES	3	3	2		3	0	3	4	3	3	3		3

												Q 3	Q4-a								Q4-b				
Type of Database Information (Total Project Cost)	Type of Database Information (Overhead & Profit)	Type of Database Information (Item Cost)	Type of Database Information (Labor Productivity)	Type of Database Information (Material Cost)	Type of Database Information (Equipment Cost)	Type of Database Information (Labor Wages)	Type of Database Information (Indirect Cost)	Type of Database Information (Escalation)	Type of Database Information (Project Information)	Type of Database Information (Models)	Type of Database Information (NA)	Monitoring Program	Database Software	Company developed estimating software	Commercially developed estimating software	Design / Engineering Skills	Site & Project Knowledge	Scheduling	Risk Analysis	Personal Relation	Database Software (Desired Training)	Company developed estimating software (Desired Training)	Commercially developed estimating software (Desired Training)	Design / Engineering Skills (Desired Training)	Site & Project Knowledge (Desired Training)
1	1	1	1	1	1	1	1	1				YES	4	3	3	0	1	0	0	2	4	3	3	0	1
1	1	1	1	1	1	1	1	1	1	1		YES													
1	1	1		1	1	1	1	1	1	1		NO	4	4	5	3	3	2	3	3	3	5	5	3	5
1	1	1	1	1	1	1	1	1	1	1		YES	3	2	2	1	1	1	2	3	5	5	3	5	5
												YES									5	5	3	3	5
											1	YES	5	3	3	4		0	0	4		0	0	4	4
1	1	1	1	1	1	1	1		1			NO	2	1	1	1	0	1	1	1	4	3	4	0	3
1	1	1	1	1	1	1	1	1	1	1		YES	5	5	2	5	5	5	5	3	5	5	2	5	5
1		1				1						NO	3	1	4	0	2	0	1	0	5	4	5	2	4
	1	1	1	1	1	1	1	1				NO	3		4	3	3	1	1		4	4	4	4	4
												YES	3	1	4	0	2	2	3	4	4	5	4	2	4
		1	1	1		1						NO	0	5	3	0	3	0	3	4	3	5	2	3	4
1												NO		0	3	0	0	1	0	0	5	3	4		
				1	1	1	1			1		NO	3	4	0	3	3	2	3		4	4	0	4	4
1	1	1	1	1	1	1	1	1	1	1		YES	3	3	2	0	3	0	3	3	3	3	3	3	5
1			1	1	1	1			1			NO	1	1	0	2	2	1	2	1	3	3	1	4	3
		1				1			1			NO	1	1	0	0	3	1	0	0	3	4	1	3	4
1	1	1	1	1	1	1	1	1	1			YES	2	3	4	2	3	2	2	3	4	4	5	3	5
	1	1	1	1	1	1	1	1		1		NO	3		4	3	3	1	3	3	4	4	4	4	4
1	1	1	1	1	1	1	1		1			YES	5		5	5	4	4	4	4	5	5	5	5	5
1	1	1	1	1	1	1	1	1	1	1		NO	3	0	3	0	3	4	3	3	0	0	3	0	3
											1	NO	3	3	3	3	3	2	3	3	4	4	4	4	3
1	1	1	1	1	1	1	1	1	1	1		NO	2	4	4	2	3	2	3	3	5	1	4	4	3
		1	1	1	1	1	1					NO	4	3	0	4		2	3	4	5		0	5	5
1	1	1	1	1	1	1	1	1	1	1		NO	3	3	3	0	0	1		0	4	4	3	3	4
	1	1	1	1		1	1		1	1		NO	3	3	3	2	2	3	3	2	4	4	5	4	4
1	1	1	1	1	1	1	1	1	1			YES	4	4	2	4	4	4	4	4	4	2	1	2	5
											1	NO	4	3	0	3	5	2	0	0	4	5	0	3	5
												YES													
											1	NO													
1		1	1	1	1	1		1	1			NO	4	4	3	3	3	2	4	3	5	5	3	3	3
1	1	1	1	1	1	1		1	1	1			0	1	1	3	3	1	5	2	4	3	3	4	5
											1	YES	5	1	5	4	5	4	4	5	5	1	5	4	5
1		1		1	1	1	1	1	1	1		NO	2	0	4	4	4	4	5	3	3	0	4	5	4
1	1	1	1	1	1	1	1	1	1	1		YES	3	3	3	1	3	1	4	1	4	4	3	3	3
											1	NO	5	0	0		3	4	3	4	4	4	3		5
1	1	1		1	1	1	1		1			NO	0	3	3	2	3	3	2	1	3	3	3	2	2
1			1			1	1		1			YES	1	2	3	1	1	1	2	1	1	2	4	2	3
		1	1	1	1	1	1		1	1		Y	3	4	4	2	3	3	3	4	3	4	4	3	4
	1					1						NO	2	3	3	2	1	1	3	1	3	3	3	3	4
		1	1	1		1	1			1		Y	3	3	4	3	3	3	3	3	4	4	4	3	5
												NO	5	0	3	4	4	4	4	4	5	0	5	4	4
	1	1		1	1	1	1		1	1			4	4	0	3	4		5		4	4		3	4
1	1	1	1	1	1	1	1	1	1	1		NO	1	0	5	1	4	1	3	4	1	0	5	3	5
			1		1	1						YES	4	0	4	2	4	3	3	3	3	0	4	2	3
1	1	1	1	1	1	1	1	1	1	1		NO	2	3	3	3	4	3	2	3	4	4	4	5	4
											1	YES	1	0	2	0	1	1	0	1	1	0	3	3	4
1	1		1	1	1	1	1	1	1			YES	5	3	5	3	4	4	4	2	5	5	5	4	5
1	1	1	1	1	1	1	1	1	1	1		YES	3	4	1	3	5	2	3	3	4	5	2	4	5
			1	1	1							NO	0	2	0	0	0	0	3	0	4	4	0		4
1	1	1	1	1	1	1		1	1	1		NO	3	1	3	1		1	2	2	3	2	4	4	4
1				1	1	1	1		1			YES	4	2	4	0	1	0	1	3	4	3	4	2	3
1									1	1			0	0	0	0	0	0	0	0	2	0	0	0	2
1	1	1	1	1	1	1	1		1	1		YES	2	5	2	1	2	1	2	1	4	3	2	2	4
	1	1	1	1	1	1	1	1	1	1		YES	3	3	3	0	0	0	0	0	5	5	3	3	5
1		1	1	1	1	1	1					YES	2	4	3	5	5	5	5	3	5	1	5	5	5
1	1		1		1				1			YES	3	3	0	1	1	0	1	1	5	5	0	5	3
				1	1	1	1					NO	2	2	0	3	3	3	2	2	2	3	0	3	3
1		1	1	1	1	1	1	1	1			YES	4	5	4	4	4	3	4	4	5	5	5	4	4
				1		1						NO	2	2	1	2	4	3	3	4	5	2	5	3	5
1	1	1	1	1	1	1	1	1	1	1		NO	5	3	5	3	4	4	4	4	5	4	5	4	5
1	1	1	1	1	1	1	1	1	1			YES	4	4	4	2	3	3	3	3					
												NO	2	0	5	4	5	4	4	5	5	3	5	4	5
		1	1	1	1	1	1					NO	0	0	4		3	3	2	0	0	0	4		3
1		1	1	1	1	1	1	1	1	1		NO	3	1	4	2	3	2	2		3	3	3	3	3
											1	NO	1	0	0	3	3	4	4	3	3	0	0	3	3

			Q4-c								Q 5							Q6						
Scheduling (Desired Training)	Risk Analysis (Desired Training)	Personal Relation (Desired Training)	Database Software (Can be passed by Training)	Company developed estimating software (Can be passed by	Commerciall y developed estimating software (Can be passed by	Design / Engineering Skills (Can be passed by Training)	Site & Project Knowledge (Can be passed by Training)	Scheduling (Can be passed by Training)	Risk Analysis (Can be passed by Training)	Personal Relation (Can be passed by Training)	External, formal classroom based training (Method Effectiveness)	Internal, company based training program (Method Effectiveness)	Mentoring from experienced estimator (Method Effectiveness)	On-The-Job training by preparing estimates (Method Effectiveness)	Online based training programs (Method Effectiveness)	Workshop specializing in estimating (Method Effectiveness)	Publishing documents & guidelines (Method Effectiveness)	Associate degree 2-years programs (Education /Trainings	Bachelor degree - Technical based (Education /Trainings	Bachelor degree - Non Technical based (Education /Trainings	Master Degree - Technical based (Education /Trainings	Master degree - Non Technical based (Education /Trainings	On-The-Job Training - Field Experience (Education /Trainings	On-The-Job Training - Office Experience (Education /Trainings

			Q4-c								Q 5							Q6						
Scheduling (Desired Training)	Risk Analysis (Desired Training)	Personal Relation (Desired Training)	Database Software (Can be passed by Training)	Company developed estimating software (Can be passed by	Commercially developed estimating software (Can be passed by	Design / Engineering Skills (Can be passed by Training)	Site & Project Knowledge (Can be passed by Training)	Scheduling (Can be passed by Training)	Risk Analysis (Can be passed by Training)	Personal Relation (Can be passed by Training)	External, formal classroom based training (Method Effectiveness)	Internal, company based training program (Method Effectiveness)	Mentoring from experienced estimator (Method Effectiveness)	On-The-Job training by preparing estimates (Method Effectiveness)	Online Based training programs (Method Effectiveness)	Workshop specializing in estimating (Method Effectiveness)	Publishing documents & guidelines (Method Effectiveness)	Associate degree 2-years program (Education /Training	Bachelor degree - Technical based (Education /Training	Bachelor degree - Non Technical Based (Education /Training	Master Degree - Technical based (Education /Training	Master degree - Non Technical based (Education /Training	On-The-Job Training - Field Experience (Education /Training	On-The-Job Training - Office Experience (Education /Training

			Q4-c								Q 5							Q6						
Scheduling (Desired Training)	Risk Analysis (Desired Training)	Personal Relations (Desired Training)	Database Software (Can be passed by Training)	Company developed estimating software (Can be passed by	Commercially developed estimating software (Can be passed by	Design / Engineering Skills (Can be passed by Training)	Site & Project Knowledge (Can be passed by Training)	Scheduling (Can be passed by Training)	Risk Analysis (Can be passed by Training)	Personal Relations (Can be passed by Training)	External, formal classroom based training (Method Effectiveness)	Internal, company based training program (Method Effectiveness)	Mentoring from experienced estimator (Method Effectiveness)	On-The-Job training by preparing estimates (Method Effectiveness)	Online based training programs (Method Effectiveness)	Workshop specializing in estimating (Method Effectiveness)	Publishing documents & guidelines (Method Effectiveness)	Associate degree 2-years program (Education /Training)	Bachelor degree - Technical based (Education /Training)	Bachelor degree - Non Technical based (Education /Training)	Master Degree - Technical based (Education /Training)	Master degree - Non Technical based (Education /Training)	On-The-Job Training - Field Experience (Education /Training)	On-The-Job Training - Office Experience (Education /Training)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

			Q4-c								Q 5							Q6						
Scheduling (Desired Training)	Risk Analysis (Desired Training)	Personal Relation (Desired Training)	Database Software (Can be passed by Training)	Company developed estimating software (Can be passed by	Commercially developed estimating software (Can be passed by	Design / Engineering Skills (Can be passed by Training)	Site & Project Knowledge (Can be passed by Training)	Scheduling (Can be passed by Training)	Risk Analysis (Can be passed by Training)	Personal Relation (Can be passed by Training)	External, formal classroom based training (Method Effectiveness)	Internal, company based training program (Method Effectiveness)	Mentoring from experienced estimator (Method Effectiveness)	On-The-Job training by preparing estimates (Method Effectiveness)	Online based training programs (Method Effectiveness)	Workshop specializing in estimating (Method Effectiveness	Publishing documents & guidelines (Method Effectiveness	Associate degree 2-years programs (Education /Training	Bachelor degree - Technical based (Education /Training	Bachelor degree - Non Technical Based (Education /Training	Master Degree - Technical Based (Education /Training	Master degree - Non Technical Based (Education /Training	On-The-Job Training - Field Experience (Education /Training	On-The-Job Training - Office Experience (Education /Training
0	0	2	5	4	3	3	2	3	2	3	3	4	5	5	3	4	2	1	3	3	3	3	5	5
											2	3	5	5	3	3	2	2	2	2	2	2	4	5
3	3	3	3	5	3	4		3	4	4	2	3	4	5	2	3	2	2	3	4	3	4	4	5
3	4	4	4	3	3	3	3	1	4	4	3	3	4	5	2	3	3	4	3	3	2	2	3	3
4	3	4	3	5	3	3	3	4	3	4	3	4	5	5	3	3	3	3	5	3	4	3	5	4
4	4	4	5	5	5	5	3	3	3	4	3	5	5	5	3	5	4	4	4	4	4	4	4	4
2	4	3	5	4	4	3	3	3	3	3	2	4	5	4	4	4	4	5	4	2	3	2	5	4
5	5	3	4	4	4	4	3	3	3	4	3	5	5	3	3	3	3	3	5	3	3	3	5	3
2	4	2	3	3	4	3	1	3	3	3	3	4	5	4	1	2	3	4	5	4	1	1	5	5
4	4	4	3	3	3	2	3	3	3	3	1	2	3	5	1	1	3	5	5	3	1	1	5	5
3	3	5	5	5	5	3	2	3	3	3	2	4	5	5	3	3	3	2	4	4	2	1	5	4
4	5	4	1	3	2	1	3	2	2	2	2	2	4	5	1	3	1	3	3	2	3	2	4	4
4	4	1	3	1	3	1	3	4		2	3	1	5	5	1	2	1	5	4	2	2	1		3
3	0	0	4	4	1	4	4	3	1	1	3	3	5	4	2	2	2	4	5	3	3	2	4	4
5	3	3	3	5	5	3	3	5	3	3	3	3	5	5	3	5	3	3	3	3	3	3	5	5
3	3	4	4	4	4	4	3	4	2	2	3	4	4	4	3	3	2	2	4	3	3	3	3	3
3	3	3	2	4	3	4	5	3	5	5	4	4	5	4	3	3	3	3	5	3	2	2	4	4
4	5	4	4	4	4	2	2	4	3	2	2	4	4	4	2	3	3	3	3	3	2	2	4	4
4	4	4	3	3	3	3	2	3	2	3	1	3	4	5	1	1	3	5	5	3	1	1	5	4
5		5	3	3	2	3	3	3	1	4	3	5	5	5	4	3	3		3	4	1	1	5	5
5	5	5	1	1	4	1	5	3	4	5	3	5	5	5	1	5	1	1	5	2	4	1	5	5
3	4	4	3	3	3	3	3	3	4	4	4	4	4	3	3	4	3	1	5		2	3	3	4
5	5	2	5	1	4	3	5	5	5	2	3	4	5	5	3	5	2	4	4	2	2	2	5	5
4	4	4	3	3		3	3	5	3	3		3	5	4	3	4	3	3	4	2	4	3	4	3
4	4	4	3	5	5	3	3	3	3	1	3	4	4	4	3	3	3	4	4	2	3	2	5	4
2	4	4	3	5	3	3	3	4	4	1	4	4	5	5	3	3	3	5	4	2	3	3	4	5
4	4	3	3	3	3	3	5				3	4	5	3	1	5	4	3	4	4	2	3	5	4
2	0	0	5	1	1	3	1	2	1	1	1	3	5	5	1	3	2	3	5	2	3	1	5	2
											1	4	4	5	2	3								
																			4				3	2
3	3	4	4	4	4	3	3	3	4	3	3	4	5	5	3	4	3	3	4				4	4
2	2	3	4	4	4	4	5	4	3	4	3	3	4	3	3	3	2	3	3	2	3	3	4	4
5	5	5	5	5	5	5	5	4	5	5	4	4	5	5	3	5	4	4	5	5	3	1	4	4
5	3	4	3		2	3	2	3	1	3	4	3	5	4	3	3	4	3	4	3	3	3	4	3
3	4	3	3	4	3	3	3	3	4	3		4	4	4	3	4	3	3	1	3	4	4	2	2
3	4	4	5	4	4		4	4	4	5	2	4	5	4	2	3	3	2	5	1	3	1	5	4
3	3	3	5	5	5	3	1	3	1	1	1	5	5	3	1	2	3	3	2	2	1	1	5	3
3	3	3	5	3	3	3	4	4	3	4	5	4	5	5		4	3	3	5	2	3	3	4	2
3	3	4	4	4	4	4	3	4	4	1	3	4	4	4	2	2	3	3	4	2	3	2	5	4
3	3	3	4	4	4	3	3	4	4	3	1	3	5	5	1	1	5	2	4	2	3	1	5	5
4	4	4	4	4	4	3	1		3	4	3	4	4	4	3	3	3	3	3	2	3	2	5	4
4	4	4	4	1	3	4	4	4	4	4	3	4	4	5	3	4	4	2	4	2	3	3	4	4
	3		4	3		3	3		3		1	3	5	5	3	3	2	3	3	3	1	1	5	3
4	3	4	3	5	3	3	1	1	3	3	3	3	5	4	3	3	2	3	5	5	1	1	5	5
3	3	3	3	1	3	3	4	4	4	4	4	3	5	5	2	3	2	2	2	3	1	1	5	3
4	3	5	4	3	3	1	3	3	3	3	3	3	5	4	3	3	2	3	3	2	3	2	4	4
3	3	3	4	3	3	3	4	3	3	3	3	4	5	5	3	4	2	2	3	3	4	1	5	4
4	3	4	4	3	3	3	3	3	3	3	3	3	3	4	2	3	3	3	4	2	1	1	4	4
3	4	4	4	4	3	3	3	3	3	3	1	5	5	5	3	3	3	2	4	3	3	1	4	4
3	4	0	3	3	3	4	2	3	3	1	1	3		5	2	3	3	5	3	2	3	2	4	3
3	4	3	3	3	3	3	3	3	4	4	3	4	5	5	2	4	2	5	2	3	1	1	3	3
3	4	3	4	4	4	3	3	3	3	3	2	4	5	5	3	4	3	4	4	4	4	4	4	4
3	4	3	3	5	3	3	3	3	4	4		3	4	4	2	4	2	2	4	2	4	2	4	4
3	3	4	3	5	5	3	3	3	3	3	1	3	5	5	2	3	3	2	4	3	3	2	3	3
5	3	3	3	3	3	3	1	2	3	1	3	3	5	4	3	2	2	2	4	3	4	4	3	3
5	3	3	3	4	5	4	4	4	4	4	3	3	5	3	2	3	2	2	5	3	3	3	3	2
4	3	4	3	5		1	3	3	1	3	1	3	5	5	3	3	3	3		5	1	1	5	3
3	3	3	4	4	4	3	3	4	3	3	3	4	4	5	3	3	3	2	2	3	3	2	5	4
4	4	4	3	3	4	4	4	4	4	4	4	3	5	5	2	4	4	3	4	4	4	4	5	3
3	4	3	4	3	4	3	3	3	3	3	2	3	5	5	2	2	2	3	4	3	4	2	3	4
4	4	3	3	3	3	4	4	4	4	4	4	4	3	3	3	4	4	4	4	3	3	3	3	3
				2							2	3	3	4	3	3	3	1	4		2	1	2	4
3	3	3	3	3	3	4	3	3	4	3	3	4	4	3	4	3	4		4	3	3			
3	4	3	3		4		1	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3		5		2	2	2	2	2		2	2	4	3	3	2	1	1	4	3	3	2	3	4
5	3	4	3	3		3	3	3	3	3	4	3	4	4	3	3	4	3	4	3	3	1	4	4

Q 1	Q 2	Q3						Q 4	Q 5				Q 5-part 2				Q 6					Q 7	
Cost estimators shortage occur	% estimators projected to retire in 5 years	% highest qualification of (Technical Certificate)	% highest qualification of (College degree engineers)	% highest qualification of (College degree non-engineers)	% highest qualification of (Graduate degree engineers)	% highest qualification of (Graduate degree non-engineers)	% highest qualification of (No degree or certificate)	Compare estimators qualification to other professional	Current number of estimators (Less than 5 years of experience)	Current number of estimators (5-10 years of experience)	Current number of estimators (10-15 years of experience)	Current number of estimators (More than 15 years of experience)	Desired number of estimators (Less than 5 years of experience)	Desired number of estimators (5-10 years of experience)	Desired number of estimators (10-15 years of experience)	Desired number of estimators (More than 15 years of experience)	Accounting	Design/ Engineering	Contracting	Field Construction	Project Management	Intrinsic Values (Compensation)	Intrinsic Values (Diversity of work)
1	3	0%	20%	0%	0%	0%	80%	2	1	1	2	3	2	2	4	3	1	3	2	4	4	5	4
1	3	0%	75%	10%	0%	10%	5%	3	2	3	5	25	2	3	5	25	2	5	4	5	4	4	3
5	2	10%	50%	25%	5%	5%	5%	3	25	25	10	15	25	25	10	15	3	3	4	4	4	3	4
5																		5	3	3	4	3	4
1	2		30%					3	6	7	10	8	4	12	4	3	1	3	4	5	3	5	5
1	2		30%	40%	5%	5%	20%		5	10	5	10	10	10	10	10	4	3	4	4	3	3	4
5	1							3	1	0	0	1	0	1	0	1	1	4	5	5	5	5	2
4	3	25%	25%	50%				2	0	0	1	1					2	4	4	4	4	3	4
2	4	5%	10%		85%			2	50	50	10	10	100	100	20	15	2	4	2	3	4	4	4
2	5									1	1	7					2	4		4	3	4	4
1	5	4%	0%	0%	0%	0%	1%	2	0	0	1	5	4	3	4	3	2	4	3	3	2	4	4
1		0%	0%	0%	0%	0%	100%										3	4	4	5	4		
	2			30%	70%			3	6	6	4	8	6	4	6	8	1	3	3	4	2	4	4
1	4				75%		25%	3	4	3	0	8	5	6	2	10	4	4	5	5	4	5	5
1	1	10%	25%	20%	5%		40%			5		10	2	5	2	10	2	4	4	4	4	5	4
1	3	21%	40%	12%	17%	6%	4%	2	63	27	24	66					1	4	1	3	5	4	3
2	3	21%	40%	12%	17%	6%	4%	2	3	1	0	8					1	4	3	5	2	5	5
1	3						85%	3	1			11	1			11	1	1	3	5	4	4	4
1	3	30%	40%	10%	0%	0%	0%	3	4	2	0	4	4	2	0	4	1	4	1	5	5	4	4
1	2		10%	80%			10%		6	7	10	8	5	10	10	6	3	4	4		3	5	4
1	2		35%	30%	5%		30%	3	6	7	10	8	5	12	10	8	3	3	4	5	3	5	5
2	5	50%	50%					3	0	0	0	3					1	2	1	5	5	5	5
2	4		85%		15%					1	1	2	1	2	2	2	1	4	2	4	4	3	3
1	4	20%			75%	5%		3	38	11	19	10	5	15	20	40	3	5	4	5	5	3	2
1	4	10%			90%			3	40		20		10	30	20		3	4		5	4	4	4
5	4		50%	25%			25%	3	2	0	0	3	2	0	2	3	3	4	4	5	5	4	4
2	5			25%	50%		25%	4	0	0	0	4	2	0	2	2	1	5	3	4	3	5	4
1	4	25%	20%	40%	5%	10%	15%	3	4	5	3	14	4	5	7	10	2	4	3	5	4	4	4
1	3		75%	75%				2	1	0	0	0	5	0	0	0	3	4	4	4	4	4	4
1	4			50%				2	2	1	0	6	4	1	0	6	5	5	3	5	3	4	4
5	4			10%	90%			4	20	10	12	20	0	20	0	52	3	4	4	5	4	3	4
1		21%	40%	12%	17%	6%	4%	3	63	27	24	66						4	4	4	4	4	4
5	2	10%		5%	85%			4	38	11	19	10	15	20	22	21	3	5	2	5	4	1	5
1	1		70%		10%		20%		1	0	0	8	1	1	1	9	2	4	3	4	3	3	4
1	4		20%	70%			10%	3	1	0	1	8	2	2	4	4	2	4	3	5	5	5	3
1	4	21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	5	3	5	3	5	3
1	2	20%			75%	5%		3	38	11	19	10	5	15	20	40	4	5	4	5	5	3	3
1	4	10%	10%	70%		10%		3	1	0	4	7	3	5	5	7	2	3	4	5	4	4	5
2	1	20%			70%	10%		3	30	10	0	30	10	20	0	40	3	5	5	4	2	3	4
1	4		100%	50%				3	0	0	0	2	0	0	0	5	2	3	3	5	5	4	3
1	5			83%			17%	2	2	1	1	1	2	2	2	1	4	5	3	5	1	5	4
1	4				80%	20%		3	40	10	10	20	20	20	20	20	4	5	4	4	5	5	4
1	5		50%	50%				3	0	0	0	2	0	0	0	5	2	4	5	5	5	5	4
1	3	21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	3	4	4	3	4	3
1		21%	40%	12%	17%	6%	4%		63	27	24	66						4	3	4	3	4	3
5		21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	4	4	5	4	4	4
1		21%	40%	12%	17%	6%	4%	2	63	27	24	66					1	2	3	4	3	4	4
1		21%	40%	12%	17%	6%	4%	3	63	27	24	66					5	5	4	5	5	5	5
5		21%	40%	12%	17%	6%	4%		63	27	24	66					1	3		4	3	4	3
1		21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	4	3	5	5	4	5
1	3		60%				40%	3	2	2	0	6	2	2	2	4	2	3	4	5	4	3	
1	3	0%	56%	11%	11%	0%	22%	3	1	0	1	7	5	5	5	10	2	4	4	4	3	4	4
2	1	0%	0%	100%	0%	0%	0%	3	0	0	1	0	1	2	3		2	4	4	5	4	5	3
1	1	21%	40%	12%	17%	6%	4%	3	63	27	24	66	25	50	75	50	1	2	3	4	4	4	4
2		21%	40%	12%	17%	6%	4%	2	63	27	24	66					4	4	5	5	5	5	4
1	5	21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	3	1	5	1	3	4
1	4	21%	40%	12%	17%	6%	4%	3	63	27	24	66					1	5	3	5	2	4	5
2		21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	5	4	5	3	4	4
		21%	40%	12%	17%	6%	4%	3	63	27	24	66					3	4	2	4	3	3	4
1	3	21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	4	4	3	3	5	4
2		21%	40%	12%	17%	6%	4%		2	2	2	0	0	2	4	0	3	5	5	5	4	5	5
1	2	21%	40%	12%	17%	6%	4%	3	63	27	24	66					1	3	3	5	3	4	5
1		21%	40%	12%	17%	6%	4%	3	63	27	24	66					1	3	3	5	4	5	4
1		21%	40%	12%	17%	6%	4%	4	63	27	24	66					3	4	4	5	4	5	4
3	3	21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	5	3	5	4	5	4
2		21%	40%	12%	17%	6%	4%	3	63	27	24	66						4		4		3	4
		21%	40%	12%	17%	6%	4%	2	63	27	24	66					1	4	1	5	2	3	4
1	5	21%	40%	12%	17%	6%	4%	3	63	27	24	66					1	4	3	5	3	4	4
5	2	21%	40%	12%	17%	6%	4%	2	63	27	24	66	65	25	25	50	3	4	3	4	4	4	
1	2	21%	40%	12%	17%	6%	4%	3	63	27	24	66						4	2	4	5	4	5
3	1	21%	40%	12%	17%	6%	4%	3	63	27	24	66					1	3	3	4	3	3	3
1		21%	40%	12%	17%	6%	4%	2	63	27	24	66							5	5		4	4
1		21%	40%	12%	17%	6%	4%	3	63	27	24	66					4	5	4	5	5	5	4
1		21%	40%	12%	17%	6%	4%	3	63	27	24	66					1	4	4	5	3	4	4
1	2	21%	40%	12%	17%	6%	4%	4	5	10	15	10	5	5	15	15	5	4	2	3	2	3	2
5		21%	40%	12%	17%	6%	4%		63	27	24	66					1	5	1	5	5	5	5
1		21%	40%	12%	17%	6%	4%	4	63	27	24	66					1	3	1	4	4	5	4
1		21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	3	3	4	3	4	4
2		21%	40%	12%	17%	6%	4%	2	63	27	24	66					1	4	3	5	4	4	4
		21%	40%	12%	17%	6%	4%	3	63	27	24	66					3	1	4	5	5	3	4
1		21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	5	4	4	3	5	5

Q 1	Q 2	Q3						Q 4	Q 5				Q 5-part 2				Q 6					Q 7	
Cost estimators shortage occur	% estimators projected to retire in 5 years	% highest qualification of (Technical Certificate)	% highest qualification of (College degree engineers)	% highest qualification of (College degree non-engineers)	% highest qualification of (Graduate degree engineers)	% highest qualification of (Graduate degree non-engineers)	% highest qualification of (No degree or certificate)	Compare estimators qualification to other professional	Current number of estimators (Less than 5 years of experience)	Current number of estimators (5-10 years of experience)	Current number of estimators (10-15 years of experience)	Current number of estimators (More than 15 years of experience)	Desired number of estimators (Less than 5 years of experience)	Desired number of estimators (5-10 years of experience)	Desired number of estimators (10-15 years of experience)	Desired number of estimators (More than 15 years of experience)	Accounting	Design/ Engineering	Contracting	Field Construction	Project Management	Intrinsic Values (Compensation)	Intrinsic Values (Diversity of work)
1	3	21%	40%	12%	17%	6%	4%	3	63	27	24	80	70	40	30	80	2	3	3	3	4	4	4
1	5	0%	100%	0%	0%	0%	0%	3	1	0	0	2	1	1	0	2	2	5	4	4	3	4	3
1	3	21%	40%	12%	17%	6%	4%	3	63	27	24	66					1	3	3	5	3	3	5
1	3	21%	40%	12%	17%	6%	4%	2	63	27	24	66					3	3	3	5	3	4	4
2	4	75%	75%	20%	5%	2%	2%	3	2	4	2	6	2	4	2	6	1	4	2	5	2	5	5
1	3	5%	85%	5%	5%	0%	0%	3	2	3	4	1					1	4	4	3	3	3	3
1	4	0%	100%	0%	10%	0%	0%	3	2	0	0	2	2	2	2	1	1	4	3	3	4	3	4
1	1	0%	40%	0%	0%	0%	60%	3	3	1	0	1	0	0	0	0	1	3	3	5	3	3	4
	3	0%	75%	25%	0%	0%	0%	3	0	1	0	2						3	3	5	4	4	4
3	4	20%	80%	0%	0%	0%	0%	2	0	0	0	3	0	2	2	2	2	4	3	4	3	4	4
1	5	50%	25%	0%	0%	25%	0%	1	0	0	0	1	0	0	1	1	2	3	3	5		4	4
1	5	10%	80%	5%	10%	5%	0%	2	2	0	0	2	3	0	0	4	1	5	2	3	1	5	5
1	4	0%	55%	30%	8%	0%	8%	3	4	2	4	1	2	3	7	2	1	5	1	3	1	4	3
2	5	0%	80%	0%	0%	0%	20%	3	2	1	1	3	0	1	2	5	2	2	3	5	2	3	2
1	1	20%	15%	25%	0%	0%	30%	3	5	3	5	5	8	6	8	8	3	2	2	4		3	4
1	2	21%	40%	12%	17%	6%	4%		63	27	24	66					1	3	2	5	4	3	4
1	3	21%	40%	12%	17%	6%	4%	2	63	27	24	66					1	4	2	4	3	4	5
3	1	21%	40%	12%	17%	6%	4%	3	63	27	24	66					2	4	2	4	4	4	4
2	4		100%					3	1	0	0	3	3	0	1	2	4	3	3	5	3	3	4
1	5		33%	33%	33%			3	2	0	0	1	1	1	1	1	3	4	3	5	3	3	3
1	3	15%	45%				40%		3	2	1	2	3	3	3	3	1	4	3	3	2	3	3
1	3	20%	37%			13%	30%	2	0	0	1	7	1	2	3	3	4	3	3	4	2	3	4
1	4		100%					4	1	3	0	0	2	7	1	1	2	4	3	5	2	3	4
1	4	5%	75%	15%	5%			2	0	0	1	3	0	0	1	1	2	3	1	5	3	4	4
1	4	10%	65%	15%			10%	3	0	0	0	1	0	0	0	2	2	4	3	5	3	3	4
3	3	15%	25%	50%			10%	3									1	1	3	5	3	3	4
1	4	25%	50%	25%				3	3	0	1	1	3	2	2	2	3	4	4	4	4	4	3
	5	40%	50%	2%	3%	2%	3%	2	25	75	100	300	125	125	125	125	3	4	3	5	2	3	3
2	3	15%	55%		30%			3	0	0	0	3	0	0	0	4	1	2	3	5	4	3	3
2	1		95%		5%			3	0	0	5	3	0	0	5	5	2	3	3	5	3	3	3
3	5				60%			3	0	3	0	0	0	3	3	0	2	4	3	5	3	4	3
3	3		100%					3	0	0	0	3	0	0	0	3	3	4	4	5	3	4	3
2	4		50%	50%				3	0	0	3	1	0	0	0	4	1	3	2	5	3	3	3
2	4	25%	50%				25%	2	0	0	0	12	4	4	4	4	2	3	3	4	4	4	4
1	3	35%	15%				50%	3	1	3	12	11	1	3	11	11	2	3	3	5	1	3	4
2	1		100%					2	0	0	15	5						5	5	5	5	4	
3	1	20%					80%	2	3	2	3	2					1	1	3	4	2	3	4
1	4		50%	50%				2	2	2	1	1	0	2	2	2	1	3	2	5	2	4	5
1	3		55%	22%	11%		11%	2	1	4	0	4	3	2	3	4	1	3	1	5	1	4	2
1	1		100%					3	3	3	1	1	4	4	4	1	2	4	5	4	4	4	5
1	2		15%	55%	20%	10%		3	6	10	4	6	3	12	6	8	3	4	4	5	4	4	4
1	5			100%				2	0	0	0	1	0	0	0	1	3	4	5	5	4	5	4
1	3		8%	90%			2%	3	4	4	4	4	0	0	4	0	1	3	4	3	3	4	4
1	1			100%					0	1	0	2	0	2	0	2	3	3	3	4	3	3	4
1	4							2	0	0	0	2	0	0	0	3	3	3	3	4	3	4	4
2	2		80%					3	4	0	0	0	0	0	0	0	4	4	4	5	4	4	4
2	2	23%	30%	10%	5%	2%	30%	2	0	0	3	2	0	0	3	3	2	2	4	5	4	5	4
1	4	20%	10%			10%	60%	1	1	1	0	1	1	3	0	1	3	3	3	4	3	4	4
1	1		25%	75%				3	1	0	0	3	3	0	0	3	2	5	4	3	4	5	4
1	2		100%					3	2	1	2	3	4	2	3	2	3	3	4	4	4	4	4
1	1		55%		25%		20%	3	2	1	1	4	2	2	2	4	3	3	4	4	4	4	4
1	4		100%					4	0	1	0	1	0	1	0	1	1	3	4	3	4	4	3
1	4							2	2	1	0	2	3	4	0	6	1	1	5	5	4	4	3
3	3		25%			25%	50%	3	1	0	1	2	1	1	1	2	3	4	5	3	4	5	3
1	1	100%						3	0	0	0	2							3	5	3	5	3
1	3		80%				20%		6	3	1	0					1	4	4	4	3	4	4
3	2	10%	50%	10%			30%	2	0	1	1	20	10	10	10	10	2	4	3	5	3	4	4
1	2	20%	20%	20%	10%	20%	10%	3	20	20	30	10	10	20	30	20	4	3	3	5	4	3	4
1	1	10%	35%	15%	10%	15%	15%	3	30	15	15	15	15	15	20	15	3	5	4	3	4	3	5
1	2		75%	25%				3	20	10	10	30					1	5	4	5	4	4	4
2	2			80%		20%		3	28	12	27	4					4	3	3	3	4	4	4
1	2	15%	60%		5%		20%	5	25	25	10	20	20	25	15	25	2	5	3	5	4	4	
3	1	10%	10%	70%		5%	5%	2	30	10	15	23	15	15	25	23	3	4	4	4	3	4	4
1	1	13%	10%	65%	2%	2%	8%	3	20	15	15	20					3	4	3	4	4	4	4
3	2	30%															3	3	3	5	3	3	4
								3	1	0	0	0	1	0	0	0		4	3		4	4	4
1	3	10%	40%	40%			10%	3	3	8	3	7	3	5	3	5	1	3	3	5	3	3	4
1	4	5%	55%				40%	3									3	3	3	4	4	5	5
1	3							3									3	3	3	5	4	5	3
1	2	10%	20%	20%	10%	20%	20%	3	13	10	10	13	13	13	10	10	3	3	3	4	4	4	4
2	4		85%						8	3		13	0	10		13		4	4	4		4	3
																	1	3	4	4	4	4	4
																	3	2	4	5	2	5	4
1	2		25%	75%				4	3	1	1	3	0	2	3	3	3	4	3	4	4	4	5
3	3			5%			95%	4	6	1	2	2	10	8	8	6	3	4	4	5	5	3	5
1	3		15%	40%		20%	25%	2	20	10	5	5	20	15	10	5	4	3	3	4	4	4	3
1	2	5%	30%	45%	10%	10%		4	15	30	40	20	10	35	40	20	2	3	3	4	4	4	4
1	2		70%	30%				3									4	3	4	5	5	4	5
1	2	20%	5%	75%				3	15	30	30	15	15	20	30	25	4	3	3	4	3	4	4
1	1	33%	66%					2	0	0	0	3	0	1	1	3	2	3	3	3	4	4	2
3	1							4									3	3	3	2	2	3	3

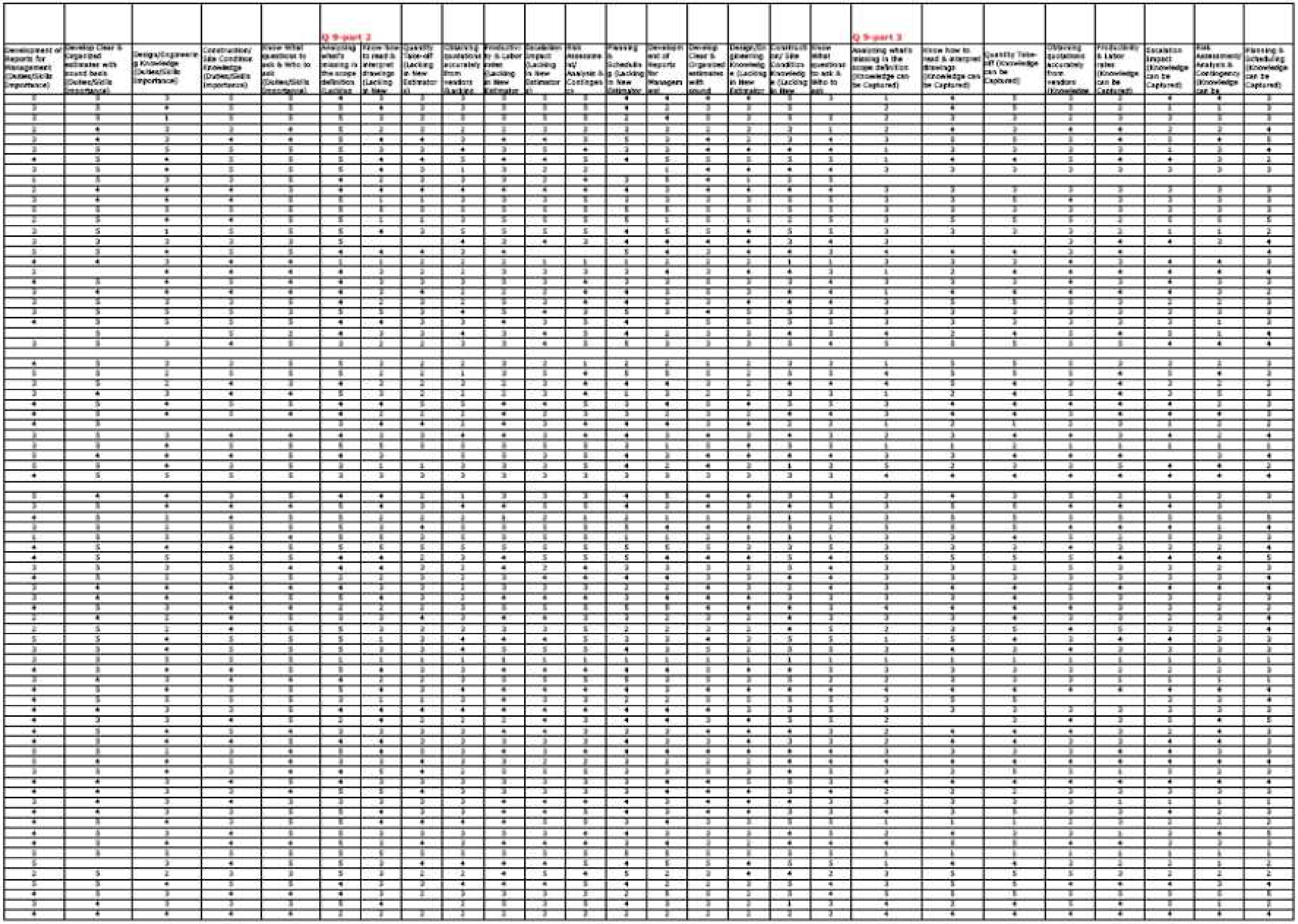
Q 1	Q 2	Q3						Q 4	Q 5				Q 5-part 2				Q 6					Q 7	
Cost estimators shortage occur	% estimators projected to retire in 5 years	% highest qualification of (Technical Certificate)	% highest qualification of (College degree engineers)	% highest qualification of (College degree non-engineers)	% highest qualification of (Graduate degree engineers)	% highest qualification of (Graduate degree non-engineers)	% highest qualification of (No degree or certificate)	Compare estimators qualification to other professional	Current number of estimators (Less than 5 years of experience)	Current number of estimators (5-10 years of experience)	Current number of estimators (10-15 years of experience)	Current number of estimators (More than 15 years of experience)	Desired number of estimators (Less than 5 years of experience)	Desired number of estimators (5-10 years of experience)	Desired number of estimators (10-15 years of experience)	Desired number of estimators (More than 15 years of experience)	Accounting	Design/ Engineering	Contracting	Field Construction	Project Management	Intrinsic Values (Compensation)	Intrinsic Values (Diversity of work)
1	4			100%				1									3	4	3	4	4	4	4
								2										3		4	3	5	4
1	2	10%	10%	30%	10%	15%	5%	3	20	20	15	20	20	20	20	20	4	3	3	4	3	5	5
4	1	10%	3%	83%		2%		3	20	15	20	15	15	20	25	15	4	4	3	3	4	4	4
1			100%						0	1	4	2					4	5	4	5	4	4	4
4	3			10%			90%	2									4	4	4	4	4		5
5	2							2									1	2	3	5	4	3	3
2	1				100%			3	3	2	3	1	0	0	5	0	4	4	5	5	5	5	5
1	3																3	2	3	5	4	4	2
2	4		100%					3	0	0	0	3					2	4		5	4	4	4
1	4	10%	20%	70%				3	4	3	3	15	5	5	5	10	1	3	3	5	3	4	3
3	4	30%		20%		10%	40%	3	0	1	1	8					4	2	4	5	3	4	3
1	1		3%	19%		2%	60%		0	0	0	2	0	0	0	25	4	2	4	5	4	4	3
5	4		60%				10%		0	0	0	10					3		3	4		4	4
1	1			30%				2	0	5	3	2	10	10	5	5	3	3	3	5	5	5	3
2	4		75%		20%		5%	3	0	0	0	2	0	0	0	2	2	3	3	4	4	4	3
1	4	30%	70%					4	0	0	0	2	0	0	0	3	2	2	4	5	5	4	4
1	3	25%	25%	25%			25%		20	20	30	30	20	30	20	30	3	3	3	4	4	4	4
2	4		100%					3	0	0	0	3	0	0	0	3	2	4	3	5	4	4	4
1	3		40%	40%			20%	3									2	3	2	5	4	4	5
1	1				30%		70%	2	10	30	60	33	30	100	100	30	1	3	5	5	5	5	2
1	3							3	2	2	2	1	4	3	3	1	3	4	4	4	4	5	4
1	4	50%						4	1								3	4	2	5	4	4	4
5	1		100%					4	0	2	1	0	0	2	1	0	1	4	4	4	4	5	4
1	4	40%		20%			40%	2	0	0	0	10	5	5	10	10	2	4	3	4	2	4	4
1	4	10%	80%				10%	3									1	5	3	5	4	4	4
1	2	10%	10%	20%	10%		20%	4	8	7	3	4	4	10	8	2	4	4	3	3	4	5	4
5	3		60%				10%	3	0	0	0	10	0	0	0	12	1	2	3	5	5	5	5
2	3																						
1																		3	3	3	3	3	3
1	3		10%		90%			3	1	0	1	7	3	3	3	0	2	4	3	4	3	4	3
1	2	10%	30%	30%	20%	10%	10%	2									3	4	3	2	4	4	4
1	4	75%	25%					3	1	0	0	0	1	2	1	1	4	3	3	5	3	4	4
2	3		60%					2	0	2	2	2	0	4	0	2	3	4	3	4	4	4	4
1	4		100%					3	0	1	1	4	1	3	3	3	3	3	4	5	3	4	3
1	3		60%		40%				0	0	0	0	1	1	2	2	1	4	4	5	4	5	4
3	1	22%	55%				22%	3	2	2	2	3	5	3	3	3	1	3	5	5	3	3	5
	4	10%	60%	40%				2	0	5	0	7	6	2	3	3	2	5	3	4	4	4	3
1	3		80%	10%	5%	5%		3	5	5	10	80	10	10	10	70	2	4	3	5	4	5	2
																	1	3	3	3	3	3	3
1	4		80%	40%				3	2	0	0	3	2	0	0	3	2	3	4	5	5	3	3
3	1	50%			50%			3	1	0	0	0	2	0	0	0	4	4	4	4	4	3	4
1	4	50%		20%	30%			3	3	2	0	10					4	5		2	2	5	4
1	3		80%				20%	3	0	0	0	2	0	0	1	1	2	2	4	5	1	5	3
1	1	100%						3	1	0	0	1	1	0	0	1	1	3	3	5	2	4	4
1	3		80%			20%		3	4	0	1	2	2	3	4	3	2	4	3	4	3	4	5
1	3		40%	40%	10%		10%		0	0	5	6	0	0	5	6	1	4	4	5	3	4	4
1	3	10%	75%	10%			5%	3	2	3	0	25	5	6	0	25	1	3	2	3	2	4	4
1	2	15%	15%		15%		55%	1	6	1	0	7	6	10	12	6	3	4	4	4	4	3	4
1	3	12%	4%	12%		8%	64%	2	1	6	6	12	4	7	6	6	1	3	2	4	4	5	4
1	3			100%				2	0	0	0	1	0	1	0	1	3	4	5	5	4	5	4
1	3							1	24	0	8	40	20	10	10	30	2	3	3	4	3	4	4
1	1		80%			20%		3	0	0	0	0	8	8	8	8	1	3	4	5	3	4	3
1	4		65%	10%	5%	5%	15%	3	10	10	10	80	15	15	15	65	2	3	3	5	4	4	4
1	5			50%	50%			5	0	0	0	6	0	0	0	8	3	4	5	5	4	4	4
1	3		70%				30%		2	5	2	12	4	8	8	6	3	3	2	5	3	4	4
1	3		88%				13%		1	2	1	9	2	2	2	7	2	4	3	5	5	4	4
2	4			67%	33%			3	0	0	0	3	1	0	1	1	3	2	2	4	4	4	3
1	1	30%	40%	20%	4%	4%	2%	4	6	3	8	9	9	6	7	10	3	4	2		5	4	4
3	2		30%	8%			62%	3	1	5	0	15	2	2	0	4	2	3	4	5	4	5	4
	4	80%			20%			3	0	5	0	1	0	8	0	3	2	4	3	5	3	5	4
1	3								5	4	1	25	5	10	10	15	2	5	3	3	3	3	4
3	3	25%	25%	25%	25%			1	0	0	7	0	0	7	1	0		3			5	5	
2	3	7%	65%	14%			19%	4	0	3	0	11	0	3	0	11	1	3	2	5	4	5	5
1	3		100%					3									1	3	4		5	3	3
2	4		60%	10%				3	0	0	0	0	0	0	1	0	2	4	3	3	4	4	3

									Q 8							Q 9							
Intrinsic Values (Professionalism)	Intrinsic Values (Challenges/Difficulties)	Intrinsic Values (Work/Life Balance)	Intrinsic Values (Future Growth Potential)	Intrinsic Values (Work Suits my Skills & Personality)	Intrinsic Values (Personal Relationships)	Intrinsic Values (Easier to find another job with my experience)	Intrinsic Values (Less Travel)	Intrinsic Values (Importance to company)	Leaving Estimating Reasons (Long Working Hours)	Leaving Estimating Reasons (Effort not appreciated or	Leaving Estimating Reasons (Promotion concerns)	Leaving Estimating Reasons (Lack of Dynamism)	Leaving Estimating Reasons (Last person in the team to be	Leaving Estimating Reasons (Poor Compensation)	Leaving Estimating Reasons (Better opportunities elsewhere)	Analyzing whats missing in the scope definition (Duties/Skills Importance)	Know how to read & interpret drawings (Duties/Skills	Quantity Take-off (Duties/Skills Importance)	Obtaining quotations accurately from vendors (Duties/Skill	Productivity & Labor rates (Duties/Skills Importance)	Escalation Impact (Duties/Skills Importance)	Risk Assessment/ Analysis & Contingency (Duties/Skills Importance)	Planning & Scheduling (Duties/Skills Importance)
3	3	4	3	2	2	2	3	4	3	5	5	3	4	3	4	4	4	4	4	4	3	3	4
5	4	5	5	4	5	4	3	4	5	5	4	3	4	4	5	5	5	5	5	5	5	4	4
4	4	4	5	5	3	4	3	4	2	4	4	2	2	2	2	5	5	4	4	4	3	3	2
4	4	4	3	3	3	4	2	3								5	3	5	5	4	4	4	3
4	4	3	3	3	2	5	3	5	3	4	4	4	4	3	4	4	3	3	3	4	5	4	4
4	4	3	4	3	4	3	3	3	4	4	3	2	3	3	4	5	3	3	3	4	3	3	3
4	3	5	5	5	5	5	1	5	1	5	5	1	5	5	5	5	5	4	2	2	3	3	3
4	4	3	4	4	3	3	3	3	3	4	4	3	3	2	3	5	5	5	5	5	4	4	3
4	4	4	4	3	3	3	3	4	3	4	4	2	2	2	4	4	4	4	3	4	4	4	2
4	4	3	3	3	3			3	3	3						5	4	4	3	3	4	3	3
4	3	5			3	3	2	2		2	3	2	2	2	3		4	4	5	5	5	3	
4	3	3	3	4	4	3	3	4	4	5	4	2	5	4	4	4	3	3	3	4	4		2
5	4	4	4	4	4	3	3	4	2	4	5	3	3	3	5	5	4	4	3	3	4	5	4
4	5	4	4	5	3	5	3	4	2	5	5	3	4	2	5	4	5	5	4	4	3	3	4
3	4	5	4	5	5	5	4	2	5	5	5	3	2	3	5	5	4	5	4	4	5	5	2
5	2	4	5	4	4	4	2	4	2	5	5	5	5	5	4	4	5	5	5	4	2	4	3
4	4	4	5	4	4	4	3	5	3	5	5		5	4	4	5	5	4	4	4	3	4	3
4	4	5	4	4	3	4	4	4	2	2	2	2	2	2	2	5	5	4	4	1	2	1	1
4	5	5	5	4	4	4	4	5	5	5	5	5	3	5	5	5	5	5	5	5	5	5	5
4	5	3	5	4	3	5	3	5	5	4	4	4	3	3	4	5	4	4	4	5	5	4	4
4	4	5	5	3	3	1	1	5	5	4	5	3	1	3	5	5	5	4	3	4	3	5	4
4	3	3	4	3	2	3	4	3	2	2	3	2	2	2	4	4	5	5	3	4	4	4	2
5	4	5	3	2	5	4	3	2	3	4	5	2	2	5	3	5	5	5	5	5	5	5	5
4	4	3	3	5	4	3	1	4	2	3	2	3	3	1	2	5	2	5	4	4	3	4	4
4	4	4	5	5	5	4	4	4	4	4	4	3	4	3	4	4	5	5	4	5	4	4	4
5	5	5	5	5	5	4	3	5	5	5	5	5	5	5	5	5	4	4	5	5	5	5	3
5	4	4	4	4	4	2	2	4	5	4	4	2	4	3	5	5	3	3	4	5	4	4	4
4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	3	5	5	3	5	5	5	5
5	5	5	5	5	5	5	1	5	5	1	1	1	1	1	1	5	5	5	5	5	3	4	3
4	4	5	4	4	4	4	2	4	5	5	4	3	3	4	3	4	3	3	4	4	4	4	3
5	3	3	3	5	5	3	1	4	2	2	4	4	1	3	4	5	5	5	5	5	4	5	4
3	3	4	4	4	3	3	3	4	4	4	1	1	1	1	3	5	4	4	3	4	3	3	2
4	3	3	2	5	3	1	2	3	5	4	4	4	4	3	3	5	4	3	3	4	3	3	2
5	3	5	4	4	4	4	3	4	5	4	4	2		4	4	5	5	5	5	5	5	5	3
3	3	5	5	5	5	4	3	5	4	4	4	5	3	5	4	5	5	5	5	5	5	5	5
3	5	5	4	4	4	4	4	4	4	4	3	3	3	3	4	5	5	5	5	5	5	5	3
5	4	4	4	4	4	4	3	5	3	4	4	2	1	1	4	5	4	5	4	3	4	3	5
4	2	3	3	4	3	3	2	4	4	3	2	2	2	3	4	5	5	5	4	5	5	5	5
5	4	5	5	3	4	3	3	4	4	5	5	3	5	4	4	4	4	4	2	3	5	5	4
4	4	5	5	5	5	2	3	3	4	5	5	5	4	5	5	5	4	5	5	4	4	4	5
5	5	5	5	5	5	5	5	5	5	5	5	3	5	3	4	4	4	3	2	3	4	5	5
4	4	2	3	4	3	3	2	2	4	4	4	3	3	3	4	5	4	4	3	4	4	3	4
4	4	4	4	4	4	3	4	4	4	3	3			4	5	4	4	4	3	4	4	4	4
5	4	3	4	4	2	3	2	4	4	3	3	2	3	2	4	5	5	5	4	5	4	5	4
4	4	5	4	4	4	4	4	4	4	5	4	4	4	4	4	5	5	5	5	5	5	5	3
4	4	5	5	5	4	5	2	3	5	5	5	4	2	5	5	5	5	5	5	4	4	3	4
4	3	5	5	4	3	3	3	4	5	3	3	3	2	2	4	5	4	4	4	4	4	3	2
5	5	4	5	4	3	4	3	5	3	4	5	4	3	4	5	4	5		3	3	5	5	5
4	4	4	4	4	4	3		4	3	5	4	4	3	3	4	4	5	5	4	5	4		4
4	4	5	4	4	4	4	3	4	4	5	4	2	2	2	5	4	5	4	4	4	5	5	3
4	4	4	4	4	3	4	4	4	4	3	4	3	3	3	5	5	5	5	5	5	5	5	4
4	4	4	5	4	4	4	4	5	3	5	4	2	3	3	5	4	4	4	3	2	4	4	2
5	4	5	5	4	4	4	5	4	3	4	5	4	3	4	5	5	5	5	5	5	5	5	4
3	3	5	4	3	4	3	3	4	3	4	2	2	1	3	3	4	5	5	3	3	2	2	2
5	5	2	4	4	5	1	1	5	1	4	4	4	3	5	5	5	5	5	5	4	4	4	5
5	4	4	5	5	4	4	3	4	4	3	4	3	2	2	4	5	4	5	4	5	5	5	4
3	3	4	4	4	4	3	3	4	2	3	4	2	2	2	4	4	4	4	3	4	3	4	3
4	4	5	5	4	4	3	3	5	3	5	3	3	3	5	5	5	4	4	4	4	3	3	3
5	5	5	5	5	5	5	3	5	5	4	5	5	5	4	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	4	4	3	5	4	3	3	3	4	5	5	5	5	5	5	5	4
4	5	3	3	4	3	4	3	3	4	4	2	2	3	5	5	5	5	3	4	5	3	4	4
4	4	3	4	3	3	4	2	4	4	4	4	2	2	4	5	5	5	4	4	4	4	3	3
4	4	5	4	4	3	3	4	5	4	4	3		3	2	5	5	5	5	4	4	4	4	3
4	4	3	3													5	5	3	3	3	3	3	3
4	4	3	3	4	3	3	1	3	4	4	4	2	2	3	4	4	4	4	3	3	1	2	2
4	5	2	4	4	2	4	1	4	5	5	4	2	4	3	4	5	4	4	4	5	4	4	4
4	4	4	4	4	4	4	4	4	3	4	4	3	4	4	4	4	4		4	4		4	4
5	4	4	5	4	5	5	3	4	2	4	5	3	4	4	5	5	5	5	5	5	5	5	3
4	4	4	4	4	4	2	2	4	4	4	4	4	4	5	2	5	5	2	5	5	5	5	4
4	5	2	2	5	2	4	1	3	3	5	4	1	4	4	4	5	4	4	4	5	5	3	4
4	4	5	4	5	4	5	5	5	4	3	3	4	2	4	5	5	4	4	4	4	3	4	2
4	3	4	4	4	3	4	4	4	4	4	3	3	3	3	4	4	3	3	4	4	3	4	3
4	3	4	4	4	2	3	1	4	1	4	4	2	3	3	5	4	3	4	4	4	4	4	4
5	5	5	5	5	5	5	1	5	1	1	1	1	1	1	1	5	5	5	5	5	5	5	5
2	5	3	5	5	5	5	2	5	1	5	5	4	5	1	2	5	4	5	5	5	5	5	5
4	3	4	4	3	4	3	1	4	3	3	4	2	2	5	4	4		3	4	3	3	4	2
	4	5	5	4	5	5	3	4	1	3	5	3	3	4	5	4	4	5	4	5	5	5	3
4	3	5	3	4	3	2	2	4	5	4	2	2	2	2	4	5	4	3	3	4		3	2
5	5	5	5	4	3	5	3	4	5	5	5	4	3	4	5	5	4	3	1	4	4	3	2

									Q 8							Q 9							
Intrinsic Values (Professionalism)	Intrinsic Values (Challenges/Difficulty)	Intrinsic Values (Work/Life Balance)	Intrinsic Values (Future Growth Potential)	Intrinsic Values (Work Suits my Skills & Personality)	Intrinsic Values (Personal Relationships)	Intrinsic Values (Easier to find another job with my experience)	Intrinsic Values (Less Travel)	Intrinsic Values (Importance to company)	Leaving Estimating Reasons (Long Working Hours)	Leaving Estimating Reasons (Effort not appreciated it	Leaving Estimating Reasons (Promotion concerns)	Leaving Estimating Reasons (Lack of Dynamism)	Leaving Estimating Reasons (Last person in the team to be	Leaving Estimating Reasons (Poor Compensation)	Leaving Estimating Reasons (Better opportunities elsewhere)	Analyzing whats missing in the scope definition (Duties/Skills Importance)	Know how to read & interpret drawings (Duties/Skills	Quantity Take-off (Duties/Skills Importance)	Obtaining quotations accurately from vendors (Duties/Skill	Productivity & Labor rates (Duties/Skills Importance)	Escalation Impact (Duties/Skills Importance)	Risk Assessment/ Analysis & Contingency (Duties/Skills Importance)	Planning & Scheduling (Duties/Skills Importance)

									Q 8							Q 9							
Intrinsic Values (Professionalism)	Intrinsic Values (Challenges/Difficulties)	Intrinsic Values (Work/Life Balance)	Intrinsic Values (Future Growth Potential)	Intrinsic Values (Work Suits my Skills & Personality)	Intrinsic Values (Personal Relationships)	Intrinsic Values (Easier to find another job with my experience)	Intrinsic Values (Less Travel)	Intrinsic Values (Importance to company)	Leaving Estimating Reasons (Long Working Hours)	Leaving Estimating Reasons (Effort not appreciated or	Leaving Estimating Reasons (Promotion concerns)	Leaving Estimating Reasons (Lack of Dynamism)	Leaving Estimating Reasons (Last person in the team to be	Leaving Estimating Reasons (Poor Compensation)	Leaving Estimating Reasons (Better opportunities elsewhere)	Analyzing what's missing in the scope definition (Duties/Skills Importance)	Know how to read & interpret drawings (Duties/Skills	Quantity Take-off (Duties/Skills Importance)	Obtaining quotations accurately from vendors (Duties/Skills	Productivity & Labor rates (Duties/Skills Importance)	Escalation Impact (Duties/Skills Importance)	Risk Assessment/ Analysis & Contingency (Duties/Skills Importance)	Planning & Scheduling (Duties/Skills Importance)
4	5	5	5	5	4	5	3	4								5	5	5	5	5	4	4	3
4	4	3	3	3	3	2	3	3	4	3	3	2	4	4	3	3	5	5	5	3	4	4	4
5	5	5	5	5	4	4	3	3	5	3	4	4	3	4	3	3	3	5	3	3	3	5	4
4	4	4	5	5	3	4	4	4	3	3	3	5	3	3	3	3	4	5	4	3	4	3	4
5	4	4	5	5	4	5	4	3	3	3	3	3	3	3	3	3	3	5	3	3	4	3	4
5	5	5	5	5	3	5	3	3	3	4	4	4	3	3	4	3	3	5	3	3	3	3	3
4	5	1	4	5	3	2	3	5	4	2	2	2	2	3	3	3	3	3	4	3	3	5	3
5	5	5	5	5	3	5		3	3	3	3	5	5	3	3	3	3	5	3	3	3	3	3
4	4	2	4	4	3	4	1	3	4	3		3	2	3	3	3	4	3	3	3	4	4	3
3	3	3	4	3	3	3	3	3	3	4	3	3	3	3	4	4	3	5	4	4	4	3	4
5	3	4	4	5	4	3	3	3	3	4		2	3	3	3	3	4	3	3	4	3		3
4	4	5	4	4	4	5	4	4	4	5	3	3	3	4	3	3	4	5	3	3	3	3	3
3	4	4	5	5	3	5	3	4	4	4	3	3	3	3	3	3	3	5	4	3	4	4	4
4	4	4	4	5	4	3	4	4	3	4	3	3	3	3	3	4	4	5	3	4	3	3	4
3	3	5	3	5	3	3	3	3	3	1	3	1	1	1	1	3	3	5	3	3	3	3	4
5	4	2	3	3	3	2	3	4	3	4	4	4	4	3	4	4	3	3	4	3	4	4	3
5	4	4	2	4	4	4	3	5	5	5	5	3		2	4	4	3	5	4	5	5	5	4
3	4	3	4	4	3	3	3	3	4	3	4	2	3	3	4	5	4	3	3	3	3	5	3
3	3	4	3	4	4	3	4	3	3	4	3	4	2	3	4	3	3	5	4	4	4	3	4
5	5	5	5	2	3	3		3	4	4	3	3	2	3	3	3	3	3	4	4	4	4	3
5	5	4	4	4	4	3	3	5	5	5	3	3	2	3	3	3	3	3	3	5	5	5	3
4	4	4	3	4	3	4	4	4	3	3	4	4	4	3	4	4	3	4	4	4	4	4	3
4	4	4	5		3	3	3	3	4	3	3	3		3	3	3	3	5	3	3	3	4	4
4	4	2	3	4	4	3	3	4	4	3	3	2	3	3	4				4		4		4
3	3	4	4	4	3	4	3	3	4	3	3	1	1	1	4	3	4	4	3	4	3	2	3
5	4	5	3	4	3	3	4	4	3	4	3	3	3	4	3	3	3	5	3	3	4	3	4
5	5	5	4	4	4	4	4	5	4	5	4	3	4	5	3	5	3	5	5	5	4	4	3
3	4	4	3	5	4	1	1	3	1	4	4	3	1	3	3	4	3	3	3	3	3	1	4
																4	4	4	3	3	3	5	3
	3	3	4	3	3	1	1	4	3	5	3	3	4	4	4	4	3	4	3	4	3	5	4
4	4	4	4	3	3	2	4	4	4	4	4	2	3	4	4	5	4	4	3	4	4	4	3
4	4	5	5	4	4	4	3	5	5	5	3	4	4	5	5	5	4	5	3	4	3	4	3
5	4	5	5	5	5	4	4	5	3	3	4	3	3	3	5	5	5	5	3	3	4	5	3
5	3	4	5	4	4	5	3	4	4	3	3	3	5	4	4	3	4	4	4	3	3	3	4
4	4	3	4	4	3	3	3	3	2	4	4	3	3	3	5	4	3	3	3	4	3	3	4
4	4	5	4	4	2	2	3	3	4	4	2	2	2	2	5	4	4	3	3	4	3	4	3
	4	5	4	5	3	3	2	5	4	2	2	2	1	3	4	5	5	5	3	2	3	3	5
4	3	4	4	4	2	3	2	4	3	3	3	3	2	4	4	3	3	4	3	4	3	3	3
4	4	3	4	5	2	2	2	4	4	4	2	2	1	1	5	3	4	4	3	3	3	4	3
3	3	3	5	3	3	3	5	5	4	1	1	1	1	4	5	3	3	5	4	4	4	4	4
4	4	4	4	4	4	5	3	5	3		4	4	3	3	4	3	5	5	5	3	3	3	4
5	4	3	3	3	3	3	3	4	3	3	4	3	4	3	4	4	4	3	3	3	3	3	3
3	3	5	4	5	3	3	2	3	4	3	3	3	2	3	4	3	3	2	5	4	4	4	3
4	3	4	3	4	1	4	4	3	4	4	3	4	4	4	4	4	4	4	4	4	4	3	3
4	4	4	5	4	4	3	3	4	3	3	3	3	3	3	5	5	3	5	5	5	4	4	4
4	4	5	4	4	3	3	1	2	2	5	4	4	4	2	5	4	4	4	3	5	4	4	3
5	3	5	4	5	4	2	4	2	4	5		1	3	5	5	5	5	5	3	5	4	5	4
5	4	4	5	4	3	4	3	4	1	3	4	2	3	4	5	4	3	4	4	3	4	3	4
4	4	4	5	4	4	2	3	4	2	3	4	3	2	3	4	5	3	3	4	3	3	4	5
3	4	3	3	4	4	5	3	4	4	3		3	3	1	4		3	4	3	3	4	4	3
4	4	2	3	2	3	3	4		3	4	4	3	3	3	4	5	4	4	5	3	3	4	4
5	3	5	5	4	3	3	3	5	5	5	4	3	5	3	3	5	4	5	4	3	5	3	3
4	4	4	5	5	4	5	3	3	5	5	4	4	5	3	5	5	3	2	4	5	1	4	4
4	3	3	4	3	4	4	3	4	3	3	4	2	3	2	4	3	3	4	3	4	4	4	4
4	4	5	4	4	4	3	3	4	5	3	5	4	3	4	5	3	3	5	3	3	3	4	4
4	3	4		4	4	3	3	5	2	5	5	3	4	3	3	5	3	4	4	5	3	4	4
4	3	4	3	3	3	2	4	3	2	2	4	5	3	3	5	5	3	5	4	5	3	5	3
3	4	4	4	4	3	3	3	4	4	4	3	2	3	3	3	4	4	3	4	4	4	4	3
4	5	4	4	4	4	4	3	5	4	5	4	4	3	3	4	5	3	5	4	4	5	5	4
3	4	3	4	4	4	4	3	4	3	4	4	3	3	3	4	5	3	5	4	4	4	3	3
4	3	5	4	5	4	4	3	3	4	5	4	3	3	3	4								
4	4	4	4	4	4	3	3	3	5	5	4	4	5	3	3	4	4	5	4	4		3	3
5	4	3	5	4	5	1	3	5	3	3	4	3	3	4	5	5	4	4	4	3	3	4	3
3	5	4	4	5	3	4	4	4	5	4	5	3	3	1	1	3	3	5	3	3	3	3	3
3	3	3	3	3	3	2	3	3	4	4	3	1	1	1	3	3	4	3	3	3	4	3	3
4	4	4	4	4	3	4	3	4	4	4	4	4	3	3	4	3	5	4	5	5	3	5	3

					Q 9-part 2													Q 9-part 3							
Development of Reports for Management (Duties/Skills Importance)	Develop Clear & Organized estimates with sound basis (Duties/Skills Importance)	Design/Engineering Knowledge (Duties/Skills Importance)	Construction/ Site Condition Knowledge (Duties/Skills Importance)	Know What questions to ask & Who to ask (Duties/Skills Importance)	Analyzing what's missing in the scope definition (Lacking	Know how to read & interpret drawings (Lacking in New	Quantity Take-off (Lacking in New Estimator)	Obtaining quotations accurately from vendors (Lacking	Productivity & Labor rates (Lacking in New Estimator	Escalation Impact (Lacking in New Estimator)	Risk Assessment w/ Analysis & Contingencies	Planning & Scheduling (Lacking in New Estimator	Development of Reports for Management	Develop Clear & Organized estimates with sound	Design/Engineering Knowledge (Lacking in New Estimator	Construction/ Site Condition Knowledge (Lacking in New	Know What questions to ask & Who to ask	Analyzing what's missing in the scope definition (Knowledge can be Captured)	Know how to read & interpret drawings (Knowledge can be Captured)	Quantity Take-off (Knowledge can be Captured)	Obtaining quotations accurately from vendors (Knowledge	Productivity & Labor rates (Knowledge can be Captured)	Escalation Impact (Knowledge can be Captured)	Risk Assessment/ Analysis & Contingency (Knowledge can be	Planning & Scheduling (Knowledge can be Captured)



Q 9-part 2

Q 9-part 3

Development of Reports for Management (Duties/Skills Importance)

Develop Clear & Organized estimates with sound basis (Duties/Skills Importance)

Design/Engineering Knowledge (Duties/Skills Importance)

Construction/ Site Condition Knowledge (Duties/Skills Importance)

Know What questions to ask & Who to ask (Duties/Skills Importance)

Analyzing what's missing in the scope definition (Lacking

Know how to read & interpret drawings (Lacking in New

Quantity Take-off (Lacking in New Estimators)

Obtaining quotations accurately from vendors (Lacking

Productivity & Labor rates (Lacking in New Estimator

Escalation Impact (Lacking in New Estimators)

Risk Assessment/ Analysis & Contingencies

Planning & Scheduling (Lacking in New Estimator

Development of Reports for Managers and

Develop Clear & Organized estimates with sound

Design/Engineering Knowledge (Lacking in New Estimator

Construction/ Site Condition Knowledge (Lacking in New

Know What questions to ask & Who to ask

Analyzing what's missing in the scope definition (Knowledge can be Captured)

Know how to read & interpret drawings (Knowledge can be Captured)

Quantity Take-off (Knowledge can be Captured)

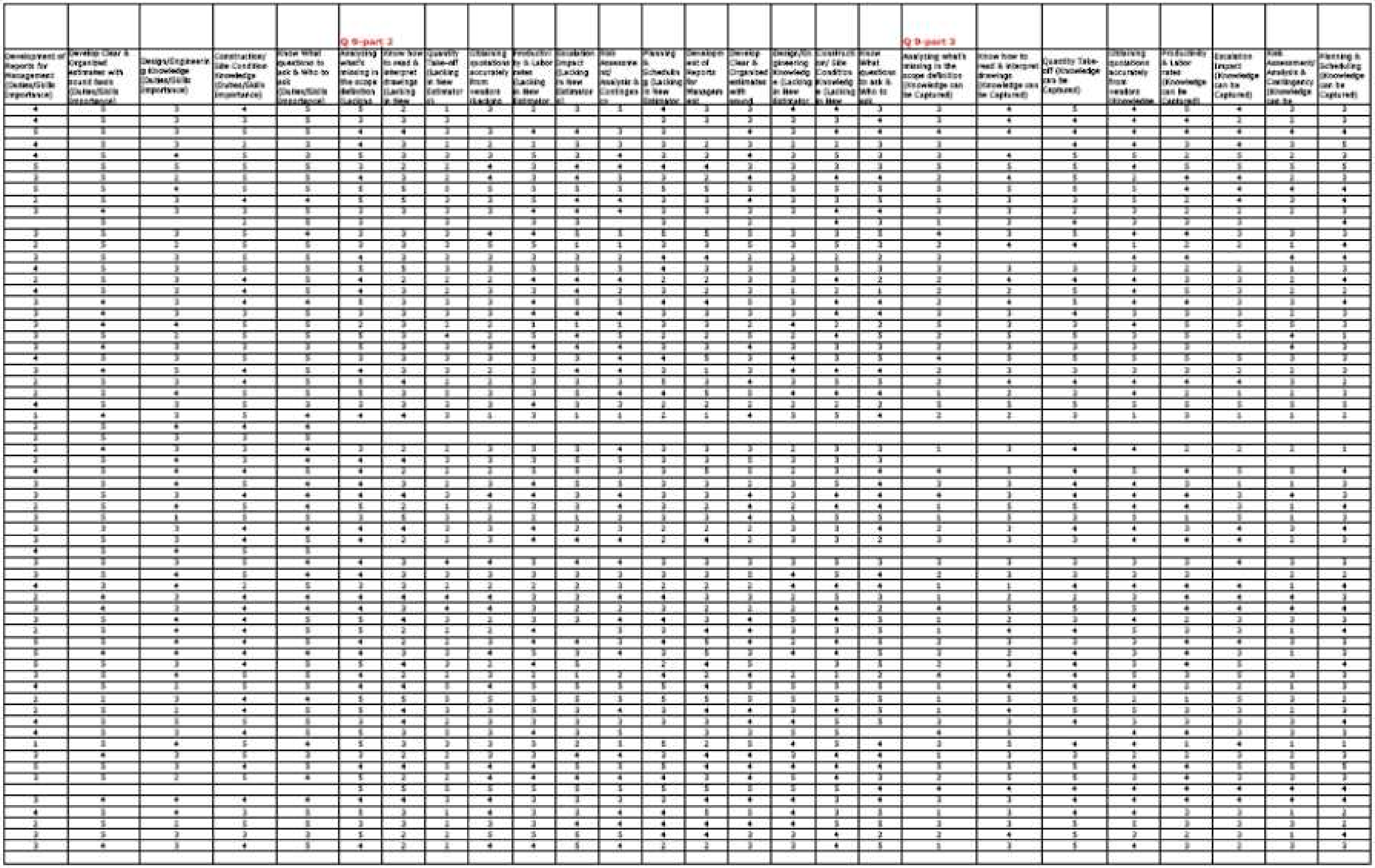
Obtaining quotations accurately from vendors (Knowledge

Productivity & Labor rates (Knowledge can be Captured)

Escalation Impact (Knowledge can be Captured)

Risk Assessment/ Analysis & Contingency (Knowledge can be

Planning & Scheduling (Knowledge can be Captured)



Q 9-part 2

Q 9-part 3

					Q 10									Q 11					Q 12		Q 13
Development of Reports for Management (Knowledge can be	Develop Clear & Organized estimates with sound basis (Knowledge can be Captured)	Design/Engineering Knowledge (Knowledge can be Captured)	Construction / Site Condition Knowledge (Knowledge can be	Know What questions to ask & Who to ask (Knowledge can be Captured)	Reasons for Estimate Deviation (Scope definition)	Reasons for Estimate Deviation (Improper Escalation)	Reasons for Estimate Deviation (Estimator Error)	Reasons for Estimate Deviation (Risk Analysis/ Contingency)	Reasons for Estimate Deviation (Field Changes)	Reasons for Estimate Deviation (Local Market Instability)	Reasons for Estimate Deviation (Changes in Execution Method)	Reasons for Estimate Deviation (Communication Problem)	Reasons for Estimate Deviation (Scheduling Problems)	Define Successful Estimate (Validated by next phase estimate)	Define Successful Estimate (Validated by actual cost)	Define Successful Estimate (Falls within expected historical	Define Successful Estimate (Third party validation)	Define Successful Estimate (Client acceptance)	Current % of work preformed using Judgment	Ideal % of work rely on Judgment	Ability to see the big picture, realize what is important (Requirement of good estimator)

					Q 10									Q 11					Q 12		Q 13
Development of Reports for Management (Knowledge can be	Develop Clear & Organized estimates with sound basis (Knowledge can be Captured)	Design/Engineering Knowledge (Knowledge can be Captured)	Construction / Site Condition Knowledge (Knowledge can be	Know What questions to ask & Who to ask (Knowledge can be Captured)	Reasons for Estimate Deviation (Scope definition)	Reasons for Estimate Deviation (Improper Escalation)	Reasons for Estimate Deviation (Estimator Error)	Reasons for Estimate Deviation (Risk Analysis/ Contingency)	Reasons for Estimate Deviation (Field Changes)	Reasons for Estimate Deviation (Local Market Instability)	Reasons for Estimate Deviation (Changes in Execution Method)	Reasons for Estimate Deviation (Communication Problem)	Reasons for Estimate Deviation (Scheduling Problems)	Define Successful Estimate (Validated by next phase estimate)	Define Successful Estimate (Validated by actual cost)	Define Successful Estimate (Falls within expected historical	Define Successful Estimate (Third party validation)	Define Successful Estimate (Client acceptance)	Current % of work preformed using Judgment	Ideal % of work rely on Judgment	Ability to see the big picture, realize what is important (Requirement of good estimator)

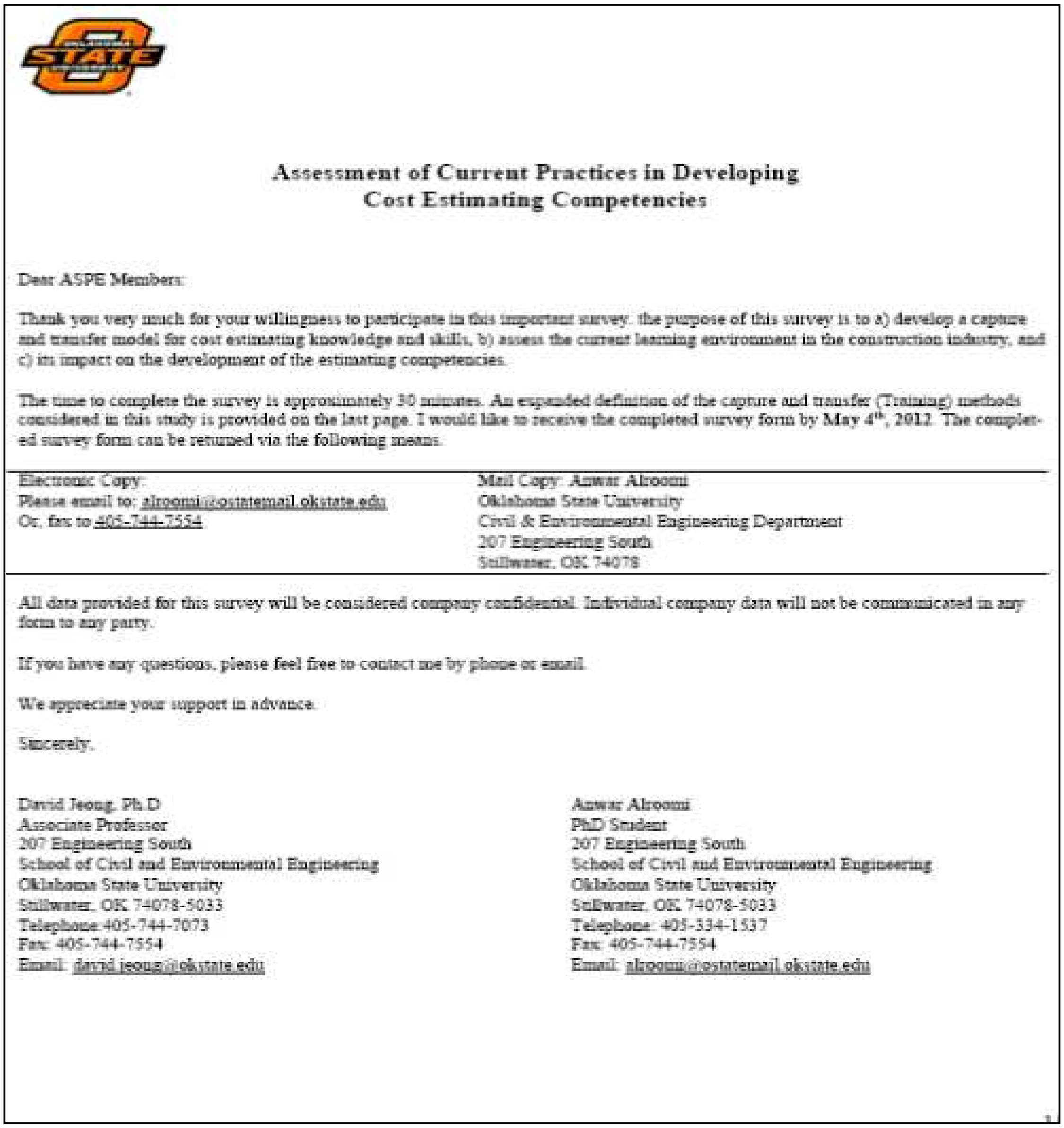
									Q 13-part 2									
Be inquisitive, ask questions, find resources & make decision (Requirement of good estimator)	Able to apply judgment, do reality checks, then explain why (Requirement of good estimator)	Able to stand ground & resist pressure to change numbers (Requirement of good estimator)	Ability to work under pressure with tight deadlines (Requirement of good estimator)	Have good communication skills, self confident, work with others (Requirement of	Have interest in details & numbers with ability to organize work (Requirement of good estimator)	Open to work in new areas where you may not feel comfortable (Requirement of good estimator)	Be dependable, straight forward, objective, fair & consistent (Requirement of good estimator)	Be task oriented with the drive to achieve the end results (Requirement of good estimator)	Ability to see the big picture, realize what is important	Be inquisitive, ask questions, find resources	Able to apply judgment, do reality checks, then	Able to stand ground & resist pressure to change	Ability to work under pressure with tight deadlines (Lacking in	Have good communication skills, self confident, work with	Have interest in details & numbers with ability to organize	Open to work in new areas where you may not feel	Be dependable, straight forward, objective, fair &	Be task oriented with the drive to achieve the end results
4	3	3	4	4	4	4	3	3	4	4	4	4	4	3	3	4	3	3
4	4	5	5	5	5	4	5	4	3	3	3	3	4	2	3	3	3	3
5	5	4	5	5	4	3	5	5	5	5	5	4	3	2	2	2	2	2
5	4	5	5	3	3	3	3	4										
3	5	4	3	3	4	3	4	4	5	4	5	5	2	3	3	3	3	4
4	3	4	4	4	4	3	4	4	2	3	2	1	3	3	4	3	3	3
4	5	5	5	4	5	2	5	4	5	3	2	1	2	2	3	2	4	4
4	4	3	3	3	4	3	4	3	4	3	4	3	3	3	3	3	3	3
5	4	4	3	4	3	2	4	3	5	3	4	2	2	2	2	2	2	2
4	4	3	4	4	3	3	3	3	4	4	4	4	2	2	3	2	3	3
4	5	4	5	4	4	4	5	4	2	2	2	1	1	3	4	3	4	3
4	4	5	5	4	5	3	4	4										
4	4	5	4	4	4	3	4	4	4	3	4	4	3	3	3	3	3	3
4	4	3	4	4	4	4	4	5	3	3	3	3	3	3	3	3	3	3
5	5	4	5	4	5	4	4	4	4	4	5	5	5	5		4	4	4
4	4	4	5	4	5	3	4	4	3	3	4	4	2	2	2	3	3	3
5	5	4		5	5	3	3	5	5	3	3	4	4	3	4	3	3	3
4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	2	2	2
5	4	1	5	5	5	4	5	5	5	3	3	3	2	3	4		3	3
5	5	5	5	5	5	5	5	5	4	5	5	4	3	4	4	5	5	5
5	5	4	5	5	5	4	5	5	4	4	5	5	3	3	3	5	4	4
5	5	5	5	5	5	4	5	5	4	5	4	4	4	3	3	3	4	4
3	5	4	4	4	4	4	3	3	4	3	4	3	3	3	4	3	3	2
5	5	5	5	5	5	4	5	5	5	5	5	5	4	4	4	4	4	5
4	4	4	4	4	4	3	4	3	5	3	4	3	2	2	3	3		3
5	4	4	5	5	5	4	5	5	3	4	4	4	4	3	3	4	3	3
5	5	5	5	5	5	3	5	5	5	1	4	4	4	3	4	3	3	3
3	5	4	5	4	4	4	4	5	5	4	5	4	5	4	3	4	4	3
3	3	3	3	4	4	3	4	4	3	4	3	4	4	3	2	4	4	4
4	4	4	5	5	4	4	4	5	2	3	2	3	2	2	2	2	2	3
	5	5	5	5	5	3	5	4	3	3	3	3	3	3	3	2	3	2
5	5	5	5	5	4	4	4	5	5	4	4	5	4	4	4	4	4	4
5	5	4	4	5	4	4	5	5	2	2	1	1	2	3	2	1	3	2
5	5	4	4	5	4	4	4	4	4	4	4	5	4	3	2	3	2	2
5	4	3	5	4	3	2	3	4	3	4	4	4	2	2	3	3	3	3
4	5	3	4	5	4	4	5	4	3	3	3	3	3	3	3	3	3	3
5	5	5	4	5	5	4	5	5	5	5	5	5	4	4	4	4	4	5
5	5	3	5	5	5	5	5	5	5	2	3	2	3	2	4	2	2	2
5	3	4		4	5		4	3	3	4	4	2		3	3		3	3
5	5	5	4	5	5	3	5	4	4	4	4	3	3	2	3	2	4	3
4	5	5	5	4	3	4	4	4	4	2	5	5	5	3	3	2	3	2
5	4	4	4	4	5	5	3	4	4	3	3	3	3	3	4	2	2	4
5	4	3	4	4	5	3	5	5	4	3	3	3	3	3	3	3	3	3
4	4	4	4	4	3	4	4	3	5	2	4	4	3	4	3	4	4	3
5	5	4	5	4	5	4	4	5	4	4	5	3	5	4	5	3	4	5
4	4	4	5	4	5	4	4	5	4	4	4	4	4	3	4	2	3	4
5	5	3	3	5	5	5	5	5	3	3	3	3	3	3	3	3	3	3
5	5	4	5	5	5	5	5	5	4	4	5	4	5	4	4	3	5	4
5	5	5	4	4	4	3	3	4	5	3	3	3	2		2	2	2	3
4	5	5	4	5	4		4	4	4	3	4	4	3	3	3	3	3	3
4	5	4	4	4	4	4	4	4	4	3	4	4	3	3	3	2	3	3
5	5	4	4	5	5	4	4	4	4	5	5	5	5	4	5	4	4	4
5	5	4	5	4	3	3	4	4	5	4	5	4	3	3	3	3	3	3
4	3	3	5	4	4	4	4	4	3	2	3	4	2	2	3	2	3	3
5	5	4	5	5	5	3	5	4	5	4	4	4	4	4	4	3	3	4
5	4	3	4	4	4	3	4	5	4	3	4	5	4	3	4	2	3	3
5	5	5	5	5	4	5	5	3	5	2	2	2	1	3	2	4	2	2
4	4	3	5	5	5	4	4	4	2	3	2	1	3	2	3	3	3	3
4	3	3	4	4	3	3	4	3	4	4	3	3	4	3	3	3	4	3
4	4	2	4	4	4	4	4	4	5	3	4	4	4	2	2	3	3	3
5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	4	4	4	2	2	2	3	2	2
4	5	3	4	4	2	2	4	3	5	1	3	3	2	1	2	2	2	2
4	4	4	5	5	4	4	4	5	4	3	3	4	4	3	2	2	2	2
5	5	4	4	5	4	4	4	4	5	3	4	4	3	4	4	3	3	3
4	4	3	3	3	4	3	4	3										
4	5	4	5	4	5	4	4	4	5	4	5	4	2	2	2	3	2	2
4	4	4	5	4	4	4	4	4	4	4	3	3	3	3	2	2	3	3
4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3
5	5	4	5	4	4	4	4	5	4	4	4	5	2	2	2	3	3	4
4	5	3	5	5	5	4	5	5	5	5	5	4	5	5	4	2	3	5
4	5	4	5	4	2	4	4	5	3	2	4	2	1	1	3	2	5	5
5	5	4	5	5	4	3	4	5	5	4	4	5	3	3	2	2	3	2
4	4	4	4	4	3	4	4	3	4	2	4	5	3	3	2	3	3	3
4	4	3	4	5	3	3	4	4	3	3	3	5	1	4	2	3	2	2
5	5	5	5	5	5	5	5	5	1	1	1	1	1	1	1	1	1	1
5	4	4	4	5	5	4	4	5	1	2	2	5	5	1	2	1	2	2
4	4	3	4	5	4	4	4	5	4	3	4	2	2	1	2	2	4	2
4	4	3	5	5	5	4	5	5	4	1	3	4	1	2	3	2	3	3
4	5	4	4	4	3	4	5	5	4	3	5	4	2	3	3	3	1	3
4	5	3	5	5	3	3	5	5	4	2	3	5	3	3	3	1	3	2

									Q 13-part 2									
Be inquisitive, ask questions, find resources & make decision (Requirement of good estimator)	Able to apply judgment, do reality checks, then explain why (Requirement of good estimator)	Able to stand ground & resist pressure to change numbers (Requirement of good estimator)	Ability to work under pressure with tight deadlines (Requirement of good estimator)	Have good communication skills, self confident, work with others (Requirement of	Have interest in details & numbers with ability to organize work (Requirement of good estimator)	Open to work in new areas where you may not feel comfortable (Requirement of good estimator)	Be dependable, straight forward, objective, fair & consistent (Requirement of good estimator)	Be task oriented with the drive to achieve the end results (Requirement of good estimator)	Ability to see the big picture, realize what is important	Be inquisitive, ask questions, find resources	Able to apply judgment, do reality checks, then	Able to stand ground & resist pressure to change	Ability to work under pressure with tight deadlines (Lacking in	Have good communication skills, self confident, work with	Have interest in details & numbers with ability to organize	Open to work in new areas where you may not feel	Be dependable, straight forward, objective, fair &	Be task oriented with the drive to achieve the end results
5	5	3	3	5	5	5	5	5	4	2	4	4	2	2	3	3	3	2
5	5	5	4	5	4	3	4	5	5	4	4	5	5	3	3	4	4	2
5	5	5	4	4	3	3	4	4	4	4	4	5	3	4	3	3	3	3
4	4	3	5	5	4	4	5	5	2	2	2	2	4	4	4	4	4	4
4	4	3	5	5	4	5	5	5	2	2	2	4	4	2	3	2	2	3
4	4	5	3	3	4	4	4	3	5	3	4	3	2	3	3	3	3	2
3	5	4	5	5	5	5	5	5	5	4	3	4	5	3	3	3	4	3
4	4	3	3	5	5	3	5	4	4	2	4	3	3	3	3	3	2	2
4	4	4	3	4	3	4	4	4	4	3	3		5	3	2	3	3	3
4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3
4	5	5	4	3	3	3	4	4	3	3	3	3	3	4	3	4	3	3
5	5	5	5	5	5	5	5	5	5	4	4	4	5	5	5	4	4	4
5	5	5	5	5	5	5	5	5	5	3	3	5	5	3	3	5	3	3
5	5	5	5	4	4	4	5	5	5	5	4	5	5	4	4	3	3	4
5	5	5	5	5	5	5	5	5										
4	4	3	5	5	5	3	4	5	4	4	4		3	3	3	3	3	4
5	5	4	4	5	4	4	4	5	2	2	2	3	3	3	3	3	2	3
4	4	4	4	4	4	4	4	4	4	3	3	4	4	2	2	4	3	3
5	5	4	4	5	4	5	4	4	5	4	5	5	5	4	4	3	4	4
4	4	4	4	4	3	3	5	4	5	3	4	4	3	4	4	4	3	3
4	4	5	4	4	3	4	5	3	4	2	4	3	3	4	2	3	2	3
4	4	5	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	4	4	5	4	5	4	5	3	4	4	3	3	3	3	4	3	3	3
4	5	5	5	5	3	4	5	3	4	2	4	2	4	4	3	3	4	3
4	5	3	5	5	3	4	5	3	3	2	3	4	4	3	3	4	3	2
3	4	4	4	4	4	3	5	3	3	3	3	3	3	3	3	3	3	3
5	5	5	5	5	4	5	5	3	2	4	2	2	2	2	3	2	3	3
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	3	3
3	4	4	3	3	4	3	4	4	3	3	4	4	3	3	2	3	2	2
4	4	4	4	5	4	3	4	4	5	4	4	5	5	5	4	4	3	3
5	4	4	5	4	4	3	4	4	4	5	5	4	4	3	4	5	4	4
4	4	4	3	4	5	3	4	3	3	2	4	4	2	2	2	3	3	3
5	5	4	5	5	5	4	5	5	5	4	3	3	4	4	3	2	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	3	3
5	5	4	4	4	5	4	5	5	5	5	5	5	4		3	3	3	3
4	4	5	5	4	4	4	4	4	4	4	4	5	5	4	3	4	4	5
3	4	3	4	4	5	3	5	4										
5	5	5	5	5	5	5	5	5	3	3	3	3	3	3	3	3	3	3
5	5	4	4	4	3	3	4	4	3	3	4	4	2	3	3	3	3	4
4	5	5	4	5	4	4	4	4	3	3	4	5	4	4	3	3	3	3
5	4	5	4	3	5	4	5	4		3	5	4	5	4	5	5	4	5
5	5		5	5	5		5	5	5	3	3	3	3	4	4	3	3	2
5	5	5	5	5	4	4	5	5	5	3	5	3	4	2	3	3	3	3
5	5	3	5	5	4	3	5	5	5	3	5	5	3	3	3	5	3	3
4	4	5	5	4	4	5	5	4	5	5	5	5	5	5	3	5	4	5
4	5	5	5	5	5	5	5	5	4	4	4		3	3	3	3	3	3
5	5	5	5	5	5	4	5	4	4	5	3	3	2	3	1	2	3	3
4	5	4	4	4	5	4	5	5	3	4	4	5	5	5	4	5	5	4
4	4	4	4	5	5	4	5	4	4	4	3	3	3	4	3	3	4	3
4	4	3	4	4	4	3	4	4	4	3	4		3	5	4	2	3	3
4	4	3	5	4	4	4	5	4	5	3	5	4	3	5	4	4	4	4
4	4	4	3	5	4	4	4	4	4	3	5	4	4	4	3	4	3	4
5	5	4	5		4	4	4	5	5	4	5	3	3		3	2	2	2
5	5	3	5		5	4	5	5	5	3	3	1	3	4	1	1	1	1
5	5	5	5	5	5	5	5	5	5	5	5	4	4	1	3	3	3	3
4	5	5	5	5	5	4	5	5	5	1	1	1	1	5	3	1	1	1
4	5	5	5	4	4	4	4	4	4	4	4	3	4	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	4	4	5	4	4	4	4	5	5	3	3	3	4	3	4	4	3	3
5	5	4	5	5	5	5	5	5	3	3	3	3	2	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	3	3	4	3	3	3	3	3	3
5	4	4	5	5	5	4	5	4	5	4	3	3	3	3	2	3	3	3
5	4	4	5	5	5	5	5	4	5	4	3	4	4	3	4	5	4	3
4	5	5	4	4	4	4	4	4	3	3	3	3	1	3	3	3	3	3
4	5	5	5	5	5	4	4	4	3	3	3	3	1	2	2	2	3	2
5	4	5	5	5	5	5	5	5	5	3	4	3	4	4	4	3	3	4
4	4	4	5	4	5	4	4	5	3	4	3	5	4	3	3	3	3	3
5	5	5	5	5	5	4	5	5	4	3	3	5	4	4	4	3	4	4
4	4	3	5	4	4	3	5	4	5	2	4	2	4	3	3	1	2	2
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	4	5	5	4	3	5	4	4	4	3	3	4	5	3	3	3	3	4
5	5	4	5	5	4	4	4	4	5	2	4	5	3	3	3	3	3	3
5	5	5	5	5	5	5	5	5	3	4	2							
5	5	4	5	5	5	4	5	5	4	3	3	3	2	4	2	3	3	2
5	5	5	5	5	5	5	5	5	3	3	3	3	4	2	2	2	3	2
4	5	4	5	5	4	3	4	4	5	4	3	3	4	4	2	3	3	4
5	5	5	5	5	5	4	5	5	5	5	5	5	3	2	4	3	3	3
5	5	4	5	5	4	5	5	5	3	3	3	3	4	3	4	3	3	3
4	5	4	4	4	5	4	5	5	4	4	4	3	3	3	4	3	3	3
5	4	4	4	4	4	3	4	3	4	4	4	3	3	3	3	3	3	3
5	5	4	5						5	3	4	3	3					

					Q 10									Q 11					Q 12		Q 13
Development of Reports for Management (Knowledge can be	Develop Clear & Organized estimates with sound basis (Knowledge can be Captured)	Designing/Engineering Knowledge (Knowledge can be Captured)	Construction / Site Condition (Knowledge (Knowledge can be	Know What questions to ask & who to ask (Knowledge can be Captured)	Reasons for Estimate Deviation (Scope definition)	Reasons for Estimate Deviation (Improper Escalation)	Reasons for Estimate Deviation (Estimator Error)	Reasons for Estimate Deviation (Risk Analysis/ Contingency)	Reasons for Estimate Deviation (FMM Changes)	Reasons for Estimate Deviation (Local Market Instability)	Reasons for Estimate Deviation (Changes in Execution Method)	Reasons for Estimate Deviation (Communication Problem)	Reasons for Estimate Deviation (Scheduling Problems)	Define Successful Estimate (Validated by next phase estimate)	Define Successful Estimate (Validated by actual cost)	Define Successful Estimate (Falls within expected historical)	Define Successful Estimate (Third party validation)	Define Successful Estimate (Client acceptance)	Current % of work preformed using Judgement	Ideal % of work rely on Judgment	Ability to see the big picture, realize what is important (Requirement of good estimator)

APPENDIX C

"ASSESSMENT OF CURRENT PRACTICES IN DEVELOPING COST ESTIMATING COMPETENCIES" SURVEY



Assessment of Current Practices in Developing Cost Estimating Competencies

Dear ASPE Members:

Thank you very much for your willingness to participate in this important survey. the purpose of this survey is to a) develop a capture and transfer model for cost estimating knowledge and skills, b) assess the current learning environment in the construction industry, and c) its impact on the development of the estimating competencies.

The time to complete the survey is approximately 30 minutes. An expanded definition of the capture and transfer (Training) methods considered in this study is provided on the last page. I would like to receive the completed survey form by **May 4th, 2012**. The completed survey form can be returned via the following means:

Electronic Copy:
Please email to: alroomi@ostatemail.okstate.edu
Or, fax to 405-744-7554

Mail Copy: Anwar Alroomi
Oklahoma State University
Civil & Environmental Engineering Department
207 Engineering South
Stillwater, OK 74078

All data provided for this survey will be considered company confidential. Individual company data will not be communicated in any form to any party.

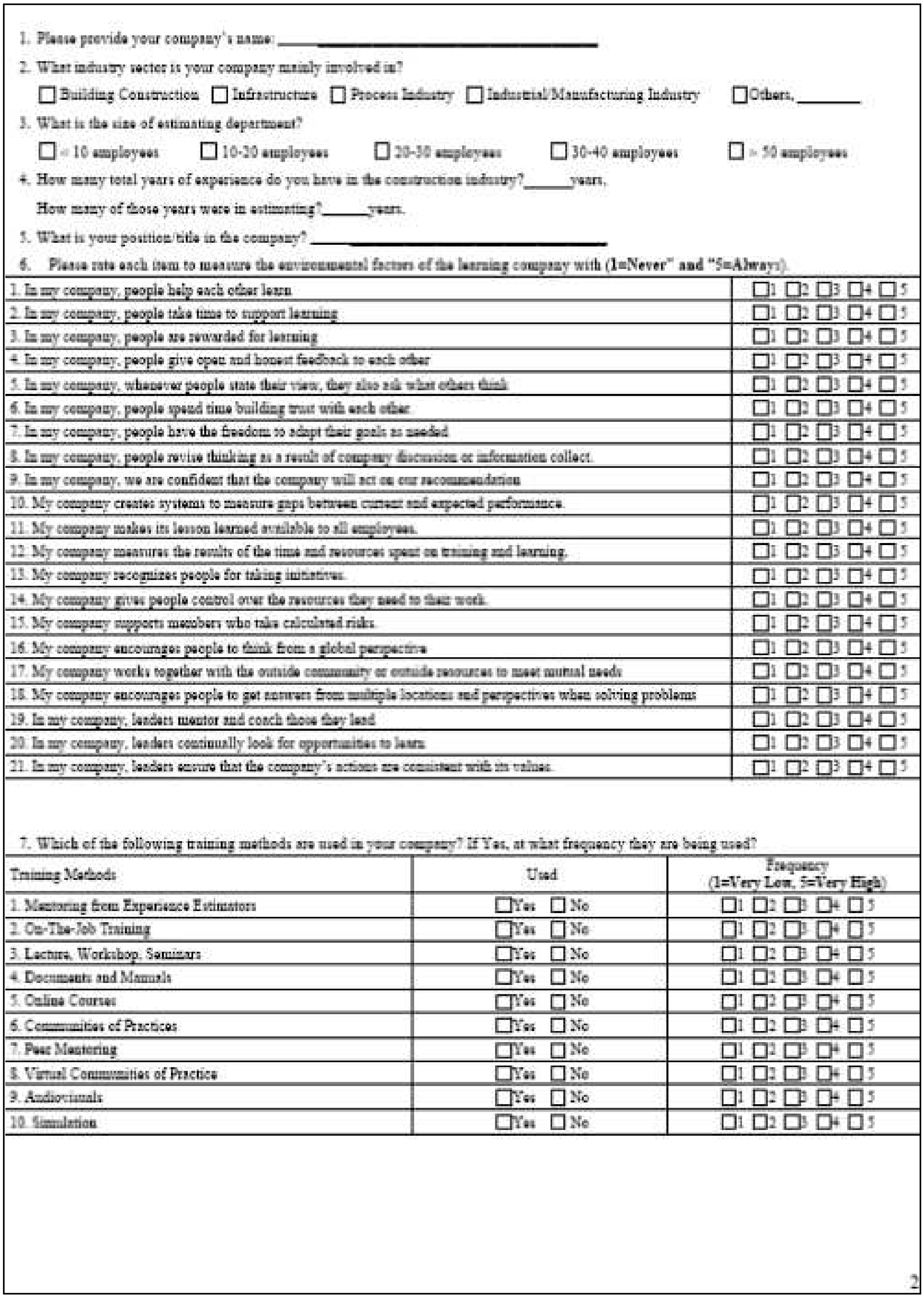
If you have any questions, please feel free to contact me by phone or email.

We appreciate your support in advance.

Sincerely,

David Jeong, Ph.D
Associate Professor
207 Engineering South
School of Civil and Environmental Engineering
Oklahoma State University
Stillwater, OK 74078-5033
Telephone:405-744-7073
Fax: 405-744-7554
Email: david.jeong@okstate.edu

Anwar Alroomi
PhD Student
207 Engineering South
School of Civil and Environmental Engineering
Oklahoma State University
Stillwater, OK 74078-5033
Telephone: 405-334-1537
Fax: 405-744-7554
Email: alroomi@ostatemail.okstate.edu



1. Please provide your company's name: ________________________________

2. What industry sector is your company mainly involved in?

☐ Building Construction ☐ Infrastructure ☐ Process Industry ☐ Industrial/Manufacturing Industry ☐ Others, ________

3. What is the size of estimating department?

☐ < 10 employees ☐ 10-20 employees ☐ 20-30 employees ☐ 30-40 employees ☐ > 50 employees

4. How many total years of experience do you have in the construction industry?______years,

How many of those years were in estimating?______years.

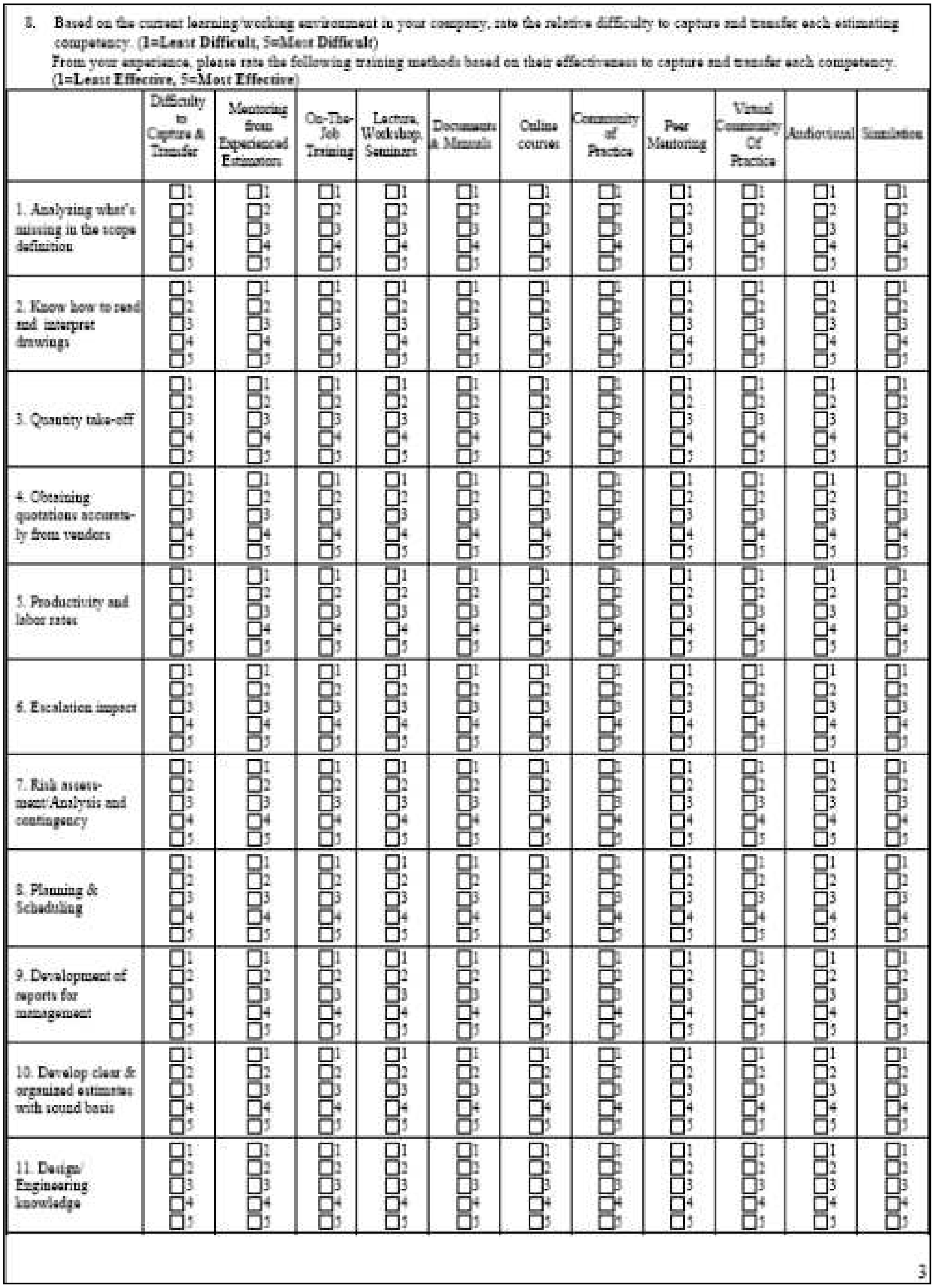
5. What is your position/title in the company? ________________________________

6. Please rate each item to measure the environmental factors of the learning company with (**1=Never" and "5=Always**).

1. In my company, people help each other learn	☐1 ☐2 ☐3 ☐4 ☐5
2. In my company, people take time to support learning	☐1 ☐2 ☐3 ☐4 ☐5
3. In my company, people are rewarded for learning	☐1 ☐2 ☐3 ☐4 ☐5
4. In my company, people give open and honest feedback to each other	☐1 ☐2 ☐3 ☐4 ☐5
5. In my company, whenever people state their view, they also ask what others think	☐1 ☐2 ☐3 ☐4 ☐5
6. In my company, people spend time building trust with each other	☐1 ☐2 ☐3 ☐4 ☐5
7. In my company, people have the freedom to adapt their goals as needed	☐1 ☐2 ☐3 ☐4 ☐5
8. In my company, people revise thinking as a result of company discussion or information collect.	☐1 ☐2 ☐3 ☐4 ☐5
9. In my company, we are confident that the company will act on our recommendation	☐1 ☐2 ☐3 ☐4 ☐5
10. My company creates systems to measure gaps between current and expected performance.	☐1 ☐2 ☐3 ☐4 ☐5
11. My company makes its lesson learned available to all employees.	☐1 ☐2 ☐3 ☐4 ☐5
12. My company measures the results of the time and resources spent on training and learning.	☐1 ☐2 ☐3 ☐4 ☐5
13. My company recognizes people for taking initiatives.	☐1 ☐2 ☐3 ☐4 ☐5
14. My company gives people control over the resources they need to their work.	☐1 ☐2 ☐3 ☐4 ☐5
15. My company supports members who take calculated risks.	☐1 ☐2 ☐3 ☐4 ☐5
16. My company encourages people to think from a global perspective	☐1 ☐2 ☐3 ☐4 ☐5
17. My company works together with the outside community or outside resources to meet mutual needs	☐1 ☐2 ☐3 ☐4 ☐5
18. My company encourages people to get answers from multiple locations and perspectives when solving problems	☐1 ☐2 ☐3 ☐4 ☐5
19. In my company, leaders mentor and coach those they lead	☐1 ☐2 ☐3 ☐4 ☐5
20. In my company, leaders continually look for opportunities to learn	☐1 ☐2 ☐3 ☐4 ☐5
21. In my company, leaders ensure that the company's actions are consistent with its values.	☐1 ☐2 ☐3 ☐4 ☐5

7. Which of the following training methods are used in your company? If Yes, at what frequency they are being used?

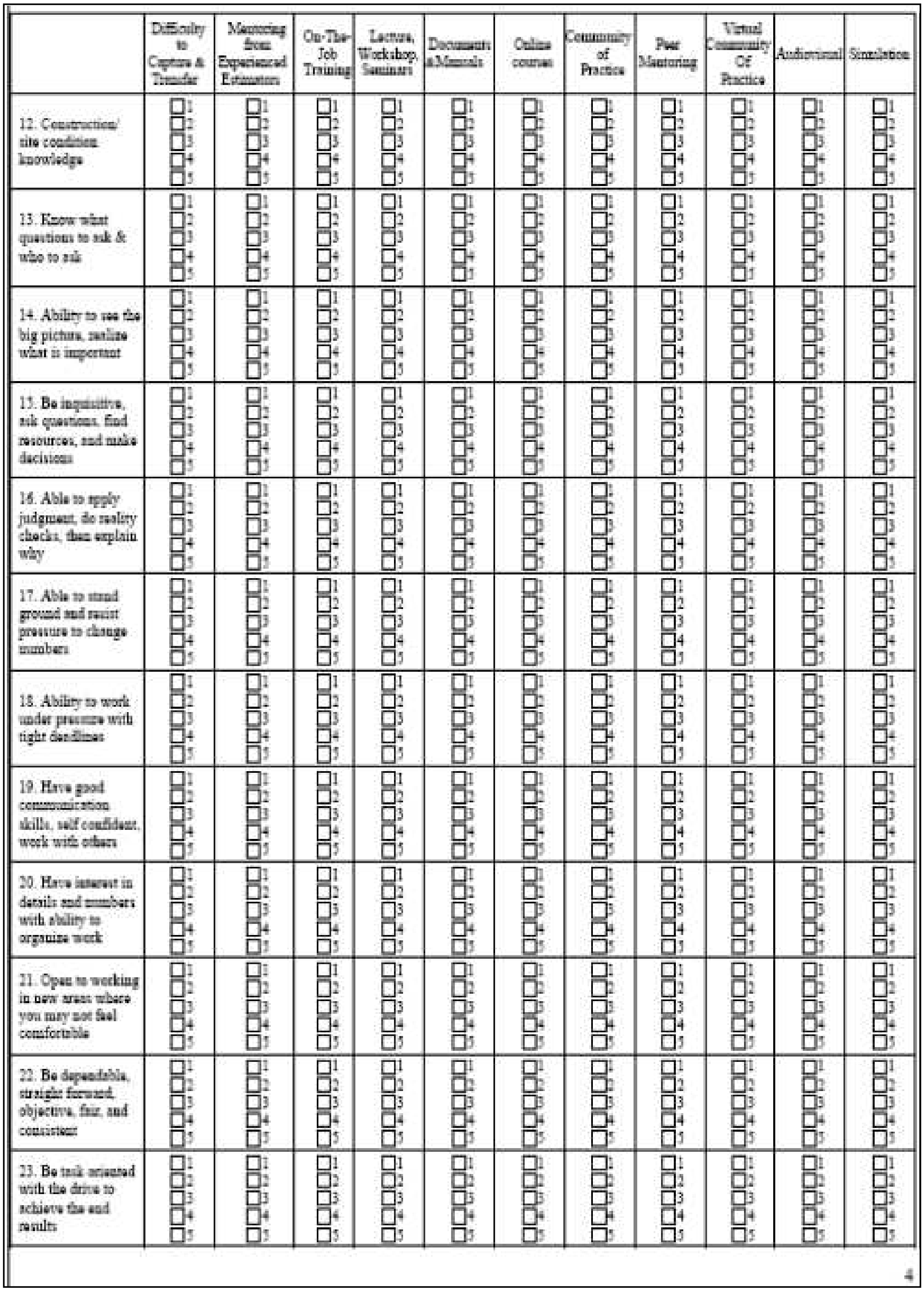
Training Methods	Used	Frequency (1=Very Low, 5=Very High)
1. Mentoring from Experience Estimators	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
2. On-The-Job Training	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
3. Lecture, Workshop, Seminars	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
4. Documents and Manuals	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
5. Online Courses	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
6. Communities of Practices	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
7. Peer Mentoring	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
8. Virtual Communities of Practice	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
9. Audiovisuals	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5
10. Simulation	☐Yes ☐ No	☐1 ☐2 ☐3 ☐4 ☐5



8. Based on the current learning/working environment in your company, rate the relative difficulty to capture and transfer each estimating competency. (**1=Least Difficult, 5=Most Difficult**)
From your experience, please rate the following training methods based on their effectiveness to capture and transfer each competency. (**1=Least Effective, 5=Most Effective**)

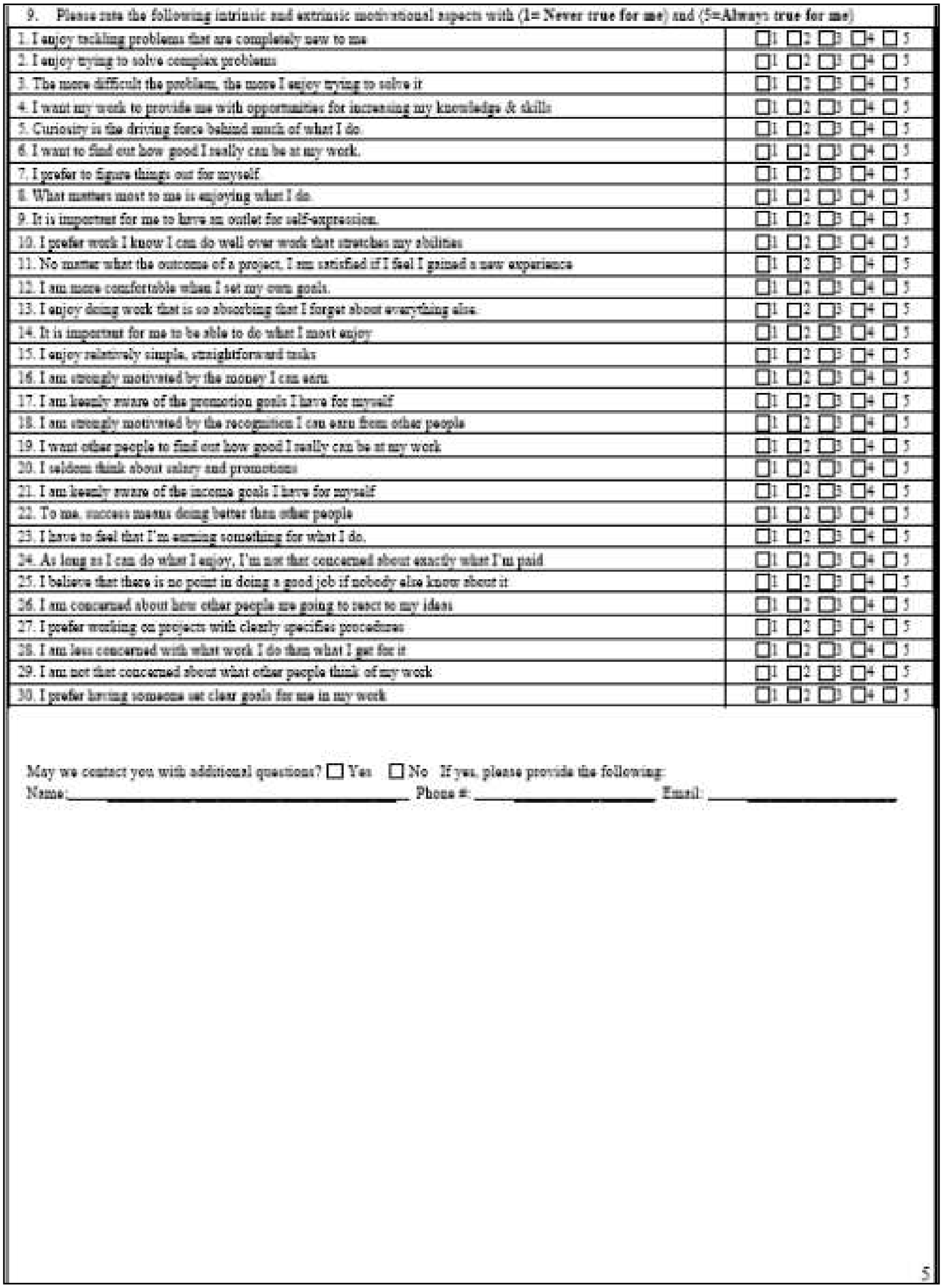
	Difficulty to Capture & Transfer	Mentoring from Experienced Estimators	On-The-Job Training	Lecture, Workshop, Seminars	Documents & Manuals	Online courses	Community of Practice	Peer Mentoring	Virtual Community Of Practice	Audiovisual	Simulation
1. Analyzing what's missing in the scope definition	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
2. Know how to read and interpret drawings	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
3. Quantity take-off	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
4. Obtaining quotations accurately from vendors	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
5. Productivity and labor rates	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
6. Escalation impact	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
7. Risk assessment/Analysis and contingency	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
8. Planning & Scheduling	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
9. Development of reports for management	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
10. Develop clear & organized estimates with sound basis	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
11. Design/ Engineering knowledge	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5

3



	Difficulty to Capture & Transfer	Mentoring from Experienced Estimators	On-The-Job Training	Lecture, Workshop, Seminars	Documents &Manuals	Online courses	Community of Practice	Peer Mentoring	Virtual Community Of Practice	Audiovisual	Simulation
12. Construction/ site condition knowledge	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
13. Know what questions to ask & who to ask	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
14. Ability to see the big picture, realize what is important	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
15. Be inquisitive, ask questions, find resources, and make decisions	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
16. Able to apply judgment, do reality checks, then explain why	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
17. Able to stand ground and resist pressure to change numbers	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
18. Ability to work under pressure with tight deadlines	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
19. Have good communication skills, self confident, work with others	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
20. Have interest in details and numbers with ability to organize work	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
21. Open to working in new areas where you may not feel comfortable	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
22. Be dependable, straight forward, objective, fair, and consistent	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
23. Be task oriented with the drive to achieve the end results	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5

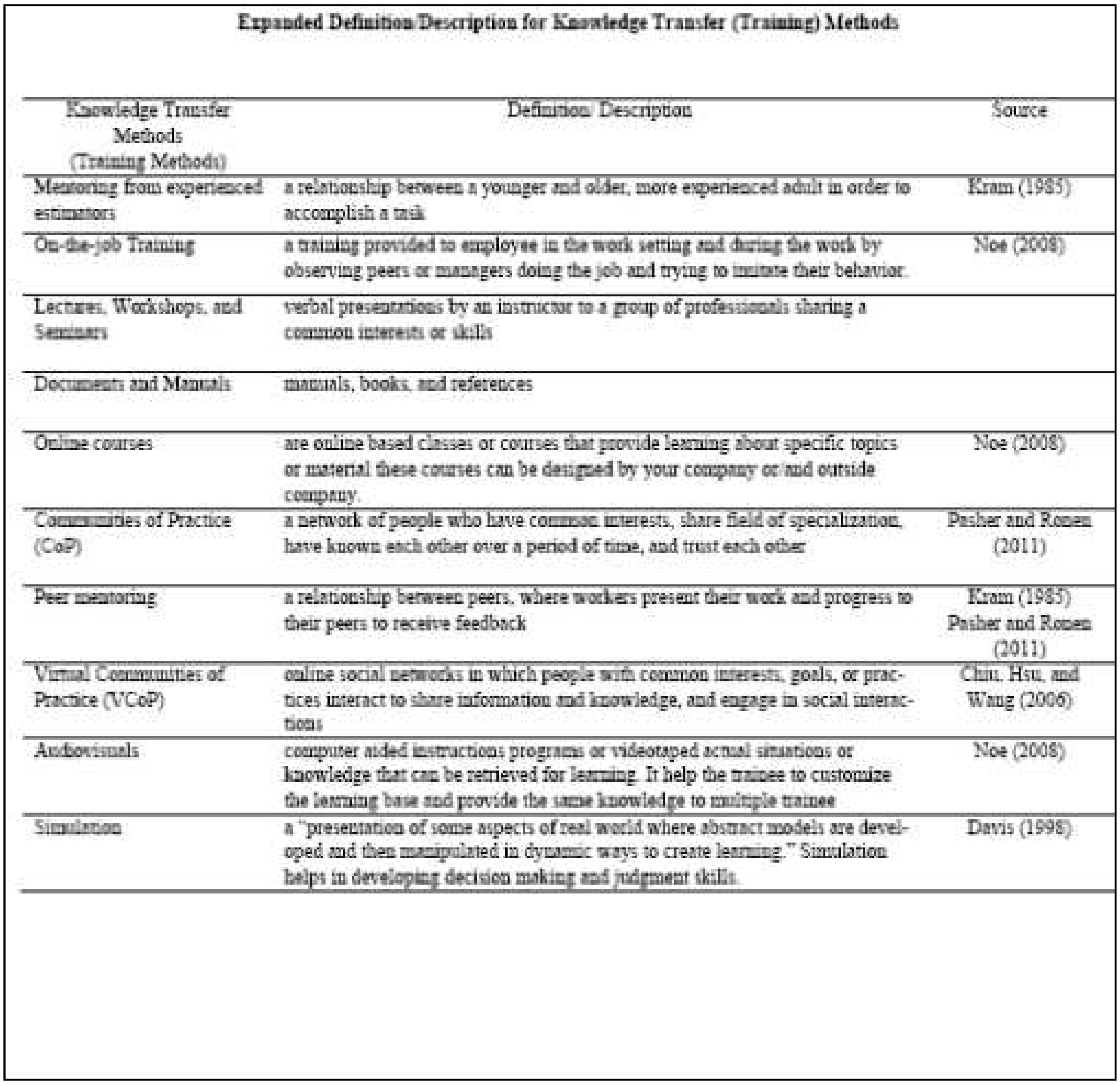
4



9. Please rate the following intrinsic and extrinsic motivational aspects with (**1= Never true for me**) and (**5=Always true for me**)	
1. I enjoy tackling problems that are completely new to me	☐1 ☐2 ☐3 ☐4 ☐ 5
2. I enjoy trying to solve complex problems	☐1 ☐2 ☐3 ☐4 ☐ 5
3. The more difficult the problem, the more I enjoy trying to solve it	☐1 ☐2 ☐3 ☐4 ☐ 5
4. I want my work to provide me with opportunities for increasing my knowledge & skills	☐1 ☐2 ☐3 ☐4 ☐ 5
5. Curiosity is the driving force behind much of what I do.	☐1 ☐2 ☐3 ☐4 ☐ 5
6. I want to find out how good I really can be at my work.	☐1 ☐2 ☐3 ☐4 ☐ 5
7. I prefer to figure things out for myself.	☐1 ☐2 ☐3 ☐4 ☐ 5
8. What matters most to me is enjoying what I do.	☐1 ☐2 ☐3 ☐4 ☐ 5
9. It is important for me to have an outlet for self-expression.	☐1 ☐2 ☐3 ☐4 ☐ 5
10. I prefer work I know I can do well over work that stretches my abilities	☐1 ☐2 ☐3 ☐4 ☐ 5
11. No matter what the outcome of a project, I am satisfied if I feel I gained a new experience	☐1 ☐2 ☐3 ☐4 ☐ 5
12. I am more comfortable when I set my own goals.	☐1 ☐2 ☐3 ☐4 ☐ 5
13. I enjoy doing work that is so absorbing that I forget about everything else.	☐1 ☐2 ☐3 ☐4 ☐ 5
14. It is important for me to be able to do what I most enjoy	☐1 ☐2 ☐3 ☐4 ☐ 5
15. I enjoy relatively simple, straightforward tasks	☐1 ☐2 ☐3 ☐4 ☐ 5
16. I am strongly motivated by the money I can earn	☐1 ☐2 ☐3 ☐4 ☐ 5
17. I am keenly aware of the promotion goals I have for myself	☐1 ☐2 ☐3 ☐4 ☐ 5
18. I am strongly motivated by the recognition I can earn from other people	☐1 ☐2 ☐3 ☐4 ☐ 5
19. I want other people to find out how good I really can be at my work	☐1 ☐2 ☐3 ☐4 ☐ 5
20. I seldom think about salary and promotions	☐1 ☐2 ☐3 ☐4 ☐ 5
21. I am keenly aware of the income goals I have for myself	☐1 ☐2 ☐3 ☐4 ☐ 5
22. To me, success means doing better than other people	☐1 ☐2 ☐3 ☐4 ☐ 5
23. I have to feel that I'm earning something for what I do.	☐1 ☐2 ☐3 ☐4 ☐ 5
24. As long as I can do what I enjoy, I'm not that concerned about exactly what I'm paid	☐1 ☐2 ☐3 ☐4 ☐ 5
25. I believe that there is no point in doing a good job if nobody else know about it	☐1 ☐2 ☐3 ☐4 ☐ 5
26. I am concerned about how other people are going to react to my ideas	☐1 ☐2 ☐3 ☐4 ☐ 5
27. I prefer working on projects with clearly specifies procedures	☐1 ☐2 ☐3 ☐4 ☐ 5
28. I am less concerned with what work I do than what I get for it	☐1 ☐2 ☐3 ☐4 ☐ 5
29. I am not that concerned about what other people think of my work	☐1 ☐2 ☐3 ☐4 ☐ 5
30. I prefer having someone set clear goals for me in my work	☐1 ☐2 ☐3 ☐4 ☐ 5

May we contact you with additional questions? ☐ Yes ☐ No If yes, please provide the following:

Name:______________________________ Phone #: __________________ Email: ____________________

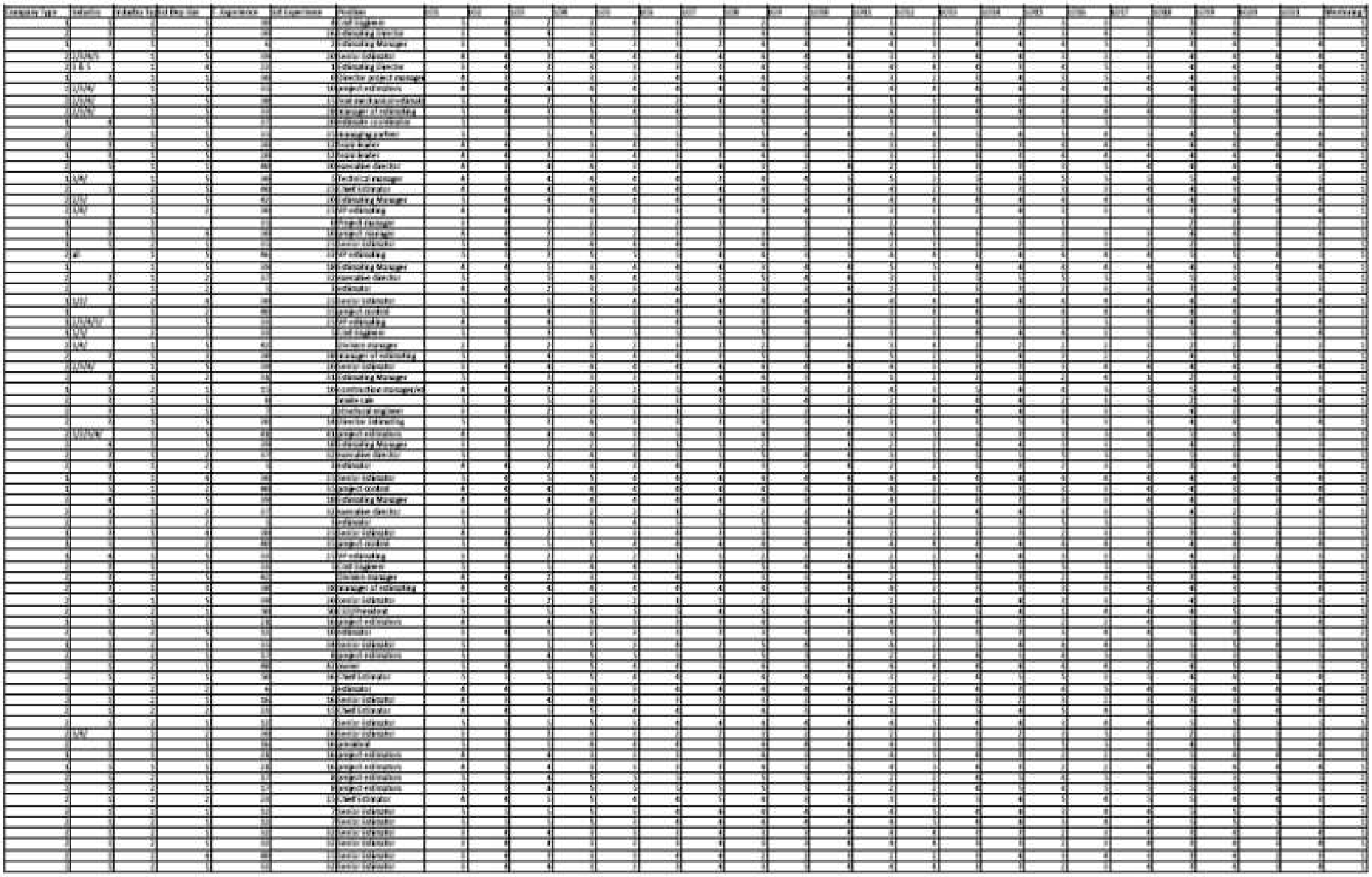


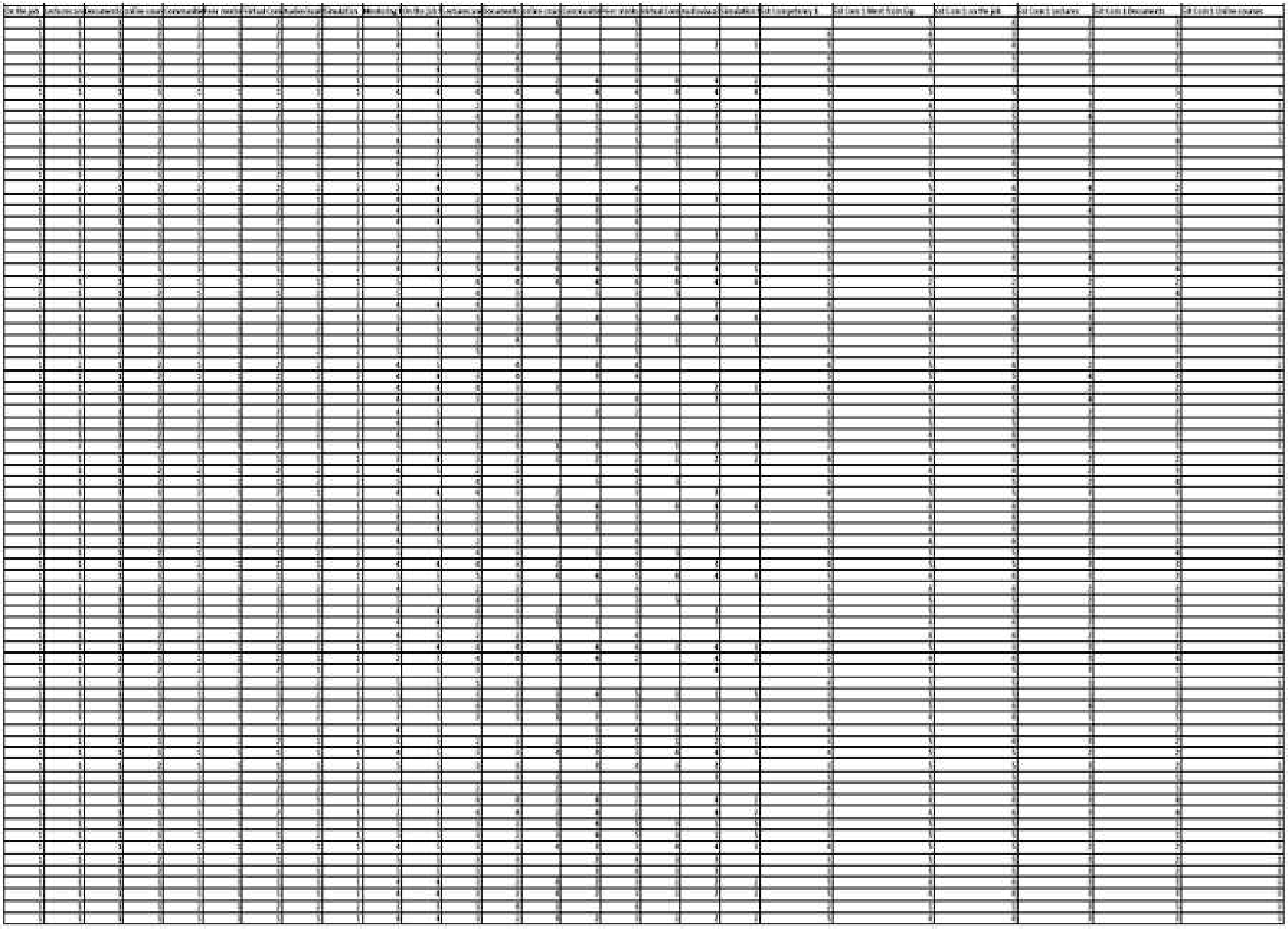
Expanded Definition/Description for Knowledge Transfer (Training) Methods

Knowledge Transfer Methods (Training Methods)	Definition/ Description	Source
Mentoring from experienced estimators	a relationship between a younger and older, more experienced adult in order to accomplish a task	Kram (1985)
On-the-job Training	a training provided to employee in the work setting and during the work by observing peers or managers doing the job and trying to imitate their behavior.	Noe (2008)
Lectures, Workshops, and Seminars	verbal presentations by an instructor to a group of professionals sharing a common interests or skills	
Documents and Manuals	manuals, books, and references	
Online courses	are online based classes or courses that provide learning about specific topics or material these courses can be designed by your company or/and outside company.	Noe (2008)
Communities of Practice (CoP)	a network of people who have common interests, share field of specialization, have known each other over a period of time, and trust each other	Pasher and Ronen (2011)
Peer mentoring	a relationship between peers, where workers present their work and progress to their peers to receive feedback	Kram (1985) Pasher and Ronen (2011)
Virtual Communities of Practice (VCoP)	online social networks in which people with common interests, goals, or practices interact to share information and knowledge, and engage in social interactions	Chiu, Hsu, and Wang (2006)
Audiovisuals	computer aided instructions programs or videotaped actual situations or knowledge that can be retrieved for learning. It help the trainee to customize the learning base and provide the same knowledge to multiple trainee	Noe (2008)
Simulation	a "presentation of some aspects of real world where abstract models are developed and then manipulated in dynamic ways to create learning." Simulation helps in developing decision making and judgment skills.	Davis (1998)

APPENDIX D

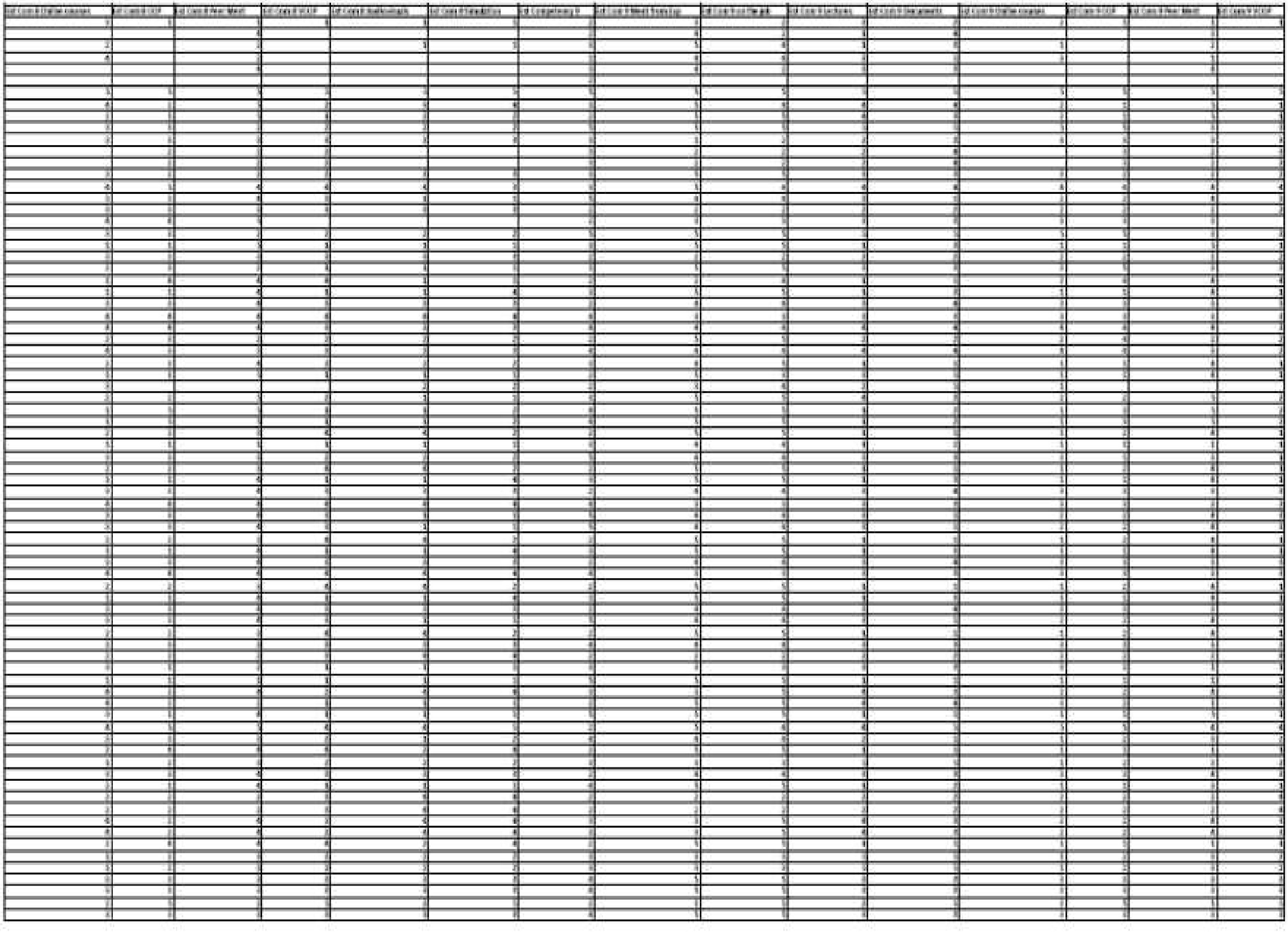
“ASSESSMENT OF CURRENT PRACTICES IN DEVELOPING COST ESTIMATING COMPETENCIES” RAW DATA





Est Com 4 Documents	Est Com 4 Online courses	Est Com 4 COP	Est Com 4 Peer Ment	Est Com 4 VCOP	Est Com 4 Audiovisuals	Est Com 4 Simulation	Est Competency 5	Est Com 5 Ment from Exp	Est Com 5 on the job	Est Com 5 Lectures	Est Com 5 Documents	Est Com 5 Online courses	Est Com 5 COP	Est Com 5 Peer Ment
3							4	5	4	3	4	3	1	1
2			3				3	3	3	2	3			4
1	1		2		1	1	4	5	4	1	1	1		3
3	3		3				2	4	4	4	4	4		4
2			4				3	2	4	2	3			4
							4							
4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
3	4	2	3	2	3	4	4	5	4	4	4	3	1	5
3	2	1	3	1	2	2	2	5	5	4	3	2	1	5
5	3	5	3	3	3	5	5	5	5	5	4	5	3	3
3	4	3	3	4	4	3	3	1	2	3	4	4	4	3
2		1	1	1			3	5	4	2	3		2	2
2		1	1	1			3	5	4	2	3		2	2
1	1	1	3	3	1	3	4	5	5	3	2	3	3	2
4	4	4	4	4	3	2	5	5	4	3	4	4	4	4
1	2	3	4	2	1	1	4	4	4	2	1	1	2	4
3	3	3	3	3	3	3	2	2	2	2	2	2	2	2
3	3	3	3				3	5	5	3	3	1	2	3
5	3	5	3	3	3	5	5	5	5	5	4	5	3	3
3	1	1	3	1	1	1	4	5	5	3	3	1	1	5
3	3	3	3	3	3	3	2	2	2	2	2	2	2	2
1	1	2	3	2	1	1	2	4	4	2	1	1	3	4
1	1	4	4	4	1	1	1	4	2	4	2	1	4	4
3	1	1	3	1	1	1	3	5	5	2	4	1	1	4
2	2	3	4	3	2	2	3	5	5	4	3	3	3	4
3	2	3	3	3	2	2	4	4	3	3	4	3	3	3
3	4	3	4	3	3	3	3	4	4	4	3	4	3	4
3	3	3	2	2	3	3	2	5	5	3	3	3	3	2
1	1	2	4	2	2	2	4	4	4	3	2	1	1	4
2	2	2	3	2	2	2	4	5	4	2	3	2	3	5
1	1	1	3	1	1	1	3	5	5	3	4	1	1	4
2	1				1	1	3	4	4	3	3	3		
3	2	2	3	2	1	1	4	5	5	4	3	2	2	3
2	1	4	3	1	1	1	4	5	5	1	2	1	3	4
2	1	4	3	1	1	1	4	5	5	1	2	1	3	4
3	3	3	3	3	3	3	4	3	2	3	3	3	3	4
1	1	1	1	1	1	1	3	5	4	1	4	1	1	1
2	1	2	3	2	2	2	4	4	5	2	3	1	1	3
3	3	3	3	3	3	3	4	3	2	3	3	3	3	4
3	1	1	3	1	1	1	3	5	5	2	4	1	1	4
2	2	3	4	3	2	2	3	5	5	4	3	3	3	4
3	2	3	3	3	2	2	4	4	3	3	4	3	3	3
1	2	3	4	2	1	1	4	4	4	2	1	1	2	4
1	2	3	4	2	1	1	4	4	4	2	1	1	2	4
3	3	3	3	3	3	3	4	3	2	3	3	3	3	4
3	1	1	3	1	1	1	3	5	5	2	4	1	1	4
2	2	3	4	3	2	2	3	5	5	4	3	3	3	4
3	2	3	3	3	2	2	4	4	3	3	4	3	3	3
3	3	3	3	3	3	3	4	3	2	3	3	3	3	4
3	1	1	3	1	1	1	3	5	5	2	4	1	1	4
2	2	3	4	3	2	2	3	5	5	4	3	3	3	4
1	2	3	4	2	1	1	4	4	4	2	1	1	2	4
3	3	3	3	3	3	3	4	3	2	3	3	3	3	4
3	1	3	3	3	3	3	4	5	4	4	4	1	3	3
2	3	4	3	4	4	4	4	3	3	4	4	5	5	4
1	2	1	3	1	1	1	3	5	5	3	2	2	1	3
1	1	1	1	1	1	1	5	5	5	1	1	1	1	1
2	2	2	3	1	1	1	4	2	5	3	5	2	2	3
2	2	2	1	1	1	1	4	5	5	3	2	1	1	1
1	1	4	4	1	1	1	5	4	4	2	2	1	1	4
3	4	5	3	4	3	5	4	4	5	2	3	2	5	5
2	2	3	3	2	2	1	5	5	3	3	3	32	3	3
1	1	4	3	2	1	3	5	5	5	3	3	2	3	4
2	1	2	3	2	2	2	3	5	5	3	2	1	2	3
2	2	2	3	3	2	2	2	5	5	3	3	3	3	5
1	1	1	3	1	1	1	3	4	4	2	2	2	1	3
2	3	4	3	4	4	4	4	3	3	4	4	5	5	4
2	3	4	3	4	4	4	4	3	3	4	4	5	5	4
2	2	2	3	1	1	1	4	2	5	3	5	2	2	3
2	2	2	3	1	1	1	4	2	5	3	5	2	2	3
1	1	4	3	2	1	3	5	5	5	3	3	2	3	4
2	1	2	3	2	2	2	3	5	5	3	2	1	2	3
2	1	2	3	2	2	2	3	5	5	3	2	1	2	3
2	2	2	4	3	3	3	5	4	4	3	2	2	2	3
2	2	2	4	3	3	3	5	4	4	3	2	2	2	3
5	5	5	1	5	3	5	3	1	2	5	2	2	5	1
2	2	2	4	3	3	3	5	4	4	3	2	2	2	3

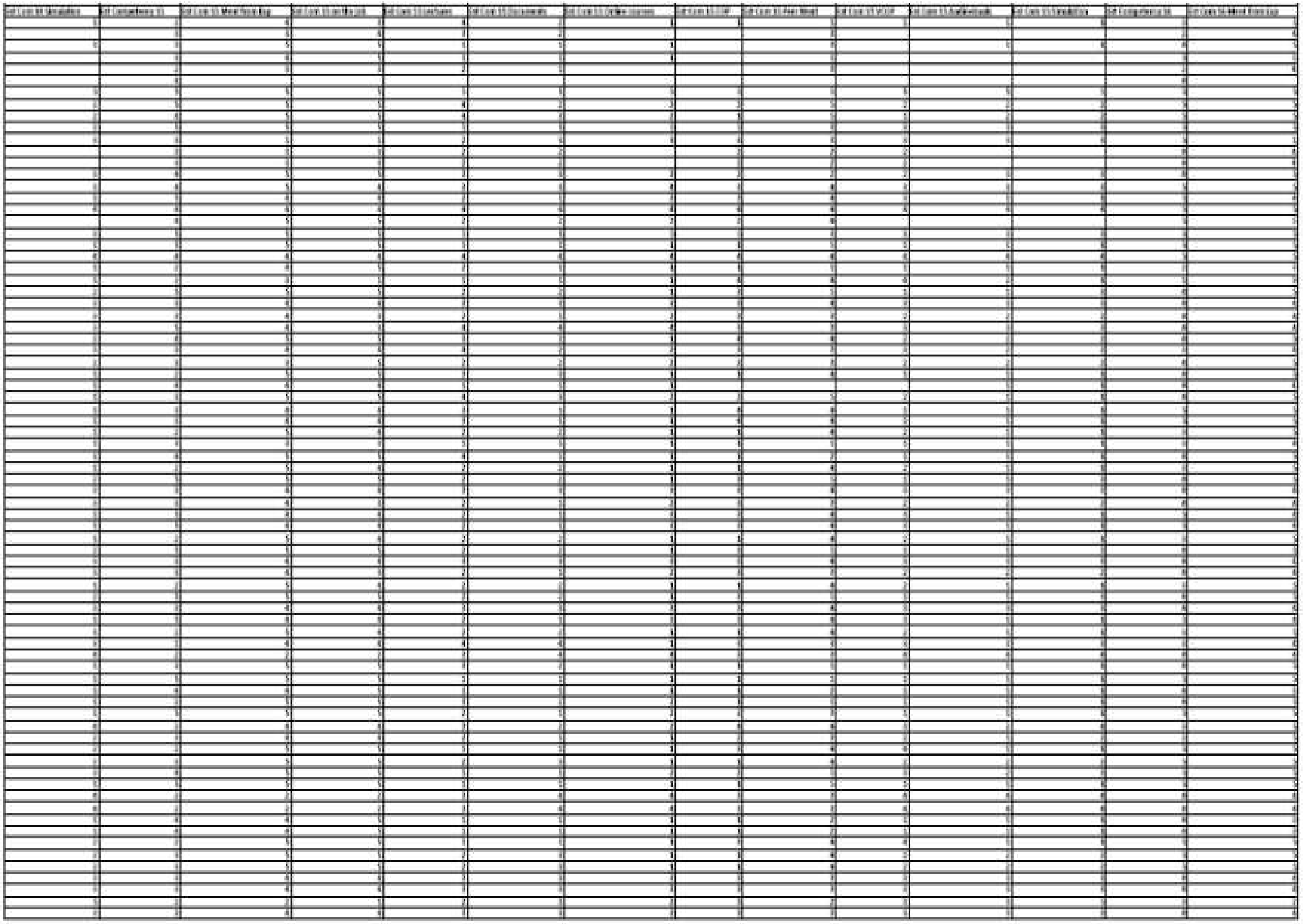
Est Com 5 VCOP	Est Com 5 Audiovisuals	Est Com 5 Simulation	Est Competency 6	Est Com 6 Ment from Exp	Est Com 6 on the job	Est Com 6 Lectures	Est Com 6 Documents	Est Com 6 Online courses	Est Com 6 COP	Est Com 6 Peer Ment	Est Com 6 VCOP	Est Com 6 Audiovisuals	Est Com 6 Simulation	Est Competency 7
1	1	1	4	5	4	3	5	4	1	1	1	1	1	3
			3	4	3	2	2			4				3
	1	1	4	5	4	1	2	1		2		1	1	4
			3	4	4	3	3	3		3				5
			3	3	4	2	2			3				3
			1											4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1	3	4	4	5	4	4	3	3	1	5	1	3	3	5
1	2	2	2	5	5	4	3	2	1	5	1	2	2	2
3	3	5	5	5	5	5	5	5	5	3	3	3	3	5
4	4	4	4	1	2	2	3	4	3	3	3	4	4	4
2			3	4	3	2	2		1	1	1			5
2			3	4	3	2	2		1	1	1			5
2	2	3	3	5	5	3	3	3	2	2	2	3	3	5
4	4	3	3	4	4	4	4	2	4	4	4	4	3	5
2	1	1	4	4	4	3	1	1	3	4	2	1	1	4
2	2	2	3	3	3	3	3	3	3	3	3	3	3	4
			4	5	5	3	3	3	3	3				4
3	3	5	5	5	5	5	5	5	5	3	3	3	3	5
1	1	1	3	5	5	1	3	1	1	5	1	1	1	5
2	2	2	3	3	3	3	3	3	3	3	3	3	3	4
3	1	1	5	4	4	2	4	5	3	3	3	5	1	2
4	1	1	1	2	1	2	2	1	4	4	4	1	2	1
1	1	2	4	5	5	2	3	1	1	4	1	1	4	4
3	3	3	3	4	4	3	3	3	3	3	3	3	3	4
3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
3	3	3	4	4	4	4	3	4	3	4	2	3	3	4
2	2	2	1	5	5	4	4	4	3	2	2	3	3	5
2	2	2	4	4	4	4	4	3	3	4	3	2	2	4
2	2	2	3	5	3	3	3	2	2	4	2	2	2	5
1	1	1	4	5	5	3	3	1	1	3	1	1	1	5
	2	2	3	4	4	3	3	3				2	2	4
2	1	1	5	5	5	4	3	2	2	5	2	1	1	5
1	1	1	2	4	4	2	3	1	3	5	1	1	1	3
1	1	1	2	4	4	2	3	1	3	5	1	1	1	3
2	2	2	3	3	3	3	3	3	3	3	3	3	3	4
1	1	1	3	4	3	1	1	1	1	1	1	1	1	3
1	1	1		4	3	2	1	2	1	3	2	2	2	4
2	2	2	3	3	3	3	3	3	3	3	3	3	3	4
1	1	2	4	5	5	2	3	1	1	4	1	1	4	4
3	3	3	3	4	4	3	3	3	3	3	3	3	3	4
3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
2	1	1	4	4	4	3	1	1	3	4	2	1	1	4
2	1	1	4	4	4	3	1	1	3	4	2	1	1	4
2	2	2	3	3	3	3	3	3	3	3	3	3	3	4
1	1	2	4	5	5	2	3	1	1	4	1	1	4	4
3	3	3	3	4	4	3	3	3	3	3	3	3	3	4
3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
2	2	2	3	3	3	3	3	3	3	3	3	3	3	4
1	1	2	4	5	5	2	3	1	1	4	1	1	4	4
3	3	3	3	4	4	3	3	3	3	3	3	3	3	4
2	1	1	4	4	4	3	1	1	3	4	2	1	1	4
2	2	2	3	3	3	3	3	3	3	3	3	3	3	4
3	3	3	3	4	4	4	3	3	3	3	3	3	3	3
5	5	5	3	3	3	4	3	4	4	3	4	4	4	4
1	1	1	3	5	5	3	3	3	1	3	1	1	1	5
1	1	1	5	5	5	1	1	1	1	1	1	1	1	5
2	1	1	3	5	5	5	1	1	3	2	4	1	1	4
1	1	1	5	5	5	4	4	1	3	2	1	1	1	5
1	1	1	3	4	4	2	2	1	3	3	1	1	1	5
4	2	4	4	5	5	4	2	3	3	4	3	1	4	4
2	1	1	3	4	3	5	2	3	3	3	3	1	1	2
3	2	3	5	5	5	1	1	1	4	4	4	1	1	5
2	2	2	3	5	5	3	2	1	2	3	2	2	2	3
3	3	3	5	5	5	1	1	1	3	5	3	2	2	5
1	1	1	5	5	5	1	1	1	1	5	1	1	1	5
5	5	5	3	3	3	4	3	4	4	3	4	4	4	4
5	5	5	3	3	3	4	3	4	4	3	4	4	4	4
2	1	1	3	5	5	5	1	1	3	2	4	1	1	4
2	1	1	3	5	5	5	1	1	3	2	4	1	1	4
3	2	3	5	5	5	1	1	1	4	4	4	1	1	5
2	2	2	3	5	5	3	2	1	2	3	2	2	2	3
2	2	2	3	5	5	3	2	1	2	3	2	2	2	3
3	3	3	5	4	3	3	3	3	3	3	3	3	3	4
3	3	3	5	4	3	3	3	3	3	3	3	3	3	4
5	5	5	1	1	5	5	5	3	3	5	5	5	5	4
3	3	3	5	4	3	3	3	3	3	3	3	3	3	4



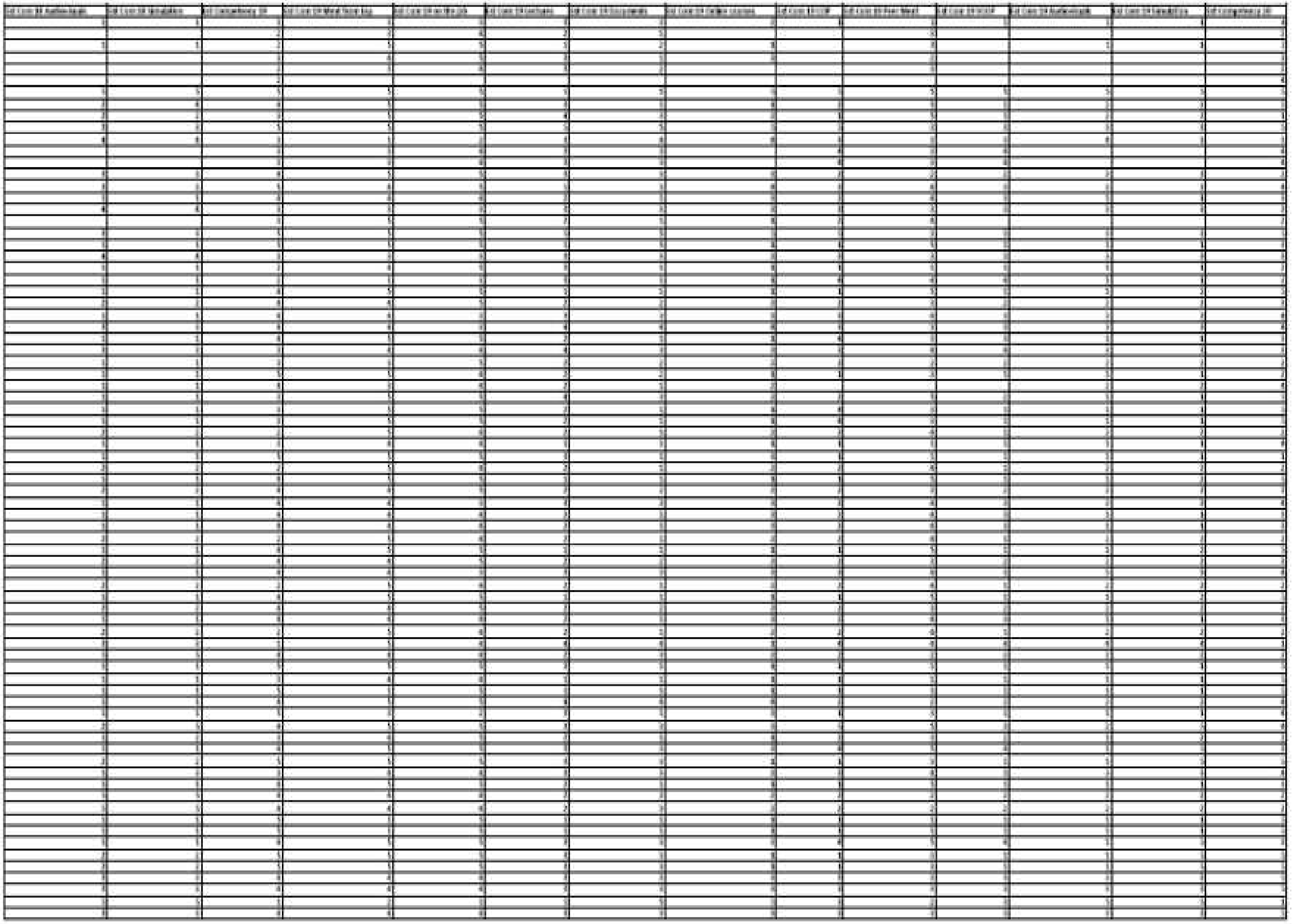
Est Com 9 Audiovisuals	Est Com 9 Simulation	Est Competency 10	Est Com 10 Ment from Exp	Est Com 10 on the job	Est Com 10 Lectures	Est Com 10 Documents	Est Com 10 Online courses	Est Com 10 COP	Est Com 10 Peer Ment	Est Com 10 VCOP	Est Com 10 Audiovisuals	Est Com 10 Simulation	Est Competency 11
1	1	3	5	5	4	4	4	1	1	1	1	1	2
		4	4	2	3	4			3				3
1	1	4	5	4	1	2	1		3		1	1	3
		3	5	5	3	3	3		1				3
		4	4	3	2	3			4				3
		4											4
5	5	5	5	5	5	5	5	5	5	5	5	5	5
2	2	5	5	4	3	3	2	1	5	1	2	2	5
2	2	4	5	5	4	3	2	1	5	1	2	2	4
3	3	5	5	5	5	5	5	5	3	3	3	3	5
3	3	3	1	2	2	3	3	3	3	3	3	3	4
		4	4	4	2	3		3	2	3			4
		4	4	4	2	3		3	2	3			4
3	3	4	5	5	3	3	3	2	2	2	3	3	4
4	4	4	5	4	5	5	5	4	5	5	4	3	5
1	1	5	4	4	3	1	2	2	4	2	1	1	4
2	2	4	4	4	4	4	4	4	4	4	4	4	4
		5	5	5	3	3	3	3	5				5
3	3	5	5	5	5	5	5	5	3	3	3	3	5
1	1	4	5	5	1	3	1	1	5	1	1	1	4
2	2	4	4	4	4	4	4	4	4	4	4	4	4
5	1	1	5	5	4	4	3	3	3	3	4	1	1
1	2	1	1	2	1	1	3	4	4	4	1	1	1
1	3	5	5	5	2	3	1	1	5	1	1	2	5
3	3	5	5	5	3	3	3	3	4	3	2	3	5
3	3	4	3	3	3	3	3	3	3	3	3	3	5
3	3	4	4	4	4	3	4	3	4	3	3	3	4
2	2	2	5	5	3	3	3	4	2	2	2	2	3
3	3	4	4	4	4	4	4	3	3	3	3	3	4
1	1	4	4	5	2	3	2	2	4	2	2	2	4
1	1	5	5	5	1	4	1	1	5	1	1	1	5
1	1	4	4	4	1	1	1				1	1	3
1	1	5	5	5	4	3	2	2	5	2	1	1	4
1	1	2	5	5	1	3	1	4	5	1	1	1	5
1	1	2	5	5	1	3	1	4	5	1	1	1	5
1	1	4	5	5	4	4	2	4	5	1	1	1	4
1	1	3	4	4	1	1	1	1	1	1	1	1	2
1	1	4	5	3	3	3	3	3	5	1	1	1	4
1	1	4	5	5	4	4	2	4	5	1	1	1	4
1	3	5	5	5	2	3	1	1	5	1	1	2	5
3	3	5	5	5	3	3	3	3	4	3	2	3	5
3	3	4	3	3	3	3	3	3	3	3	3	3	5
1	1	5	4	4	3	1	2	2	4	2	1	1	4
1	1	5	4	4	3	1	2	2	4	2	1	1	4
1	1	4	5	5	4	4	2	4	5	1	1	1	4
1	3	5	5	5	2	3	1	1	5	1	1	2	5
3	3	5	5	5	3	3	3	3	4	3	2	3	5
3	3	4	3	3	3	3	3	3	3	3	3	3	5
1	1	4	5	5	4	4	2	4	5	1	1	1	4
1	3	5	5	5	2	3	1	1	5	1	1	2	5
3	3	5	5	5	3	3	3	3	4	3	2	3	5
1	1	5	4	4	3	1	2	2	4	2	1	1	4
1	1	4	5	5	4	4	2	4	5	1	1	1	4
3	3	1	5	4	4	3	1	3	3	3	3	3	1
4	4	2	2	2	3	2	3	3	3	4	4	4	3
1	1	5	4	4	3	3	3	1	1	1	1	1	4
1	1	5	5	5	1	1	1	1	1	1	1	1	3
1	1	2	4	5	4	2	2	1	3	1	1	1	4
1	1	4	5	5	4	3	3	2	2	1	1	1	3
1	1	5	4	4	1	1	1	1	3	1	1	1	4
5	4	5	5	5	4	3	3	5	4	3	2	4	5
3	2	2	5	4	3	2	1	2	3	2	2	1	4
1	1	3	5	5	4	1	1	4	4	4	3	3	5
2	2	5	5	5	3	2	1	2	3	2	2	2	5
3	3	5	5	5	3	3	3	3	4	3	3	3	3
1	1	3	5	5	1	1	1	1	5	1	1	1	3
4	4	2	2	2	3	2	3	3	3	4	4	4	3
4	4	2	2	2	3	2	3	3	3	4	4	4	3
1	1	2	4	5	4	2	2	1	3	1	1	1	4
1	1	2	4	5	4	2	2	1	3	1	1	1	4
1	1	3	5	5	4	1	1	4	4	4	3	3	5
2	2	5	5	5	3	2	1	2	3	2	2	2	5
2	2	5	5	5	3	2	1	2	3	2	2	2	5
3	3	5	5	5	4	4	4	4	3	3	3	3	5
3	3	5	5	5	4	4	4	4	3	3	3	3	5
5	5	2	1	1	2	2	2	5	1	5	5	5	4
3	3	5	5	5	4	4	4	4	3	3	3	3	5

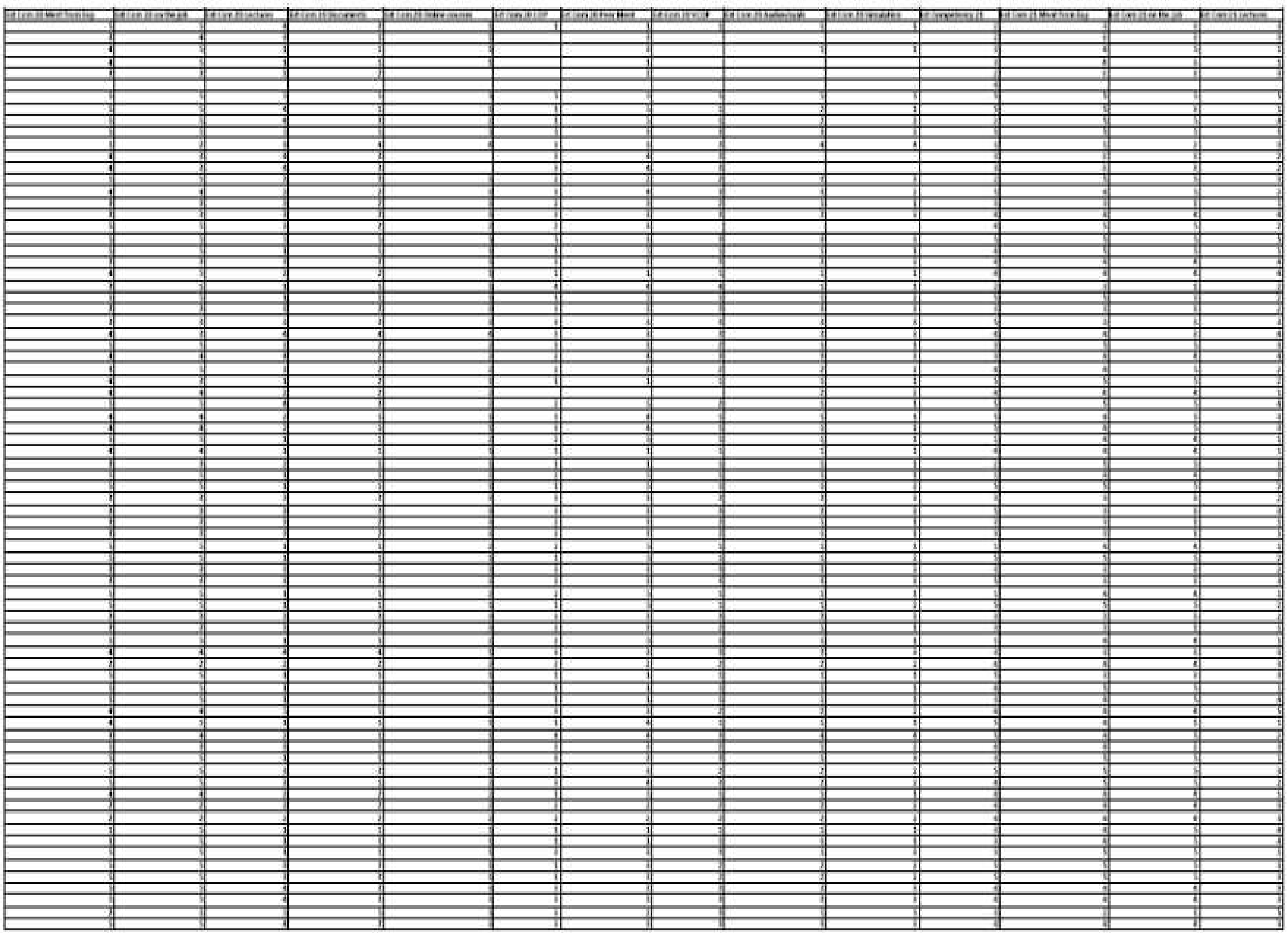
Est Com 12 Documents	Est Com 12 Online courses	Est Com 12 COP	Est Com 12 Peer Ment	Est Com 12 VCOP	Est Com 12 Audiovisuals	Est Com 12 Simulation	Est Competency 13	Est Com 13 Ment from Exp	Est Com 13 on the job	Est Com 13 Lectures	Est Com 13 Documents	Est Com 13 Online courses	Est Com 13 COP
							3	4	3	3	2	2	5
							4	4	3	3	3		
							3	5	5	1	1	5	
							4	5	5	1	1	5	
							3	4	3	3	3		
							5						
5	5	5	5	5	5	5	5	5	5	5	5	5	5
3	3	2	5	2	3	2	5	5	5	3	1	5	3
3	2	1	5	1	2	2	4	5	5	4	3	2	3
5	5	5	3	3	3	3	5	5	5	5	5	5	5
4	4	4	4	4	4	3	3	1	2	2	3	3	3
3		2	2	2			4	5	5	2	4		2
3		2	2	2			4	5	5	2	4		2
3	3	2	2	2	3	3	5	5	5	3	3	3	2
4	3	3	4	3	3	2	5	5	4	4	3	4	5
1	1	3	4	1	1	1	5	4	4	1	1	1	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4
3	3	3	5				3	5	5	2	2	2	2
5	5	5	3	3	3	3	5	5	5	5	5	5	5
3	1	1	5	1	1	1	3	5	5	1	3	1	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4
1	1	3	3	3	1	1	2	5	5	2	1	1	3
2	1	4	4	4	1	1	1	3	2	1	1	1	3
2	1	1	5	1	1	3	5	5	5	2	3	5	5
3	3	3	4	3	3	3	3	4	4	3	3	3	3
3	3	4	4	3	2	2	3	4	4	3	2	2	3
4	4	3	3	3	3	3	5	4	3	4	4	4	3
2	2	3	1	2	1	2	4	5	5	1	1	1	4
3	2	2	4	2	2	2	3	4	3	2	2	2	2
2	2	2	4	2	2	2		4	5	1	2	1	1
1	1	1	4	1	1	1	3	5	5	2	1	1	1
2	2				3	1	4	4	4	2	3	2	
3	2	2	5	2	1	1	5	5	5	4	3	2	2
3	1	4	5	1	1	1	5	5	3	4	3	1	5
3	1	4	5	1	1	1	5	5	3	4	3	1	5
4	2	2	4	1	1	1	2	4	4	2	2	1	1
1	1	1	3	1	1	1	3	4	4	1	1	1	1
2	1	1	3	1	1	1	5	5	5	2	2	2	2
4	2	2	4	1	1	1	2	4	4	2	2	1	1
2	1	1	5	1	1	3	5	5	5	2	3	1	1
3	3	3	4	3	3	3	3	4	4	3	3	3	3
3	3	4	4	3	2	2	3	4	4	3	2	2	3
1	1	3	4	1	1	1	5	4	4	1	1	1	3
1	1	3	4	1	1	1	5	4	4	1	1	1	3
4	2	2	4	1	1	1	2	4	4	2	2	1	1
2	1	1	5	1	1	3	5	5	5	2	3	1	1
3	3	3	4	3	3	3	3	4	4	3	3	3	3
3	3	4	4	3	2	2	3	4	4	3	2	2	3
4	2	2	4	1	1	1	2	4	4	2	2	1	1
2	1	1	5	1	1	3	5	5	5	2	3	1	1
3	3	3	4	3	3	3	3	4	4	3	3	3	3
1	1	3	4	1	1	1	5	4	4	1	1	1	3
4	2	2	4	1	1	1	2	4	4	2	2	1	1
4	3	3	3	3	3	3	1	5	4	4	4	2	3
4	4	3	3	4	4	4	3	3	3	3	3	3	4
2	2	1	3	1	1	1	5	5	5	3	2	2	1
1	1	1	3	1	1	1	5	5	5	1	1	1	1
2	1	1	5	1	1	1	5	4	5	3	1	2	2
4	4	3	2	1	1	1	4	5	5	4	3	3	2
2	2	2	3	1	1	2	4	4	4	2	2	2	2
2	2	4	3	3	3	3	5	4	5	4	2	2	4
2	2	3	3	2	2	1	2	5	4	2	1	1	2
1	1	4	4	2	2	2	1	5	5	1	1	1	1
3	1	1	4	2	2	2	5	5	5	2	3	1	1
1	1	1	5	1	1	2	3	5	5	1	1	2	3
1	1	1	4	1	1	1	5	5	5	1	2	2	1
4	4	3	3	4	4	4	3	3	3	3	3	3	4
4	4	3	3	4	4	4	3	3	3	3	3	3	4
2	1	1	5	1	1	1	5	4	5	3	1	2	2
2	1	1	5	1	1	1	5	4	5	3	1	2	2
1	1	4	4	2	2	2	1	5	5	1	1	1	1
3	1	1	4	2	2	2	5	5	5	2	3	1	1
3	1	1	4	2	2	2	5	5	5	2	3	1	1
2	2	3	4	4	3	3	4	4	4	43	3	3	3
2	2	3	4	4	3	3	4	4	4	43	3	3	3
4	4	5	3	5	5	5	1	1	2	2	2	2	5
2	2	3	4	4	3	3	4	4	4	43	3	3	3

Est Com 13 Peer Ment	Est Com 13 VCOP	Est Com 13 Audiovisuals	Est Com 13 Simulation	Est Competency 14	Est Com 14 Ment from Exp	Est Com 14 on the job	Est Com 14 Lectures	Est Com 14 Documents	Est Com 14 Online courses	Est Com 14 CoP	Est Com 14 Peer Ment	Est Com 14 VCOP	Est Com 14 Audiovisuals
3	1	1	1	2	3	3	3	2	1	1	1	1	1
3				3	4	3	2	3			4		
3		1	1	4	3	4	1	2	1		3		1
3				4	4	4	4	2	3		3		
4				3	4	3	3	1			4		
				5									
5	5	5	5	5	5	5	5	3	5	5	3	3	5
5	1	1	1	4	5	5	4	2	2	2	5	2	2
5	1	2	2	5	5	5	4	3	2	1	5	1	2
3	3	3	3	5	5	5	5	3	5	5	3	3	3
3	3	3	3	4	1	2	2	3	3	3	3	3	4
2	2			5	4	3	3	3		3	3	3	
2	2			5	4	3	3	3		3	3	3	
2	2	3	3	5	5	5	3	3	3	2	2	2	3
4	5	3	3	4	5	4	4	3	4	4	4	4	3
4	1	1	1	5	4	4	1	1	2	2	4		3
4	4	4	4	4	4	4	4	4	4	4	4	4	4
5				5	5	5	2	2	2	3	4		
3	3	3	3	5	5	5	5	3	5	5	3	3	3
5	1	1	1	5	5	5	1	3	1	1	5	1	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4
4	2	1	1	3	4	3	1	1	1	1	1	1	1
4	4	1	1	2	3	3	1	1	1	4	4	4	2
5	1	1	3	5	5	5	2	3	1	1	5	2	1
4	3	3	3	4	4	5	3	3	3	3	4	3	3
4	3	2	2	5	4	4	2	3	2	3	4	3	3
3	3	3	3	5	4	3	4	4	4	3	3	3	3
4	2	1	1	5	5	5	3	1	1	4	2	3	1
3	3	2	2	4	4	4	4	4	4	4	4	4	3
5	1	1	1	4	5	5	2	2	2	2	3	2	2
5	1	1	1	3	5	5	4	1	1	1	3	1	1
		1	2	4	4	4	2	1	1				1
5	2	1	1	5	5	5	4	3	2	2	5	2	1
5	1	1	1	4	5	5	2	2	1	5	5	1	1
5	1	1	1	4	5	5	2	2	1	5	5	1	1
3	1	1	1	2	4	4	2	2	2	1	4	1	1
5	1	1	1	3	4	4	1	1	1	1	1	1	1
3	1	1	1	5	5	5	2	1	2	2	3	1	1
3	1	1	1	2	4	4	2	2	2	1	4	1	1
5	1	1	3	5	5	5	2	3	1	1	5	2	1
4	3	3	3	4	4	5	3	3	3	3	4	3	3
4	3	2	2	5	4	4	2	3	2	3	4	3	3
4	1	1	1	5	4	4	1	1	2	2	4		1
4	1	1	1	5	4	4	1	1	2	2	4		1
3	1	1	1	2	4	4	2	2	2	1	4	1	1
5	1	1	3	5	5	5	2	3	1	1	5	2	1
4	3	3	3	4	4	5	3	3	3	3	4	3	3
4	3	2	2	5	4	4	2	3	2	3	4	3	3
3	1	1	1	2	4	4	2	2	2	1	4	1	1
5	1	1	3	5	5	5	2	3	1	1	5	2	1
4	3	3	3	4	4	5	3	3	3	3	4	3	3
4	1	1	1	5	4	4	1	1	2	2	4		1
3	1	1	1	2	4	4	2	2	2	1	4	1	1
3	3	3	3	1	5	5	4	4	1	3	3	3	3
3	4	5	5	4	4	4	4	4	4	4	4	5	5
5	1	1	1	5	5	5	3	2	2	1	1	1	1
5	1	1	1	4	5	5	1	1	1	1	1	1	1
4	2	1	1	3	4	5	4	1	1	4	4	4	2
2	1	1	1	4	5	5	4	3	3	1	1	1	1
3	1	1	1	5	5	5	1	1	1	1	4	1	1
4	3	3	4	4	4	5	4	2	2	4	4	3	2
3	2	1	2	4	5	4	2	1	2	2	3	2	1
5	3	2	2	5	5	5	1	1	1	3	4	4	2
4	2	2	2	5	5	5	2	3	1	1	4	2	2
5	3	1	2	4	5	5	1	1	2	2	3	3	2
5	1	1	1	5	5	5	1	1	1	1	3	1	1
3	4	5	5	4	4	4	4	4	4	4	4	5	5
3	4	5	5	4	4	4	4	4	4	4	4	5	5
4	2	1	1	3	4	5	4	1	1	4	4	4	2
4	2	1	1	3	4	5	4	1	1	4	4	4	2
5	3	2	2	5	5	5	1	1	1	3	4	4	2
4	2	2	2	5	5	5	2	3	1	1	4	2	2
4	2	2	2	5	5	5	2	3	1	1	4	2	2
3	3	3	3	5	5	4	3	2	2	3	3	3	3
3	3	3	3	5	5	4	3	2	2	3	3	3	3
2	5	5	5	2	2	3	2	3	2	5	2	5	5
3	3	3	3	5	5	4	3	2	2	3	3	3	3

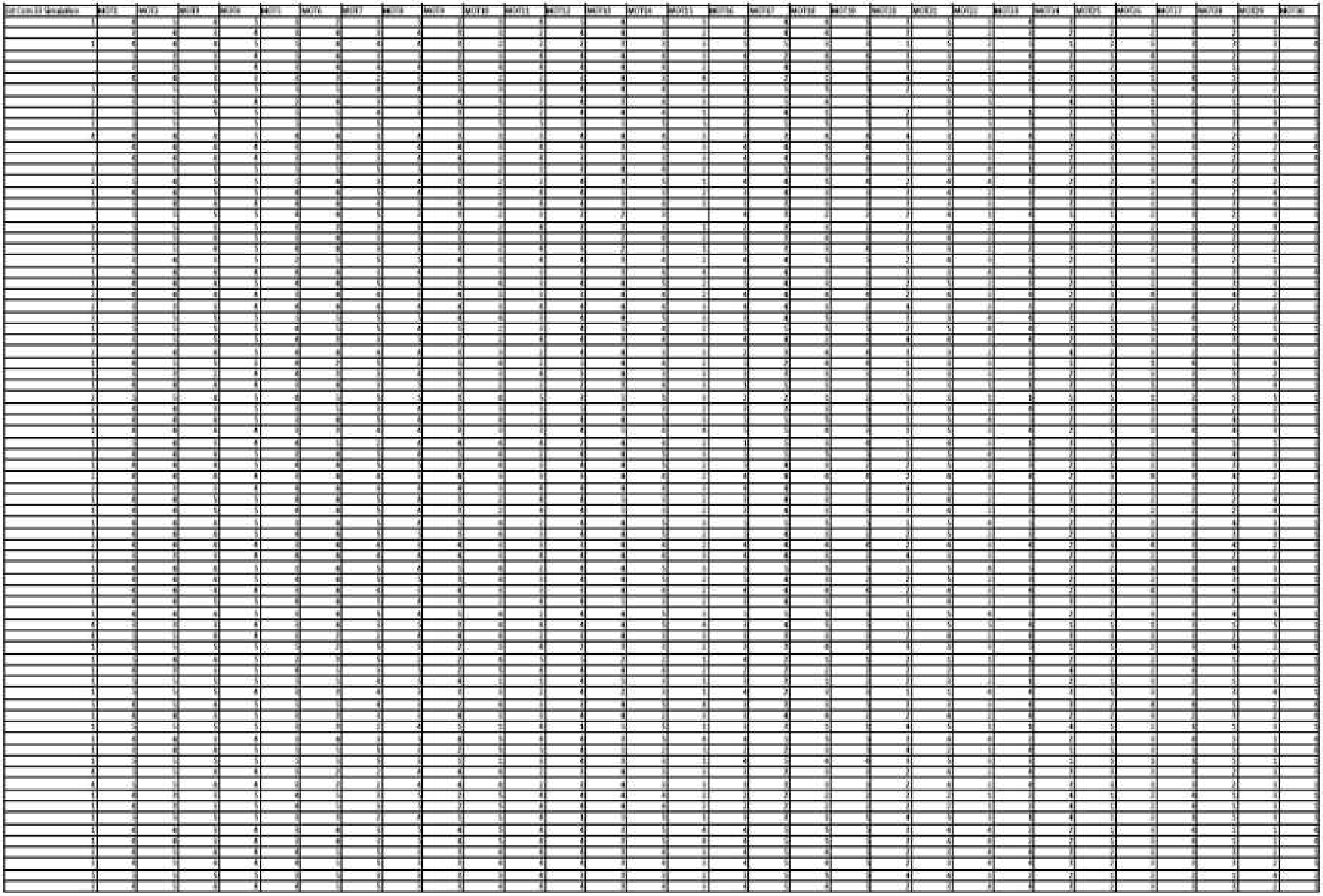


Ed Com 16 on the job	Ed Com 16 Lectures	Ed Com 16 Documents	Ed Com 16 Online courses	Ed Com 16 COP	Ed Com 16 Peer Ment	Ed Com 16 VCOP	Ed Com 16 Audiovisuals	Ed Com 16 Simulation	Ed Competency 17	Ed Com 17 Ment from Exp	Ed Com 17 on the job	Ed Com 17 Lectures	Ed Com 17 Documents





Est Com 22 Peer Ment	Est Com 22 VCOP	Est Com 22 Audiovisuals	Est Com 22 Simulation	Est Competency 23	Est Com 23 Ment from Sup	Est Com 23 on the job	Est Com 23 Lectures	Est Com 23 Documents	Est Com 23 Online courses	Est Com 23 COP	Est Com 23 Peer Ment	Est Com 23 VCOP	Est Com 23 Audiovisuals
3	1	1	1	3	4	4	3	3	3	1	1	1	1
3				2	4	3	1	1			4		
2		1	1	2	5	5	1	2	1		3		1
1				3	3	3	1	1	1		1		
3				2	4	3	3	2			3		
				4									
5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	1	1	1	5	5	5	3	1	2	5	5	1	2
5	1	2	2	1	5	5	4	3	2	5	5	1	2
3	3	3	3	5	5	5	5	5	5	5	3	3	3
3	3	4	4	3	1	2	3	4	4	3	3	3	4
3	3			4	3	3	2	2		2	2	2	
3	3			4	3	3	2	2		2	2	2	
2	2	3	3	3	5	5	3	3	3	2	2	2	3
3	2	2	2	5	4	4	3	2	3	3	4	3	3
4	2	1	1	4	4	4	2	2	2	3	4	2	1
3	3	3	3	3	3	3	3	3	3	3	3	3	3
4				3	5	5	1	1	1	5	4		
3	3	3	3	5	5	5	5	5	5	5	3	3	3
5	1	1	1	3	5	5	1	5	5	1	5	1	1
3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	1	1	1	2	4	5	1	1	1	1	1	1	1
4	4	1	1	1	2	1	1	3	2	4	4	4	1
5	1	1	2	4	5	5	1	2	1	2	4	1	1
3	2	2	2	3	4	4	2	2	2	2	3	2	2
3	3	3	3	5	4	3	3	3	3	3	3	1	3
3	3	3	3	4	4	4	4	4	4	3	3	3	3
3	2	1	1	4	5	5	3	1	1	3	4	2	1
4	3	2	2	3	4	4	4	3	3	3	2	2	3
3	2	2	2	3	3	5	2	2	2	2	3	2	2
1	1	1	1	3	5	3	1	1	1	1	1	1	1
		1	1	4	3	4	1	1	1				1
5	2	1	1	4	5	5	4	3	2	2	5	2	1
5	2	1	1	3	4	4	1	1	1	4	4	1	1
5	2	1	1	3	4	4	1	1	1	4	4	1	1
5	2	1	2	4	5	4	1	2	2	2	5	2	2
1	1	1	1	4	5	5	1	1	1	1	1	1	1
1	1	1	1	2	3	3	1	1	1	1	1	1	1
5	2	1	2	4	5	4	1	2	2	2	5	2	2
5	1	1	2	4	5	5	1	2	1	2	4	1	1
3	2	2	2	3	4	4	2	2	2	2	3	2	2
3	3	3	3	5	4	3	3	3	3	3	3	1	3
4	2	1	1	4	4	4	2	2	2	3	4	2	1
4	2	1	1	4	4	4	2	2	2	3	4	2	1
5	2	1	2	4	5	4	1	2	2	2	5	2	2
5	1	1	2	4	5	5	1	2	1	2	4	1	1
3	2	2	2	3	4	4	2	2	2	2	3	2	2
3	3	3	3	5	4	3	3	3	3	3	3	1	3
5	2	1	2	4	5	4	1	2	2	2	5	2	2
5	1	1	2	4	5	5	1	2	1	2	4	1	1
3	2	2	2	3	4	4	2	2	2	2	3	2	2
4	2	1	1	4	4	4	2	2	2	3	4	2	1
5	2	1	2	4	5	4	1	2	2	2	5	2	2
4	4	4	4	1	5	4	4	4	1	4	4	4	4
3	4	4	3	3	3	3	2	3	3	2	2	2	4
1	1	1	1	5	5	5	3	1	1	1	1	1	1
1	1	1	1	4	5	5	1	1	1	1	1	1	1
1	1	1	1	2	2	5	1	1	1	1	1	1	1
1	1	1	1	3	5	5	5	3	1	1	1	1	1
1	4	1	1	1	5	5	1	1	1	1	5	1	1
4	3	3	4	5	5	5	4	4	4	5	4	3	3
4	2	1	2	2	4	5	3	1	1	2	3	2	1
3	3	1	1	4	5	5	1	1	1	5	5	5	1
3	1	1	1	5	5	5	3	1	1	1	3	1	1
5	1	1	1	3	5	5	1	1	2	3	5	1	1
4	1	1	1	4	4	4	2	2	2	1	4	1	1
3	4	4	3	3	3	3	2	3	3	2	2	2	4
3	4	4	3	3	3	3	2	3	3	2	2	2	4
1	1	1	1	2	2	5	1	1	1	1	1	1	1
1	1	1	1	2	2	5	1	1	1	1	1	1	1
3	3	1	1	4	5	5	1	1	1	5	5	5	1
3	1	1	1	5	5	5	3	1	1	1	3	1	1
3	1	1	1	5	5	5	3	1	1	1	3	1	1
3	3	3	3	4	4	4	3	3	3	3	3	3	3
3	3	3	3	4	4	4	3	3	3	3	3	3	3
2	3	5	5	1	2	3	5	5	5	3	2	3	5
3	3	3	3	4	4	4	3	3	3	3	3	3	3



VITA

Anwar Salman Alroomi

Candidate for the Degree of

Doctor of Philosophy

Thesis: INTEGRATIVE FRAMEWORK FOR SUSTAINABLE DEVELOPMENT OF THE COST ESTIMATING PROFESSION

Major Field: Civil and Environmental Engineering

Biographical:

Personal Data:

Born in Kuwait. She is the first of seven childrens of Mr. and Ms. Alroomi.

Education:

- Completed the requirements for the Doctor of Philosophy in Civil Engineering at Oklahoma State University, Stillwater, Oklahoma in May, 2013.
- Completed the requirements for the Master of Science in Civil Engineering at Kuwait University, Kuwait in February, 2006.
- Completed the requirements for the Bachelor of Science in Civil Engineering at Kuwait University, Kuwait in February, 2003.

Experience:

As a student, she was employed by Oklahoma State University as a Graduate Research Assistant (2007-2011) working on CII research project, and as a Graduate Teaching Assistant (2010-2012) for several classes in the field of project and construction management. In spring 2013, she was employed by Oklahoma State University as an Instructor to teach the project management for engineering and construction class and lab.

Professional Memberships:

- Construction Industry Institute (2007 – 2010)
- Chi-Epsilon the Civil Engineering Honor Society (2012 – Present)
- Golden Key International Society (2010 – Present)
- American Society of Civil Engineers (ASCE) (2006 – 2008)
- Project Management Institute (PMI) (2006 – 2007)