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Development of a Competency Indicator Model for Thai Engineering Auditors

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Abstract

The purpose of this study is to develop a competency indicator model for enhancing soft skills competencies of engineering auditor to the third party, specifically in Thailand. Personal skills are crucial for professional success. The researchers collected data through documentary analysis of relevant research papers and expert interviews by using Delphi technique to develop soft skills competencies that are the required competencies for Engineering Inspector Model (SSCE Model). The model consists of 64 necessary competency indicators, derived from Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). All indicators were found to be valid, with factor loadings ranging from 0.6785 to 0.9315, indicating good to excellent reliability. Pearson's Correlation Coefficient was employed to assess interrelationships among the components, revealing that all 13 components were positively correlated, with coefficients above 0. The components of ethics and time management exhibited the strongest correlation, with a coefficient of 0.7187. These 13 components can explain the competency model for engineering inspectors, with the top 5 most significant components: 1) Personality, 2) Adaptability, 3) Ethics, 4) Life -long Learning, and 5) Complicated Problem-Solving Skill. These findings elucidate the competency model for engineering auditors in Thailand.

Keywords: Soft skills Competencies, Engineering Auditor, Long-life Learning, Complicated Problem-Solving Skill.

1. Introduction

Over the past decade, Thailand has seen an increasing role of third-party engineering inspectors, such as those inspecting buildings or overseeing energy management, in carrying out functions on behalf of governmental agencies. This shift aims at controlling, supervising, and ensuring safety and energy efficiency in buildings in line with the principles of New Public Management. The transformation in public administration allows for greater involvement of external engineers in providing public services (Nathamploy, 2020). However, there is a challenge concerning the skills expected by service recipients, which often do not align with the skills possessed by current engineering auditor.

The references provided are: "Engineering Inspector competence required of Third Party" (Kitsiriteeraphak et al., 2022) and "A Study on conceptual framework for Development of Soft Skills As the required competencies for Engineering Inspectors" (Kitsiriteeraphak et al., 2023). This study outlined a process comprising six steps: synthesis of soft skills competencies, selection of essential soft skills competencies for engineering inspectors, prioritization of soft skills competencies using the Delphi technique, creation of engineering auditors, third-party evaluation of competency development, and documentation of soft skills competencies development.

The Department of Public Works and Town & Country Planning has issued ministerial regulations specifying the qualifications of inspectors, criteria for registration and deregistration as inspectors, and inspection criteria for buildings. Additionally, the Department of Alternative Energy Development and Efficiency has announced regulations and training methods for inspectors and certification of energy management by both public and private sectors. They have developed training courses and defined competencies for the role of engineering auditors, focusing on vertical professional ability in the I-Sharp model, with ethics being the only non-professional skill specified for building inspectors. This differs from skill development in other countries, which include both deep and broad aspects in the T-Sharp model. Reference is also made to engineering skills in the second century, where surveys among leading entrepreneurs have found that engineers lack various skills, particularly interpersonal or soft skills, such as online meeting skills and digital skills (Channuwong et al., 2023; Kokoc & Ersoz, 2020; Gordon et al., 2020; Hugus, 2022)

Based on the study of regulations and laws related to the qualifications of building inspectors and auditors and certifiers of energy management currently in place, the researchers believe that developing a competency indicator model for soft skills competencies engineering auditor is crucial and urgently needed. Therefore, the researchers have developed a competency indicator model for soft skills competencies engineering auditor to serve as a guideline for future development of soft skills competencies training courses.

2. Research Objective

The aim of this study is to determine a competency indicator model for soft skills competencies engineering auditor in Thailand.

Theory and Related Research

Engineering auditor is a profession which requires the application of hard skills defined by regulations and overseen by regulatory agencies. Engineers must also possess soft skills to ensure the efficiency and effectiveness of their work.

The committee compiling the contemporary educational terminology dictionary defines " Soft skill" as the distinctive attributes or specific characteristics of individuals regarding intelligence, emotional abilities, or moral qualities. It is an abstract noun, encompassing traits such as personality, temperament, politeness, language proficiency for communication with others, friendliness, positive worldview, educational attainment, creativity, emotional regulation, understanding of various situations' realities, and the ability to interact smoothly with others. That's why " Soft skill " is a characteristic that helps individuals navigate life smoothly, excel in their professions, and advance. As for assessing and evaluating " Soft skills" is challenging and often involves methods such as observation, recording, and continuous behavior analysis.

In this research, the researchers have identified the problem statement as "Development of a curriculum on soft skills for third-party engineering inspectors." Upon consideration, it's noted that the population group is not large, and the research problem requires input from experts to assess the current issues and future skill requirements. Additionally, Delphi technique is utilized to minimize the influence of individuals during face-to-face interactions. Four specific groups of experts were selected: building factory managers utilizing the services of engineering auditors (5 individuals), human resource developers or academics (4 individuals), association managers of building inspectors (5 individuals), and government agency managers overseeing engineering auditors (4 individuals), totaling 18 individuals with minimal deviation rates and a deviation level of 0.02. Macmillan (1971) was referenced for this, employing the Delphi technique in three rounds (Petchsrisom, 2023).

The initial round consisted open-ended surveys, but subsequent rounds involved closed-ended via Rating Scale. By this, the finalization was the formal or definitive assessment of group opinions. The decision on whether the expert group opinions were consistent or not are based on statistical criteria set by the researchers, considering median values and interquartile range deviations. The research findings were summarized based on the expert group opinions that align with these established criteria.

3. Research Methodology

1.The development of indicators in this article will refer to steps 2, 3, and 4 from the conceptual framework for developing necessary soft skills for third-party engineering inspectors, as depicted in Figure 1. Referencing the article "A Study on conceptual framework for Development of Soft Skills As the required competencies for Engineering Auditors". All above, the studies have found that the soft skills play a major role as the required competencies of engineers. These skills also enhance competitiveness, international recognition, consistency with the changing world as well as applicability for the actual work contexts.

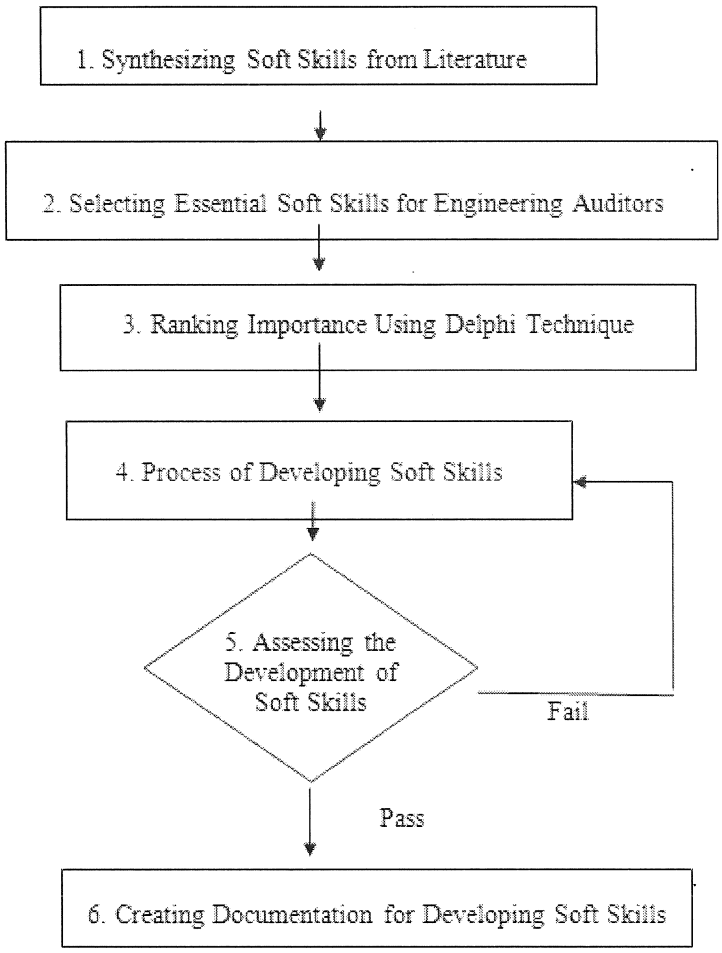


Figure 1 Conceptual Framework for Developing Necessary Soft Skills

2. Statistical analysis of the third-round interview shown results from experts, using the Delphi Technique to determine the relationship between components and the ranking of component importance.

Research Procedure

The process of developing soft skills from the conceptual framework of skill development involved four main steps:

Step 1: Analyzing the necessary soft skills components for engineering auditors in Thailand, both for building inspectors and energy management inspectors. This step involved reviewing legal requirements and literature, including international research and reports such as those from the World Economic Forum in 2023 and the Thailand Development Research Institute (TDRI) in 2565. Additionally, international standards related to soft skills competencies engineering auditor, such as ISO 19011:2018 Guideline for auditing management systems, were referenced. They will have components of various essential skills important to the professional engineering auditors.

Step 2: Using the research tool that have been approved by experts and validated for its consistency and alignment, data collection was carried out in three rounds from the 18 selected experts. Each round utilized the following methods:

Round 1: Expert interviews with open-ended questions. Experts were interviewed individually with open-ended questions to allow them to freely express their opinions. This round aimed to identify all necessary soft skills for engineering auditors.

Round 2: Experts survey with Rating Scale. Experts completed a questionnaire consisting of items related to each identified soft skills component. Each item was rated on a Likert scale or similar, with a total of 64 items covering all soft skills competencies Experts were encouraged to provide additional comments or suggestions regarding the clarity of language used in the questionnaire.

Round 3: Experts survey with revision opportunity. Experts completed a second survey, similar to the one in Round 2. Each expert had the opportunity to review their previous responses and make any necessary revisions. Experts could confirm their original answers or make changes if their initial responses were deemed outside the scope or context of the item. This three-round data collection process allowed for a comprehensive understanding of the necessary soft skills for engineering auditors, incorporating both qualitative insights from open-ended questions and quantitative ratings from structured surveys.

The Data Analysis
Data analysis utilizes statistics as follows
1.Statistics used with the Delphi technique, which is a process or tool used in decision-making or consensus finding in a systematic manner. With a relatively small population group and research issues in this study, these data are needed from expert opinions to consider current problems and future skill requirements (Petchsrisom, 2023). Data obtained from this technique will be analyzed statistically, including percentage, median, mean, interquartile range, and standard deviation

2.Analyzing survey components using survey statistics, by extracting main components Churunsawat (2022).

3.Confirmatory Factor Analysis examine the relationships of the components

Study Results
Research findings from data collection with a group of 18 experts and analysis of exploratory factor analysis (EFA) components of soft skills competencies using the Delphi technique revealed the following: There were 16 components with 64 indicators analyzed, including:1) Leadership; 2) Ethics; 3) Communication Skill; 4) Collaboration; 5) Complex Problem Solving; 6)Attitude; 7)Time Management; 8)Adaptability; 9)Life-Long Learning; 10) Analytical Thinking and Decision-making; 11) Digital skill; 12) Personality; 13) Writing communication; 14) Conflict management; 15) Presentation; 16) Open mind. After analyzing the 16 components and 64 indicators, it was found that all questions that passed the criterion of an item-total correlation (ITC) greater than 0.5, with an ITC value of 1 for 47 items and an ITC value of 0.67 for 17 items.

Statistical analysis from a sample group of 30 individuals found that all questions had factor loadings greater than 0.7, indicating that the questions were at a good level of validity. Additionally, the Cronbach's Alpha coefficient, which analyzes the reliability of the questionnaire, ranged from 0.7081 to 0.9486, all exceeding the threshold of 0.7. Thus, it can be concluded that the questionnaire has a high level of reliability - very good.

And when extracting variables with low factor loadings, the results yielded 13 main components of skills with 59 indicators, as shown in Table 1. Subsequently, these results were subjected to confirmatory factor analysis (CFA) using methods such as Factor Loading, % Total Variance, and Cronbach's Alpha coefficient to verify appropriateness and accuracy with statistical software. This analysis aimed to examine the relationships among all factors comprehensively. The statistical values obtained from all three methods ranged from 0 to 1, with an acceptable threshold value of greater than 0.7. The results of the confirmatory factor analysis revealed that the factor loading weights of all components ranged from 0.6785 to 0.9315, % Total Variance ranged from 0.6176 to 0.8209, and Cronbach's Alpha coefficient ranged from 0.6621 to 0.9492. These values were close to or exceeded 0.7, indicating that the components were reliable at a good to very good level, as shown in Table 1.

Table 1 Results of exploratory factor analysis (EFA) and confirmatory factor analysis. (Confirmatory Factor Analysis: CFA) using Factor Loading, % Total Variance and Cronbach Alpha – Coefficient.

Components	Variables	Factors / Questions related to the components of soft skills competencies engineering auditor	Factor Loading	%Total Variance	Cronbach Alpha
1		Ethics		0.7012	0.9448
	3	Creating a practical example of someone, be a pragmatist, take action to make the plans, clear goal setting.	0.8331		
	7	Respecting regulations, rules, or engineering ethics.	0.7886		
	8	Recognizing and honoring colleagues in the workplace.	0.9125		
	11	Transparency and clarity.	0.7436		
	12	Ability to ask open-ended questions.	0.8529		
	14	Providing assistance within both the inspection team and the support team.	0.8840		
	22	Overcoming fear in the heart with positive thinking.	0.8879		
	29	Working in new environments throughout the work period in various locations across the country.	0.7896		
	52	Understanding of both Thai and foreign languages.	0.8296		
2		Personality		0.7499	0.9492
	17	Understanding the cause of problems properly	0.7401		
	20	Able to utilize knowledge from multiple disciplines and sensory perceptions, including all five senses, to perceive and solve problems.	0.8955		
	32	Physical adaptability to new work environments at all times.	0.8167		

Components	Variables	Factors / Questions related to the components of soft skills competencies engineering auditor	Factor Loading	%Total Variance	Cronbach Alpha
	36	Developing plans to enhance personal capabilities to cope with future workloads	0.9028		
	37	Accessing and analyzing Big data for decision-making and problem-solving.	0.9033		
	45	Dressing appropriately for the job and work practices.	0.8957		
	46	Trustworthy personalities who are knowledgeable and friendly.	0.8660		
	47	Good personality, adapt and adjust appropriately to the job and workplace	0.8939		
3		Adaptability		0.7983	0.9484
	24	Self-esteem and the team.	0.8862		
	28	Ability to be flexible with plans whenever faced with changing situations.	0.9218		
	41	Fast learning digital technologies perception.	0.8592		
	42	Using digital technologies appropriately for the job.	0.8903		
	48	Maintaining good health to avoid health-related issues that may affect one's professional image, such as unpleasant odors which could be problematic when working with others.	0.8721		
	59	Creating interesting media and presentation methods for work.	0.9292		
4		Life-Long Learning		0.7418	0.9295
	19	Understanding the interconnections and business context to creatively devise solutions in various formats tailored to each situation, and making appropriate decisions to address problems.	0.9096		
	33	Embracing leaps in technology development that foster innovation and new knowledge, as well as evolving work methodologies.	0.8351		
	34	Engaging in research, studying new regulations, laws, and standards.	0.8494		
	53	Genuinely listening to feedback from the auditing team within the organization.	0.8869		
	54	Accepting feedback from those being assessed	0.8879		
	63	Acknowledging mistakes and apologizing for any erroneous decisions made.	0.7936		
5		Complex Problem Solving		0.6774	0.8951
	10	Active listening and empathy.	0.7143		
	21	Seeking the good aspects of the team and customers.	0.8044		
	26	Managing the sequence of important steps	0.9082		
	35	Acquiring new knowledge from work, colleagues, customers, and new products	0.7565		
	49	Report writing skills for audit results	0.8168		
	51	Language skills, such as avoiding colloquial	0.9181		

Components	Variables	Factors / Questions related to the components of soft skills competencies engineering auditor	Factor Loading	%Total Variance	Cronbach Alpha
		language and mixing Thai with foreign languages.			
6		Communication Skill		0.7084	0.8919
	9	Well - adapted communication styles appropriately.	0.8064		
	50	Skills in written communication for presentation at meeting.	0.8360		
	60	Listening and responding to questions respectfully.	0.8702		
	61	Being open to feedback from team leaders and teammates sincerely.	0.8499		
	64	Accepting and respecting colleagues and experts.	0.8447		
7		Adaptability		0.7031	0.8537
	18	Identifying the root causes of problems by analyzing the relationships among components and various factors in the structure, to address issues directly and prevent recurring problems.	0.8215		
	30	Adapting to the organizational culture, work environment, and diverse practices.	0.8447		
	31	Flexibility and adaptability in thinking, where individuals with skills in adjusting and changing perspectives can effectively cope with changes.	0.8623		
	43	Prioritizing cybersecurity, including protecting both personal data and confidential customer information.	0.8250		
8		Conflict Management		0.7802	0.8538
	5	Pride and dedication in the engineering profession.	0.8712		
	25	Effective time management, especially in today's fast-paced environment where people must work efficiently to maximize benefits.	0.9315		
	56	Compromising in conflict resolution.	0.8450		
9		Leadership		0.6916	0.7413
	1	Trust from both the teammate and clients.	0.8319		
	4	Being the anchor of everyone's morale and someone whom everyone trusts.	0.8957		
	58	Properly sequencing presentations and managing time effectively.	0.7620		
10		Analytical Thinking and Decision-making		0.6176	0.6621
	2	Being a critical thinker and decision-maker who sets a vision and direction for others to follow.	0.6785		
	38	Ask analytical questions, identify problems, gather data, interpret evaluations.	0.8734		
	39	Making decisions to maximize benefits and minimize errors.	0.7934		
11		Time Management		0.7615	0.6741

Components	Variables	Factors / Questions related to the components of soft skills competencies engineering auditor	Factor Loading	%Total Variance	Cronbach Alpha
	15	Self-responsibility for own tasks and self-development.	0.8726		
	27	Assigning or delegating tasks that align with skills and abilities.	0.8726		
12		Open Mind		0.7704	0.6967
	55	Persuasively present reasoned arguments.	0.8777		
	62	Willing to listen and support feedback from assessors and evaluators.	0.8777		
13		Collaboration		0.8209	0.7799
	13	Respect and listen to the opinions of others within the auditing team and support team.	0.9060		
	23	Passionate about the work and responsibilities undertaken.	0.9060		

Results of Table1 show finding the correlation coefficient of 13 components using Pearson's Correlation Coefficient method. This indicates the relationship between pairs of variables. The coefficient value ranges from -1.0 to +1.0.

- A coefficient closes to -1.0 indicates a strong negative correlation between the two variables.
- A coefficient closes to +1.0 indicates a strong positive correlation between the two variables.
- A coefficient equal to 0 indicates no correlation between the variables.

Table 2 Results of correlation test using Pearson's Correlation Coefficient method.

F	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13
x1	1												
x2	0.5597**	1											
x3	0.3709	0.6499***	1										
x4	0.3133	0.6231***	0.3507	1									
x5	0.5746**	0.5796**	0.2963	0.5139**	1								
x6	0.3999	0.7204***	0.5309**	0.5892**	0.3594	1							
x7	0.1839	0.5739**	0.259	0.5732**	0.5089**	0.2516	1						
x8	0.3719	0.599***	0.6734***	0.4343*	0.2478	0.6178***	0.2002	1					
x9	0.3262	0.4155*	0.6018***	0.0861	0.194	0.4194*	0.0781	0.4938**	1				
x10	0.2917	0.4189*	0.1075	0.5971***	0.3925	0.2338	0.5126**	-0.0258	0.0291	1			
x11	0.7187***	0.5685**	0.4904**	0.2415	0.2993	0.3494	0.3942	0.4179*	0.2553	0.3478	1		
x12	0.4800**	0.5590**	0.1941	0.5345**	0.4966**	0.5461**	0.2223	0.4783**	0.3245	0.3256	0.2213	1	
x13	0.4457*	0.5959***	0.6263***	0.6655***	0.4605*	0.4189*	0.3814	0.4226*	0.2747	0.3586	0.3034	0.3683	1

* Statistically significant at 0.10, ** statistically significant at 0.05, and *** statistically significant at 0.01.

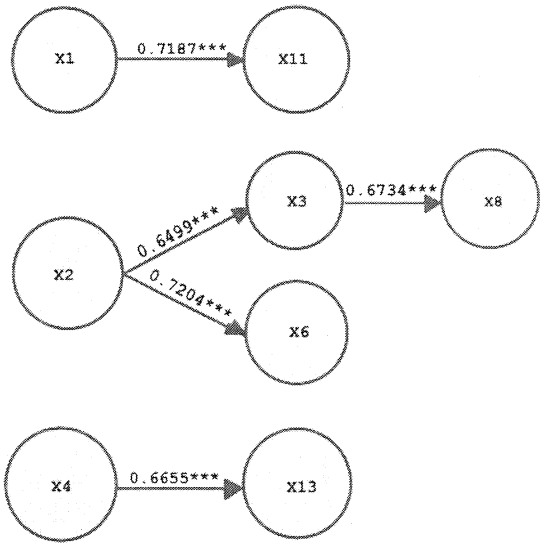
From Table 2, the results of testing the Pearson's Correlation Coefficient to examine the relationship between the 13 skill components revealed that all components have a positive correlation with each other, except for Component 8 (Conflict Management) with Component 10 (Analytical Thinking and Decision Making). However, the lack of statistical significance does not affect the test. In summary, all factors have a positive relationship. The correlation coefficient values are greater than 0. The highest correlations are observed between Component 2 (Personal Image) and Component 6 (Communication Skills), with a correlation coefficient of 0.7204 at a statistically significant level of 0.01 or 99%.

From Figure 2, which depicts the factors influencing skills using Pearson's Correlation Coefficient in dimensional analysis, it is found that the components with the highest correlation and influence can be categorized into 3 models:

Model 1: Component 1 (Ethics) is a predictor variable positively correlated with Component 11 (Time Management), which is a statistically significant predictor. This indicates that ethics significantly influence time management skills.

Model 2: Component 2 (Personality) is a predictor variable positively correlated with Component 3 (Adaptability) and Component 6 (Communication Skills). Additionally, Component 3 (Adaptability) is positively correlated with Component 8 (Conflict Management). All three components are statistically significant predictors.

Model 3: Component 4 (Life- long Learning) is a predictor variable positively correlated with Component 13 (Collaboration). Both are statistically significant predictor variables.



NOTE: X1 (Ethic) X2 (Personality) X3 (Adaptability) X4 (Life-Long Learning) X6 (Communication Skill) X8 (Conflict Management) X11 (Time Management) and X13 (Collaboration) *** Statistically significant at 0.01 level

Figure 2 The factors influencing soft skill competencies depict using Pearson's Correlation Coefficient.

From the research, the components derived from the confirmatory component analysis, consisting of 13 components (X1, X2, X3.....X13), and 59 subcomponents of core skills extracted and arranged horizontally in the T-Shape model. These can be displayed as in Figure3., comparing the competency definitions for the profession of building inspectors in the ministerial regulations, which specify the qualifications of inspectors. The criteria for registration and deregistration, the criteria for building inspections, and the profession of energy management inspectors are certified in the announcement by The Department of Alternative Energy Development and Conservation. These concern the training criteria and methods for energy management inspectors. All are certified under the engineering council regulations, only the main component of ethics (X1) appears in the specific subcomponent C. The subcomponent of adhering to regulations or ethical standards in engineering (C7) and honoring contributions to the profession (C8) are presented. However, subcomponents C3, C11, C12, C14, C22, C29, and C52 are essential core skills which are not included in the current competency model for engineering auditors.

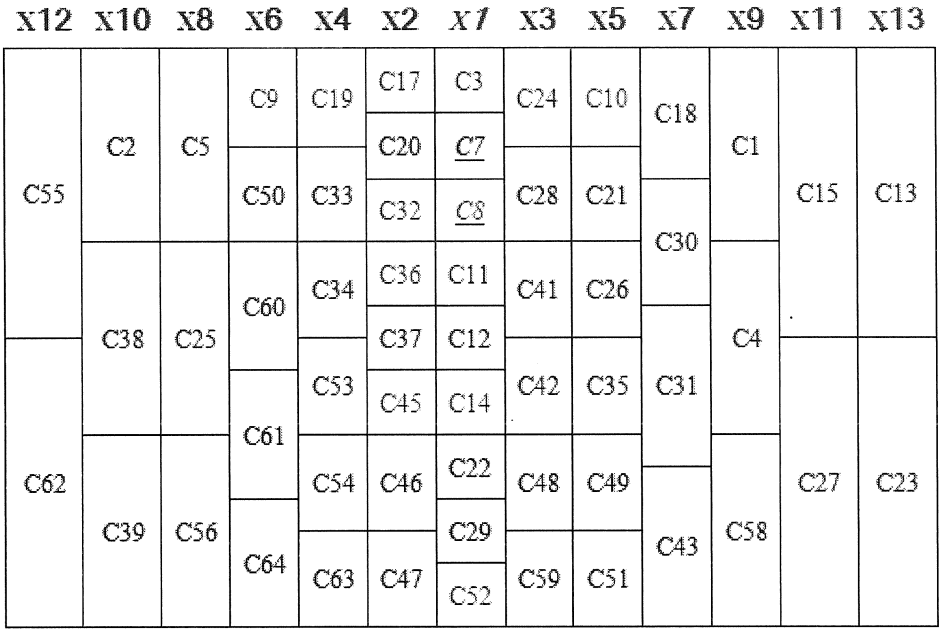


Figure 3 The model indicating the competency measurements shows for the 13 components of soft skills engineering auditors.

However, we only consider the top 5 most essential components derived from confirmatory component analysis—5 items (X1, X2, X3,...X5)—and 35 subcomponents of core skills extracted and arranged horizontally in the T-Shape. The data can be displayed in Figure 4.

X4	X2	X1	X3	X5
C19	C17	C3	C24	C10
	C20	C7		
C33	C32	C8	C28	C21
C34	C36	C11	C41	C26
	C37	C12		
C53	C45	C14	C42	C35
C54	C46	C22	C48	C49
		C29		
C63	C47	C52	C59	C51

Figure 4 The model indicating the measurements illustrate the 5 key components of soft skills competencies for engineering auditors.

Study Results

1. The indicators in core skills for soft skills engineer auditors involving 5 key components are as follows: Personality, Adaptability, Ethics, Life-Long Learning, and Complicated Problem-Solving Skill. These models are required competencies in core skills for soft skills engineer auditors. (Soft Skills as the Required Competencies for Engineering Inspector Model: SSCE Model)

2. All 13 components are positively correlated, with correlation coefficients greater than 0, indicating that they contribute in a similar direction. The components of ethics and time management have the highest correlation, with a coefficient value of 0.7187. This indicates that the 13 components can collectively explain the competency model for core skills of engineering auditors. The relationship between these components is beneficial for developing skill development programs. For example, if a program focuses on developing ethics, participants will not only improve their ethical skills but also their time management skills.

Recommendations and Future Research

1. The research findings utilized the third-party competency model for engineering auditors developed in Thailand. The data should be supported by related documents and research works, verified by various experts in the field using the Delphi technique. Analysis of the confirmatory components reveals a robust structural validity, making it suitable as a model for curriculum development aimed at achieving desired competencies for future engineering auditors.

2. Recommendations for future research could include developing a new third-party competency model for engineering auditors by analyzing and comparing it with the current professional competency model for engineering auditors in Thailand.

3. Recommendations for future research could involve developing a skill development curriculum specifically targeting the top 5 most important components from the existing competency model of building inspectors and energy management inspectors.

4. This research will be beneficial not only for engineering auditors to the third parties currently practice, but also for enhancing individuals' skill sets. Additionally, it will aid in refined training programs for governmental and private sector entities. They are responsible or involved in the development of soft skills engineering auditors which are needed for the future.

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