REVIEWING AND IMPROVING IT ENGINEERING CURRICULUM IN TRA VINH UNIVERSITY

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ABSTRACT

The information technology engineering curriculum at Tra Vinh University has been designed in the CDIO approach 6 years before. Up to now, we have two cohorts of graduates from this program. Therefore, it is time to review to improve the curriculum. The program evaluation is based on standard 12 of CDIO. The paper focuses on reassessing the importance of intended learning outcomes and levels of competencies. To carry out this task, we have conducted a stakeholder survey including companies, alumni, lecturers, and students. Based on the surveyed results, the current program will be reviewed and improved.

KEYWORDS

Information Technology engineering curriculum, Importance of intended learning outcomes, achieved level of proficiency, expected level of proficiency, Standards 12

INTRODUCTION

This is the first time we review the Information Technology (IT) engineering curriculum, which has been designed according to the CDIO framework (CDIO, The CDIO Syllabus 2.0 An Updated Statement of Goals for Engineering Education, 2011), (Crawley, E. F., Malmqvist, J., Östlund, S., Brodeur, D. R., & Edström, K., 2014). Since the program has been implemented 6 years before, there have been 2 cohorts of graduates from this program. And this is the time we need to review the curriculum to aim at carrying out the censorship of the curriculum.

At the time of designing the curriculum, we selected the appropriate learning outcomes along with the expectations of the most viable student competency levels for the future indicated in the curriculum framework. However, it is necessary to initiate an experimental process to verify the developed curriculum, including every procedure from the curriculum to the specific teaching implementation. Besides, in the teaching process, both learners and lecturers must constantly update new technology and professional expertise to adapt to the global trend. To carry out the program evaluation, stakeholders evaluate the program implementation results after the actual implementation time. Based on that result, we review the achievements according to the original plan as well as the achieved results.

REVIEWING IT ENGINEERING CURRICULUM

Process of Survey

To collect data for the program evaluation, we conducted a stakeholder survey on 4 groups of stakeholders:

Group A - IT lecturers of our school and some lecturers of other universities having IT programs designed with the CDIO approach;
Group B - IT employers, IT workers and IT alumni of Tra Vinh University (TVU);
Group C - Final-year IT students of the school;
Group D - Third-year IT students of the school.

The content of the learning outcomes survey consists of three focuses: the importance of intended learning outcomes, achieved levels of proficiency, and expected levels of proficiency. The importance of the intended learning outcomes is assessed according to 4 levels: No important, Less important, Important, and Very important on a 4-point scale. Levels of proficiency are assessed according to 7 levels: Having no knowledge, Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation on a 7-point scale. Level-2 learning outcomes are surveyed as shown in Table 1. The interval scale is used to classify the surveyed value and Bloom's scale (Bloom, 1984) is used to assess the achieved and expected level of proficiency.

Table 1. Level-2 Learning Outcomes

Learning Outcomes	Level-2 Learning Outcomes
1.1	Knowledge of underlying sciences
1.2	Core engineering fundamental knowledge
1.3	Advanced engineering fundamental knowledge
1.4	Other support knowledge
2.1	Analytic reasoning and problem solving
2.2	Experimentation and knowledge discovery
2.3	System thinking
2.4	Personal skills and attitudes
2.5	Professional skills and attitudes
3.1	Teamwork
3.2	Communications
3.3	Communications in foreign languages
4.1	External, societal and environmental context
4.2	Enterprise and business context
4.3	Conceiving and engineering systems
4.4	Designing
4.5	Implementing
4.6	Operating

Results of a Survey About the Importance of Intended Learning Outcomes

With the review of the importance of the level-2 learning outcomes presented in Figure 1, it can be seen that all of the intended learning outcomes have a greater average score than 2.5 - an Important point frame. In particular, the learning outcomes 3.3 was rated by both surveyed

teams A and B to have a greater average score than 3.50, the highest compared to the other learning outcomes belonging to a Very Important group. Meanwhile, the learning outcomes 1.4 is rated by both groups A and B, which has the lowest average score compared to the average of the remaining learning outcomes but they are still in an Important group. Besides, the remaining learning outcomes evaluated by both groups A and B have slight deviations compared to each learning outcome.

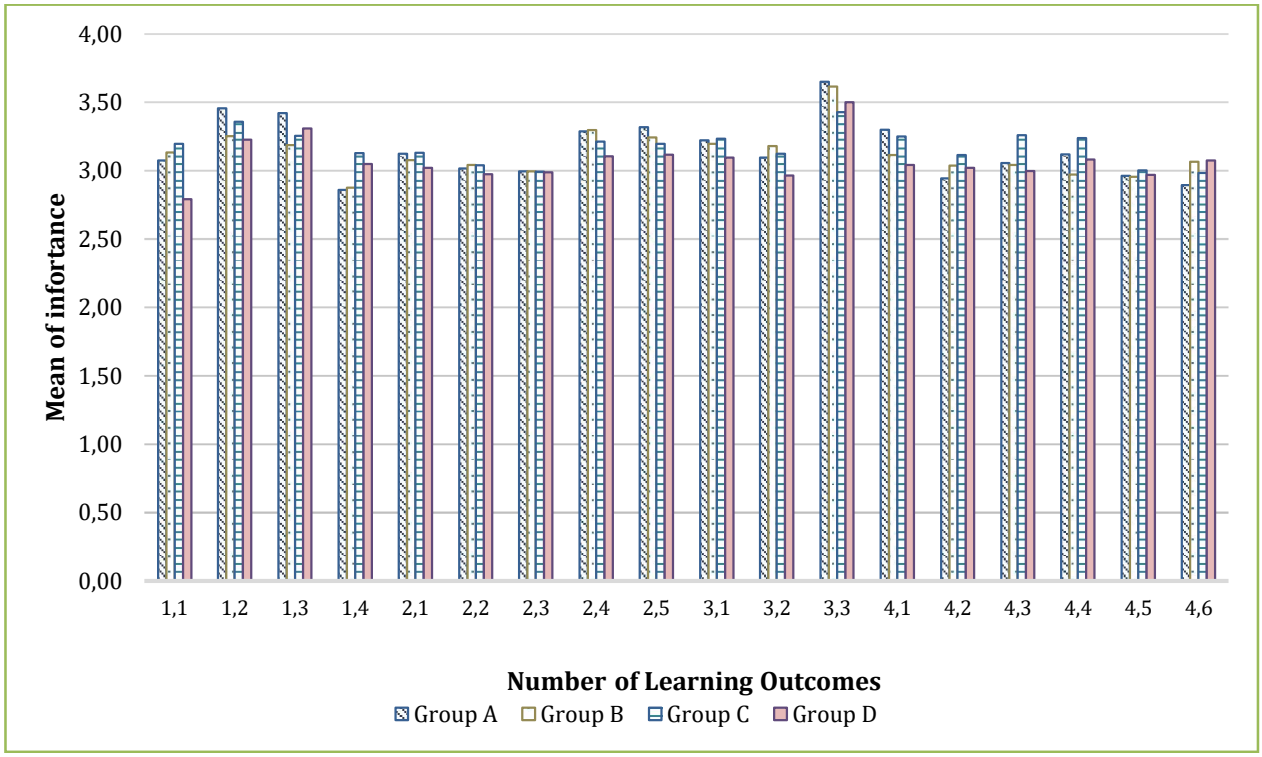

Figure 1. Diagram of the results of the survey of the importance

Students in both groups C and D have similar assessments regarding the importance of similar assessing standards of groups A and B. However, self-evaluation of group C has a higher average score than that of the others for learning outcomes 4.2, 4.3, and 4.4.

Results of Levels of Proficiency

Achieved Levels of Proficiency

According to the surveyed results presented in Table 2, generally, the average of the evaluation score of all 4 surveyed groups for the learning outcomes reached level Application on the Bloom's scale, except for the learning outcomes 2.2, 2.3, 4.5, and 4.6, which only reached level comprehension on the Bloom's scale. Therefore, compared to the initial goals of the expected level of proficiency, the program implementation process has initially achieved the set goals.

Table 2. Achieved levels of proficiency at level-2 learning outcomes

Learning Outcomes	Group A		Group B		Group C		Group D		Total Survey	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1.1	3.64	0.35	3.50	0.48	3.55	0.27	3.65	0.4	3.58	0.37
1.2	3.96	0.10	3.69	0.17	3.97	0.29	3.97	0.29	3.90	0.20
1.3	3.91	0.30	3.63	0.26	3.97	014	4.19	015	3.93	0.14
1.4	3.76	0.17	3.31	0.28	3.99	0.23	4.27	0.15	3.83	0.17
2.1	3.26	0.08	3.35	0.18	4.02	0.19	4.09	0.33	3.67	0.11
2.2	3.20	0.18	3.27	0.15	3.92	0.15	4.04	0.15	3.57	0.14
2.3	3.34	0.09	3.10	0.18	4.01	0.19	4.07	0.13	3.52	0.09
2.4	3.36	0.11	3.43	0.22	3.93	0.15	4.17	0.21	3.72	0.08
2.5	3.43	0.10	3.44	0.21	4.02	0.13	4.09	0.22	3.75	0.07
3.1	3.40	0.11	3.40	0.18	4.18	0.16	4.21	0.17	3.80	0.10
3.2	3.22	0.18	3.45	0.16	3.90	0.19	4.05	0.14	3.66	0.08
3.3	3.10	0.00	3.31	0.00	4.43	0.00	4.08	0.00	3.73	0.00
4.1	3.40	0.07	3.46	0.11	4.14	0.10	4.13	0.06	3.78	0.00
4.2	2.96	0.07	3.25	0.13	4.13	0.26	4.01	0.12	3.59	0.08
4.3	3.25	0.10	3.36	0.15	4.13	0.22	4.12	0.19	3.71	0.07
4.4	3.40	0.12	3.35	0.09	4.05	0.23	4.07	0.16	3.72	0.05
4.5	3.06	0.22	3.27	0.10	3.85	0.21	3.99	0.16	3.54	0.08
4.6	3.09	0.12	3.18	0.17	3.85	0.15	4.15	0.19	3.57	0.10

However, when considering each specific output group learning outcomes 1.1, 1.2, and 1.3 evaluated by the whole group illustrate level Application on the Bloom's scale. Additionally, learning outcome 1.4 was evaluated level Comprehension on the Bloom's scale by group B level. Compared to the goal of the expected levels of proficiency in the curriculum, the requirements have been reached. This is a positive result of the efforts to achieve the goals of the curriculum.

Besides, both groups A and B strictly evaluated levels of proficiency regarding learning outcomes from 2.1 to 4.6. Therefore, these learning outcomes only reach level Comprehension on the Bloom's scale. However, there is an average score which has proximity to level Application on the Bloom's scale. In contrast, two groups C and D self-evaluated to achieve level Application on the Bloom's scale.

Expected Levels of Proficiency

The surveyed data of the expected levels of proficiency that need to be achieved in the future are shown in Figure 2. Figure 2 presents that all 4 groups showed their higher expectation on expected levels of proficiency than on achieved levels. All surveyed groups expected level Analysis on the Bloom's scale. Although the achieved average score in each group is different in each learning outcome, it is still in level Analysis on the Bloom's scale. Figure 2 illustrates that group A wanted to achieve significantly higher results than group B in learning outcomes like 1.2, 1.3, 1.4, and 4.1. However, regarding other learning outcomes, group B wanted to achieve higher than its counterparts – group A. For groups C and D, the expected levels of proficiency are not different between them and their expectations are higher than those of groups A and B.

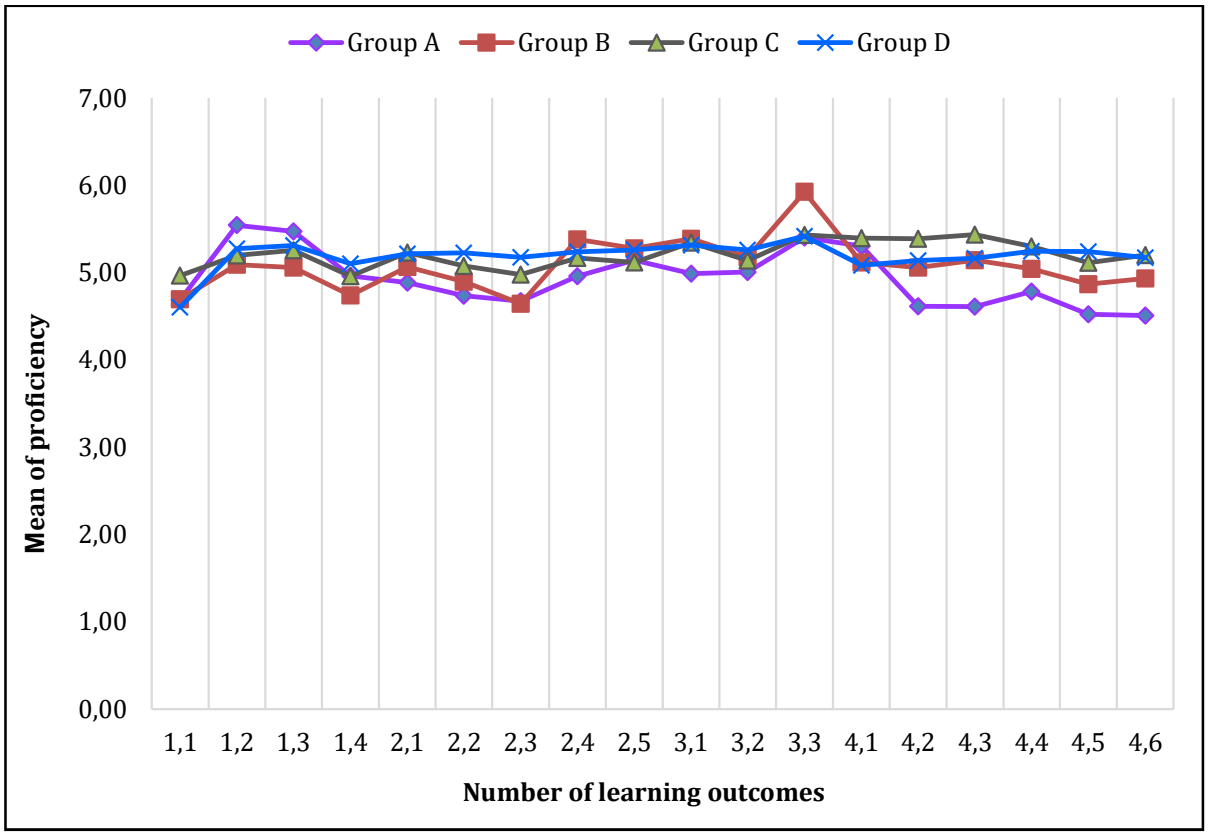

Figure 2. The levels of proficiency required from the 4 groups

To have more detailed data in the program evaluation and improvement, especially the data on group B's higher expectation on the intended learning outcomes comparing with group A's, the study continues to evaluate the results of the level-3 learning outcomes, which are presented in Table 3 (see Appendix).

According to the data, the average score of all learning outcomes expected by each surveyed groups reached level Analysis on the Bloom's scale. This result is the pieces of evidence that help us conduct a review and improvement to the curriculum.

CONCLUSIONS AND FUTURE WORK

Generally, the survey results indicated that the process of implementing the IT engineering curriculum at Tra Vinh University has reached the program objectives closely. Learning outcomes Technical knowledge and reasoning (1.1, 1.2 and 1.3) are evaluated by the whole group achieved the program objectives, meanwhile, learning outcomes from 2.1 to 4.6 are evaluated well by groups C and D. However, these output standards are lower than the expected program objectives in terms of the other groups. Therefore, we need to improve proficiency with all learning outcomes so that the evaluation of the stakeholders is going to be higher than the current proficiency.

We suggest that program improvements should include to following actions:

1. Continuing to survey students on teaching activities and the level of students' ability to meet the learning outcomes of each subject;
2. Not only enhancing experiential learning activities on each subject but also combining business partners for students to do design projects and graduation projects according to Standard 5 of CDIO (CDIO, CDIO Standards 2.0, 2010);
3. Improving the technical learning space to support students enhance the experience of designing and implementing experience according to Standard 6 of CDIO;
4. Assessing lecturers' competency in terms of professional skills and teaching competencies to plan training for lecturers following Standards 9 and 10 of CDIO;
5. Improving the process of assessing learning outcomes, performing learning assessment, using a variety of appropriate methods to learning outcomes that measure student's disciplinary knowledge, personal and interpersonal skills, as well as product, process, and system building skills according to Standard 11 of CDIO;
6. Continuously improving, the development of a course curriculum map. This requires developing an assessment plan, rubrics and other assessment tools, upgrading the Introduction to Engineering course, and enhancing lecturers' capabilities for CDIO and teaching skills;
7. Supplementing learning outcomes to improve personal, professional and quality skills, teamwork, communication, and CDIO skills, used in the inspection of the Accreditation Board of Engineering and Technology (ABET, 2019);
8. Identifying the levels of skills evaluation in the syllabus from Introduce –Teach - Use (ITU) to Teach – Use - Assess (TUA); and improving the level of competencies regarding expected learning outcomes.

With the solutions above, we are expecting to raise at least one Bloom's scale for all learning outcomes such as the survey results for the expected level of proficiency because of the following reasons:

We continue to survey students on teaching activities and the level of students' abilities on courses of the curriculum so that leaders can plan teaching and learning improvement skills for lecturers and students as they don't find competent skills. For example, lecturers will be supported to join activity experiences inside and outside the school to store up experiences for themselves. Furthermore, the technical learning space will be improved to support the hands-on experience of design, implementation, operation products, processes, and systems for students.

Established plans improve both process and form for assessment to support the evaluation of learning outcomes. The learning outcomes evaluation will be used with various forms and assessment tools that are suitable for different output standards. Moreover, by using a variety of assessment methods which adapt to a variety of learning styles, not only the reliability of the outcome results will be enhanced but also the evaluated data towards similarity in desired outcomes of the parties. Finally, improving both process and form for assessment also meets the continuous improvement process of the CDIO standard 12 as well as inspects of the Accreditation Board of Engineering and Technology next year.

REFERENCES

ABET. (2019). *Criteria for Accrediting Computing Programs.* Retrieved from https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-computing-programs-2020-2021/

Bloom, B. S. (1984). *Taxonomy of educational objectives: Book 1 Cognitive domain.* New York: Longman.

CDIO. (2010). *CDIO Standards 2.0*. Retrieved April 27, 2020, from http://www.cdio.org/implementing-cdio/standards/12-cdio-standards

CDIO. (2011). *CDIO Syllabus.* Retrieved from http://www.cdio.org/files/project/file/cdio_syllabus_v2.pdf

Crawley, E. F., Malmqvist, J., Östlund, S., Brodeur, D. R., & Edström, K. (2014). The CDIO Approach. Rethinking Engineering Education. Cham: Springer International. doi:10.1007/978-3-319-05561-9_2

BIOGRAPHICAL INFORMATION

Thi-Phuong-Nam PHAN has been a lecturer in the Department of Information Technology, School of Engineering and Technology, Tra Vinh University, Vietnam since 2011. She received a degree of engineer in Information and master's degree in Information Systems from Can Tho University in Vietnam in 2001 and 2013, respectively. Her areas of professional interest include information systems, metadata, data science, human-computer interaction, engineering education.

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Thanh-Thuy TIEU has been the Director of the Teaching and Learning Centre of Tra Vinh University since 2006, and worked as an academic developer for fifteen years. Her experiences and passion for supporting academics in enhancing their teaching capability motivated her to finish her doctoral research on academic professional development at Monash University, Australia in 2019. Her professional interests include academic professional development, curriculum development, industry collaboration, and soft skill training.

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Appendix

Table 3. Expected levels student's proficiency at level-3 learning outcomes

Level-3 Learning outcomes	Group A		Group B		Group C		Group D		Total Survey	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
2.1.1 Technical Problem Identification	4.88	0.06	4.64	0.12	5.24	0.11	5.14	0.05	4.98	0.05
2.1.2 Modeling	4.68	0.11	4.77	0.33	4.79	0.00	5.08	0.12	4.83	0.08
2.1.3 Estimation and Qualitative Analysis	4.73	0.03	4.49	0.04	4.74	0.25	5.33	0.08	4.82	0.06
2.1.4 Analysis With Uncertainty	4.88	0.08	4.77	0.08	4.88	0.04	5.28	0.10	4.95	0.05
2.2.1 Hypothesis Formulation	4.89	0.06	4.86	0.12	4.95	0.08	5.16	0.17	4.97	0.03
2.2.2 Survey of Print and Electronic documents	5.20	0.17	4.86	0.20	4.96	0.04	5.33	0.18	5.09	0.13
2.2.3 Hypothesis Test, and Defense	4.78	0.08	4.92	0.15	4.88	0.22	5.08	0.14	4.92	0.10
2.3.1 Thinking Holistically	4.70	0.13	4.79	0.04	5.02	0.16	5.06	0.05	4.89	0.09
2.3.2 Emergence and Interactions in Systems	4.63	0.08	4.59	0.16	4.90	0.15	5.28	0.13	4.85	0.12
2.3.3 Prioritization and Focus	4.68	0.08	4.69	0.13	4.98	0.04	5.03	0.10	4.84	0.04
2.3.4 Trade-offs, Judgement and Balance in Resolution	4.68	0.04	4.50	0.05	5.00	0.20	5.33	0.12	4.88	0.08
2.4.1 Initiative and Willingness to Take Risks	4.75	0.18	5.36	0.16	4.95	0.16	5.25	0.08	5.08	0.05
2.4.2 Perseverance and Flexibility	5.10	0.06	5.53	0.10	5.19	0.06	5.31	0.10	5.28	0.05
2.4.3 Creative Thinking	5.02	0.03	5.23	0.08	5.21	0.19	5.03	0.13	5.12	0.09
2.4.4 Critical Thinking	4.93	0.12	5.11	0.09	5.33	0.12	5.22	0.13	5.15	0.04
2.4.5 Curiosity and Lifelong Learning	4.98	0.18	5.65	0.05	5.11	0.05	5.33	0.24	5.27	0.08
2.4.6 Time and Resource Management	4.98	0.04	5.38	0.00	5.21	0.00	5.29	0.06	5.22	0.01
2.5.1 Professional Ethics, Integrity, Responsibility	5.27	0.13	5.26	0.12	5.14	0.12	5.31	0.13	5.24	0.07
2.5.2 Professional Behavior	5.10	0.07	5.23	0.11	5.11	0.15	5.08	0.12	5.13	0.02
2.5.3 Proactively Planning for One's Career	5.12	0.19	5.49	0.04	5.12	0.08	5.28	0.10	5.25	0.03
2.5.4 Staying Current on World of Engineer	5.08	0.20	5.13	0.24	5.10	0.11	5.36	0.05	5.17	0.08
3.1.1 Forming Effective Teams	5.08	0.08	5.37	0.17	5.21	0.13	5.32	0.11	5.25	0.05
3.1.2 Team Operation	5.08	0.10	5.37	0.19	5.44	0.10	5.27	0.16	5.29	0.08
3.1.3 Team Growth	4.90	0.07	5.12	0.16	5.43	0.10	5.21	0.06	5.16	0.10
3.1.4 Team Leadership	4.95	0.00	5.54	0.20	5.38	0.11	5.31	0.05	5.29	0.09
3.1.5 Technical Teaming	4.93	0.04	5.54	0.22	5.25	0.15	5.46	0.06	5.29	0.09
3.2.1 Communications Strategy	5.08	0.04	5.27	0.05	5.25	0.05	5.29	0.06	5.22	0.00
3.2.2 Graphical Communication	4.93	0.13	5.08	0.13	5.02	0.08	5.22	0.10	5.06	0.06
4.1.1 Roles and Responsibility of Engineers	5.30	0.14	5.12	0.05	5.39	0.15	5.08	0.00	5.22	0.06
4.2.1 Enterprise Strategy, Goals, and Planning	4.58	0.03	5.19	0.04	5.38	0.06	5.10	0.10	5.06	0.03

Level-3 Learning outcomes	Group A		Group B		Group C		Group D		Total Survey	
	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean
4.2.2 Technical Entrepreneurship	4.65	0.07	4.92	0.11	5.39	0.15	5.17	0.12	5.03	0.00
4.3.1 Setting System Goals and Requirements	4.69	0.11	5.13	0.04	5.48	0.11	5.18	0.13	5.12	0.05
4.3.2 Defining Function, Concept and Architecture	4.43	0.04	5.12	0.05	5.46	0.25	5.21	0.18	5.05	0.02
4.3.3 Modeling of System and Ensuring Goals Can Be Met	4.73	0.06	5.10	0.18	5.36	0.19	5.22	0.05	5.10	0.06
4.3.4 Development Project Management	4.59	0.04	5.22	0.10	5.44	0.06	5.03	0.15	5.07	0.05
4.4.1 The Design Process	4.68	0.10	5.12	0.15	5.16	0.08	5.20	0.10	5.04	0.04
4.4.2 The Design Process Phasing and Approaches	4.55	0.09	5.00	0.08	5.36	0.19	5.36	0.10	5.07	0.05
4.4.3 Utilization of Knowledge in Design	4.88	0.04	5.19	0.05	5.43	0.20	5.25	0.00	5.19	0.06
4.4.4 Disciplinary Design	5.03	0.04	4.85	0.00	5.25	0.15	5.17	0.00	5.07	0.05
4.5.1 Planning manufacturing process	4.79	0.10	4.98	0.13	5.00	0.12	5.42	0.15	5.05	0.08
4.5.2 Manufacturing and assembly process	4.40	0.05	4.87	0.22	5.07	0.07	5.19	0.21	4.88	0.10
4.5.3 Implementation Management	4.38	0.03	4.74	0.16	5.26	0.04	5.11	0.05	4.87	0.06
4.6.1 Designing and Optimizing Operations	4.30	0.00	4.92	0.00	5.29	0.00	5.25	0.00	4.94	0.00
4.6.2 Training and Operations	4.54	0.13	4.83	0.11	5.24	0.06	5.15	0.11	4.94	0.05
4.6.3 System Improvement and Evolution	4.42	0.03	4.97	0.04	5.19	0.04	5.00	0.08	4.90	0.03
4.6.4 Operations Management	4.78	0.16	5.00	0.06	5.09	0.14	5.27	0.14	5.03	0.10