WP 1 - Non-university capacity assessment

Outcome 1.1. A capacity assessment execution plan

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REVISION SHEET

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1	2021/02/12	Rui M. Lima (UMinho)	First draft of WP1 working plan
2	2021/04/30	Rui M. Lima (UMinho)	Second version of the WP1 plan considering comments from all partners and after revisions by UMinho team.
3	2021/05/05	Rui M. Lima (UMinho)	Adaptation to deliverable template.
4	2021/07/31	Rui M. Lima (UMinho)	Revision after QCMB evaluation.
5	2021/09/06	Rui M. Lima (UMinho)	Revision after PEC evaluation.

DISTRIBUTION LIST (WP1)

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1 Executive Summary

The ReCap4.0 project aims to develop competences of the non-university sector in Thailand for Industry 4.0 (I4.0) and innovative teaching and learning approaches. Thus, the potential target institutions are the 40 Rajabhat Universities and the 9 Rajamangala Universities of Technology. Considering the scope of the project, the target teachers are mainly teachers from Industrial Engineering or similar departments and programs. This report aims to deliver a viable plan for work package 1 (WP1), which objective is to assess the capacity of teachers from the non-university sector in Thailand, regarding: (i) knowledge related to product, process and production in I4.0 Era, (ii) teaching skills enhancement, and (iii) competence-based curriculum development. The Assessment of the teachers' capacity will be conducted through a self-perception questionnaire. This questionnaire will be developed and validated during March, April and May 2021. Validation will be carried on with think-aloud procedures with 6 teachers from non-university sector, and test and retest statistics validation will be developed with up to 30 teachers from non-university sector. Then, the questionnaire will be applied during the month of June with up to 100 to 200 teachers. Finally, the results will be analysed and reported in July. The results of this work package will be part of the input information for training design, the next work package.

2 Introduction

In order to follow the evolution that currently takes place at various levels, the non-university sector at the tertiary level in Thailand needs to improve its competencies in terms of I4.0 knowledge, as well as in relation to innovative approaches for the teaching/learning process. Besides the first aspect, which is obviously paramount, the second is particularly important, as it is widely known that the teaching / learning approaches have a major impact on the way learners acquire, develop and retain knowledge regarding not only technical competences but also transversal competences (soft skills).

The purpose of WP1 is to assess the capacity of a set of institutions of the non-university sector at the tertiary level in Thailand (Rajabhat Universities and Rajamangala Universities of Technology) and propose a set of recommendations for the training program (training needs) necessary to capacitate the teaching staff of those institutions. That capacitation involves I4.0 knowledge, innovative teaching/learning approaches and competence-based curriculum development.

This document is structured according to the tasks involved in the achievement of WP1 purpose, namely: (i) design of the capacity assessment instrument (task 1.2), (ii) application of the capacity assessment instrument (task 1.3), and, (iii) analysis of the results and creation of the set of recommendations for the training program (task 1.4).

3 WP 1 members and their responsibilities

Table 1 presents a list of contact persons from each partner institution and their email addresses. The chair and co-chair will be responsible for coordinating the work developed in this work package. The WP1 team will be supporting the chair and co-chair, and developing subtasks of the work package. Some examples of subtasks are: development of items of the questionnaire, review items, validate items, apply the questionnaire, analyze data, report the results, and review the report.

Table 1. WP1 Partner institutions contact persons.

Partner	Role	Name	Email
UMinho	Chair	Rui M Lima	rml@dps.uminho.pt
KMUTNB	Co-Chair	Athakorn Kengpol	athakorn.kengpol@gmail.com
AIT	Contact Person	Pisut Koomsap	pisut@ait.asia
KKU	Contact Person	Kanchana Sethanan	skanch@kku.ac.th
MU	Contact Person	Thananya Wasusri	thananya.was@mahidol.edu
MIC	Contact Person	Cathal de Paor	cathal.depaor@mic.ul.ie
PSU	Contact Person	Chukree Daesa	chukree.d@psu.ac.th
UPB	Contact Person	Gabriela Marina Parvu	gabriela_marina.ene@upb.ro

UMinho team (Table 2) will be coordinating tasks 1.1 Developing a capacity assessment execution plan, 1.2 Designing capacity assessment and 1.4 Summarize, interpret results and recommendations.

Table 2. WP1 UMinho contact persons.

Partner	Role	Name	Email
UMinho	Chair	Rui M Lima	rml@dps.uminho.pt
UMinho	Team member	Rui M Sousa	rms@dps.uminho.pt
UMinho	Team member	Lino Costa	lac@dps.uminho.pt
UMinho	Team member	Cristiano Jesus	cristiano.jesus@gmail.com
UMinho	Invited member	Diana Mesquita	diana@dps.uminho.pt

KMUTNB team (Table 3) will be coordinating tasks 1.3 Conducting non-university capacity assessment and will be responsible for coordinating the collection of information about Rajabhat Universities, contacts, and numbers for application of the questionnaire and activities for application of the questionnaire.

Table 3. WP1 KMUTNB contact persons.

Partner	Role	Name	Email
KMUTNB	Co-Chair	Athakorn Kengpol	athakorn.kengpol@gmail.com
KMUTNB	Team member	Warapoj Meethom	warapoj.m@eng.kmutnb.ac.th
KMUTNB	Team member	Phattarasaya Tantiwattanakul	phattarasayat@gmail.com
KMUTNB	Team member	Siravit Swangnop	siravit.s@eng.kmutnb.ac.th
KMUTNB	Team member	Naritsak Tantitippawan	supernst88@gmail.com

4 WP 1 plan

WP1 consists of four tasks:

- T1.1 Developing a capacity assessment execution plan
- T1.2 Designing capacity assessment
- T1.3 Conducting non-university capacity assessment
- T1.4 Summarize, interpret results and recommendations

UMinho and KMUTNB will lead the WP1, and all partners will participate and be responsible for tasks related to their geographical regions. Considering the plan of the proposal, we intend to develop the plan in the time period illustrated by the following Gantt Chart (Figure 1).

Task	M1 - February	M2 - March	M3 - April	M4 - May	M5 - June	M6 - July
Task 1.1 - Developing a capacity assessment execution plan						
Task 1.2 - Designing capacity assessment						
Task 1.3 - Conducting non-university capacity assessment						
Task 1.4 - Summarize, interpret results and recommendations						

Figure 1. WP1 plan Gantt chart

4.1 Plan for WP1 - Task 1.2: Designing capacity assessment

The design of the capacity assessment tool comprises four phases: (1) development and identification of critical knowledge; (2) development of items (questions) for each dimension; (3) improvement of the questionnaire using the think-aloud technique; (4) measurement of the reliability of the questionnaire using test and retest validation. During the task 1.2, there will be additional details about the number of items to be developed, but at this point the team estimates a maximum of 80 items, aiming to reduce as much as possible this number. Additionally, it is expected to develop two parts of the questionnaire, one dedicated to I4.0 and the other to the educational dimensions, including teaching skills and Learning Experience-Focused Course Design and Development.

4.1.1 Development of critical knowledge

Acquisition of critical knowledge through bibliographic research on Industry 4.0 and teaching skills and curriculum development, aiming to develop a two-part questionnaire to be applied among professors of Rajabhat Universities in Thailand.

The team will use the Acatech maturity model [1] and courses developed in the MSIE4.0 project as theoretical foundations for item development. The theoretical foundations of the educational part of the questionnaire will be active learning, communication, problem and project-based learning, coaching and mentoring, Curriculum Development processes, including assessment and evaluation, and Learning Experience-Focused Course Design and Development concepts.

4.1.2 Development of items

The wording of the items should be objective. It should not aim at "impressionistic" answers but rather that the subject shows "to be or not to be able..." or "to agree or not to agree...". A likert-type scale may counteract this effort of objectivity. In the case of the item format, the simplicity of the formulation must be taken into account. The ideal situation would be the correspondence "one item - one task, one task - one idea". Items should be relevant to the domain and purpose of the assessment and must be related and relevant to the dimension to be assessed. In other words, it is a matter of assessing the relevance and the correspondence between the item and the characteristic to be assessed. With regard to the criterion of credibility, face validity or 'apparent validity', the item should not appear ridiculous, unreasonable or childish. As for the clarity of the item, as a rule, short sentences or simple expressions should be used. It also favours the item's clarity to report behaviours rather than abstractions [2].

Items are constructed to objectively assess a given latent reality, that is, dimensions or variables that may also be referred to as constructs [2]. Construct is the same as concept, however it has the additional attribute of being observable. Therefore, constructs are concepts that can be treated scientifically [3]. Here is an

example of a construct: Business Excellence. It is possible to develop a conceptual description of this expression, however, from this theoretical basis it is necessary to extract variables that allow measuring it, for example, business excellence should be calculated by weighting the following indicators: market leadership (weight 10), growth (25), profitability (30), liquidity (15), debt (10) [4].

UMinho's team will be developing the items until April 6 and will ask for support of the WP1 team as needed. The WP1 team will be asked to give feedback about item quality until April 19, 2021.

4.1.3 Think-aloud - improvement of the questionnaire

The think-aloud research procedure, also referred to as "cognitive interviewing" and "verbal protocols", aims to understand how respondents perceive and interpret questions, and to identify potential problems that may arise in questionnaires. It should be carried out during the pre-test phase, before application. Aspects such as attention span, word recognition, action, memory, language processing, problem solving and reasoning may be assessed, exploring how knowledge is organised in memory and how memory is retrieved in relation to completing questionnaires. The procedure is usually carried out in a controlled environment or in the setting where the proposed survey is to be administered with subjects who match the characteristics of the proposed sample and involves an interviewer asking a respondent to think aloud while they go through a questionnaire and tell them everything they are thinking, with the interviewer asking probing questions of the respondent to discover their thoughts. There are two main types of interview: concurrent and retrospective. In the concurrent interview the respondent must give a verbal account of their thoughts as they answer the questionnaire and in the retrospective the answer is given after they have answered all the questions [5].

The think aloud procedure will be implemented on April 22, 2021 in 6 virtual sessions, organized as represented in Table 4. In each session one teacher, from a Rajabhat University, will read and think aloud about their interpretation of each item. These sessions will be conducted by a WP1 team. Sessions A, B and C will be dedicated to I4.0 part of the questionnaire and parts D, E and F will be dedicated to the educational part of the questionnaire.

Table 4. Think aloud organization of sessions.

One synchronous zoom meeting	Parallel sessions		
PART I4.0 (1,75H) (<40 items)	Session A – Teacher A	Session B – Teacher B	Session C – Teacher C
PART EDUC (1,75H) (<40 items)	Session D – Teacher D	Session E – Teacher E	Session F – Teacher F

4.1.4 Test and retest validation

Measuring the reliability of the questionnaire will be performed using a test and retest technique. The test corresponds to the administration of the survey to a set of respondents (approximately 30) and then, after a predetermined period of time (one week), repeat the administration of the same questionnaire. This procedure will measure the stability of scores across time and can be affected by the length of time between administrations of the survey. Moreover, the sample of respondents should be as homogeneous as possible. Thus, the sample will comprise teachers from the non-university sector at tertiary education level. The test will be performed on May 6, 2021 and the retest on May 13, 2021.

If these scores from test and retest are highly correlated with stable scores and error variability across time, then reliability can be assumed. Statistical tests such as Pearson's correlation test and t-student tests will be used to infer about reliability. Statistically significant correlations which correlation coefficients above 0.7 indicate reliability, otherwise, there is no evidence of reliability. The t-student tests allow to conclude about the existence of similar average scores between test and retest [6]. If necessary, the questionnaire will be revised taking into account the reliability analysis results.

4.2 Plan for WP1 - Task 1.3: Conducting non-university capacity assessment

The capacity assessment will be conducted through a questionnaire sent to Rajabhat Universities and Rajamangala Universities of Technology. There are 40 Rajabhat University institutions and 9 Rajamangala Universities of Technology institutions. Considering the scope of this project, the main target group are Rajabhat Universities institutions with Industrial Engineering or similar departments and programs. Rajamangala Universities of Technology will also be included in this study. Table 5 presents the complete list of institutions with this type of programs.

The plan will be to get direct access with the head of departments of included institutions and ask them to send the questionnaire to the teachers. At this point there are no exact number of teachers of those included institutions, but estimation is that there will be less than 1000 teachers in the included areas. The expected profile is teachers with master's degrees and an average of 3 years of experience. The target number of teachers for the training program is a total of approximately 60 trainees.

During the validation phase we will need to get synchronous access to 6 teachers on April 22 for the think aloud procedure and 30 teachers in two consecutive weeks, on May 6 and 13.

During the application of the questionnaire, the key person of each institution will be directly contacted and after answering the questionnaire will be asked to send it to other teachers.

The application of the questionnaire will be developed during a one-month period, in June 2021. The responses will be confidential, but login will be required to guarantee a one-to-one relation between answers and respondents.

Table 5. List of Rajabhat Universities and Rajamangala Universities of Technology institutions.

#	University	Faculty	Program
	North Eastern Part		
1	Udon Thani Rajabhat University	Technology	Industrial Management
2	Rajabhat Maha Sarakham University	Engineering	Industrial Management Engineering
3	Loei Rajabhat University	Industrial Technology	Industrial Management Engineering, Production Engineering
4	Nakhon Ratchasima Rajabhat University	Industrial Technology	Industrial Management Engineering
5	Buriram Rajabhat University	Industrial Technology	Industrial Management Engineering
6	Surindra Rajabhat University	Industrial Technology	Production Technology, Engineering and Technology Management
7	Ubon Ratchathani Rajabhat University	Industrial Technology	Industrial Management Technology, Logistics Management
8	Chaiyaphum Rajabhat University	Engineering and Industrial Technology	Production Engineering
9	Kalasin Rajabhat University (since 2016 combined to Kalasin University)	Engineering and Industrial Technology	Industrial Engineering
10	Sakon Nakhon Rajabhat University	Industrial Technology	Industrial and Production
11	Roi Et Rajabhat University	No	No
12	Sisaket Rajabhat University	No	No
13	***Rajamangala University of Technology isan***	Engineering	Industrial Engineering, Logistics Engineering
	Northern Part		
14	ChiangMai Rajabhat University	Science and Technology	Product design
15	Chiang Rai Rajabhat University	Industrial Technology	Logistics Engineering and Management
16	Lampang Rajabhat University	Industrial Technology	ProductionTechnology
17	Uttaradit Rajabhat University	Industrial Technology	Industrial Technology, Logistics Engineering
18	Pibulsongkram Rajabhat University	Industrial Technology	Industrial Technology, Logistics Engineering
19	Kamphaeng Phet Rajabhat University	Industrial Technology	Logistics Management
20	Nakhon Sawan Rajabhat University	Agricultural Technology and Industrial Technology	Engineering Management, Industrial Technology
21	Phetchabun Rajabhat University	Agricultural and Industrial Technology	Production Engineering and Management, Production Technology

#	University	Faculty	Program
22	***Rajamangala University of Technology Lanna***	Engineering	Industrial Engineering
	Central Part		
23	Kanchanaburi Rajabhat University	Industrial Technology	Industrial Technology
24	Chandrakasem Rajabhat University	Science	Production engineering and energy management
25	Thepsatri Rajabhat University	Industrial Technology	Industrial Technology
26	Dhonburi Rajabhat University	Science and Technology	Industrial Management
27	Nakhon Pathom Rajabhat University	Science and Technology	Industrial Computer Technology
28	Bansomdejchaopraya Rajabhat University	Industrial Technology	Production and Logistics Engineering Management
29	Phranakhon Rajabhat University	Industrial Technology	Industrial Technology
30	Phranakhon Si Ayutthaya Rajabhat University	Science and Technology	Engineering Management
31	Phetchaburi Rajabhat University	Engineering and Industrial Technology	Industrial Engineering, Industrial Technology
32	Rajabhat Rajanagarindra University	Industrial Technology	Industrial Management Engineering, Industrial Technology
33	Rambhai Barni Rajabhat University	Industrial Technology	Logistics Engineering, Industrial Technology (Continuing Program)
34	Valaya Alongkorn Rajabhat University under the Royal Patronage	Industrial Technology	Industrial Engineering Management
35	Suan Sunandha Rajabhat University	Industrial Technology	Industrial Management
36	Muban Chombueng Rajabhat University	Industrial Technology	Production in Industrial Technology
37	***Rajamangala University of Technology Tawan-ok***	Agro-Industrial Technology	Industrial Engineering
38	***Rajamangala University of Technology Krungthep***	Engineering	Industrial Engineering
39	***Rajamangala University of Technology Thanyaburi***	Engineering	Industrial Engineering
40	***Rajamangala University of Technology Phra Nakhon***	Engineering	Industrial Engineering
41	***Rajamangala University of Technology Rattanakosin***	Engineering	Industrial Engineering
42	***Rajamangala University of Technology Suvarnabhumi***	Engineering and Architecture	Industrial Engineering
	Southern Part		
43	Suratthani Rajabhat University	Science and Technology	Industrial Management Technology
44	Nakhon Si Thammarat Rajabhat University	Industrial Technology	Industrial Technology, Industrial Management and Logistics
45	Phuket Rajabhat University	Science and Technology	Industrial Technology
46	Songkhla Rajabhat University	Industrial Technology	Industrial Technology
47	Yala Rajabhat University	No	No
48	Princess of Naradhiwas	Engineering	Industrial Engineering
49	***Rajamangala University of Technology Srivijaya***	Engineering	Industrial Engineering

Figure 2 shows the total amount of institutions with the included faculties, according to the scope of the project.

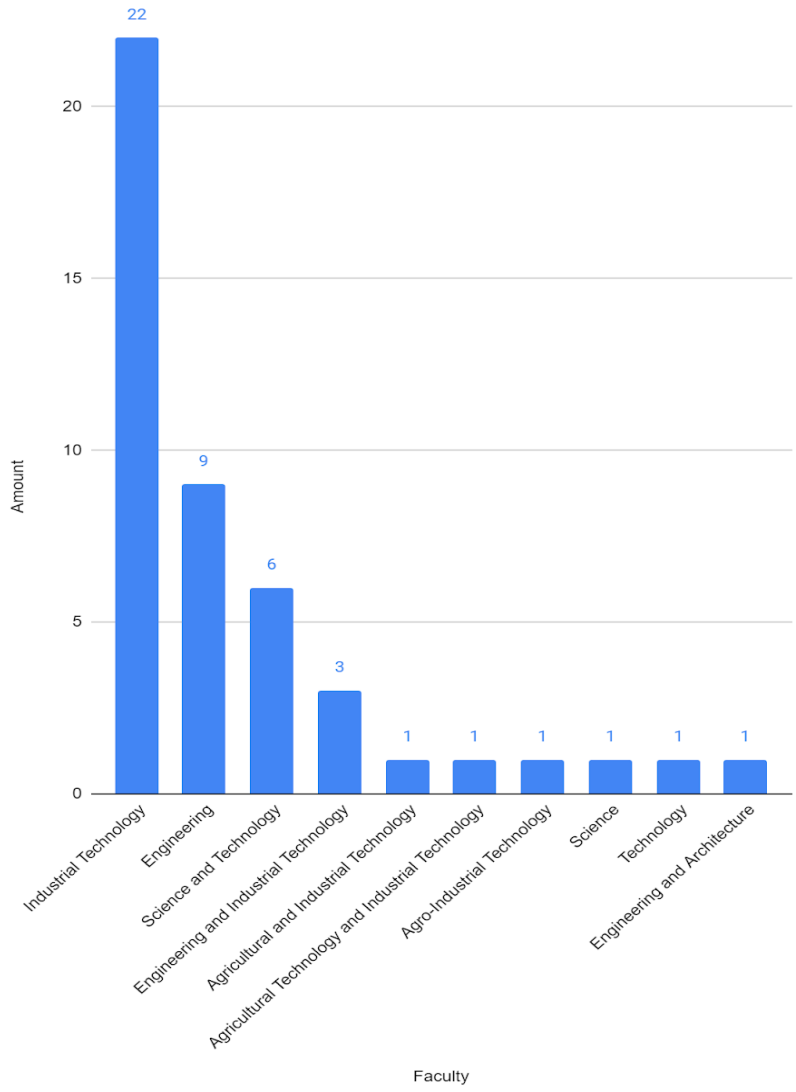

Figure 2. Number of included faculties.

Table 6 presents the relative number of institutions with the included faculties, according to the scope of the project.

Table 6. Relative number of institutions.

Faculty	Amount	%
Industrial Technology	22	47.83
Engineering	9	19.57
Science and Technology	6	13.04
Engineering and Industrial Technology	3	6.52
Agricultural and Industrial Technology	1	2.17
Agricultural Technology and Industrial Technology	1	2.17
Agro-Industrial Technology	1	2.17
Science	1	2.17
Technology	1	2.17
Engineering and Architecture	1	2.17
Total	**46**	**100.00**

Figure 3 shows the total amount of programmes in the included areas, according to the scope of the project.

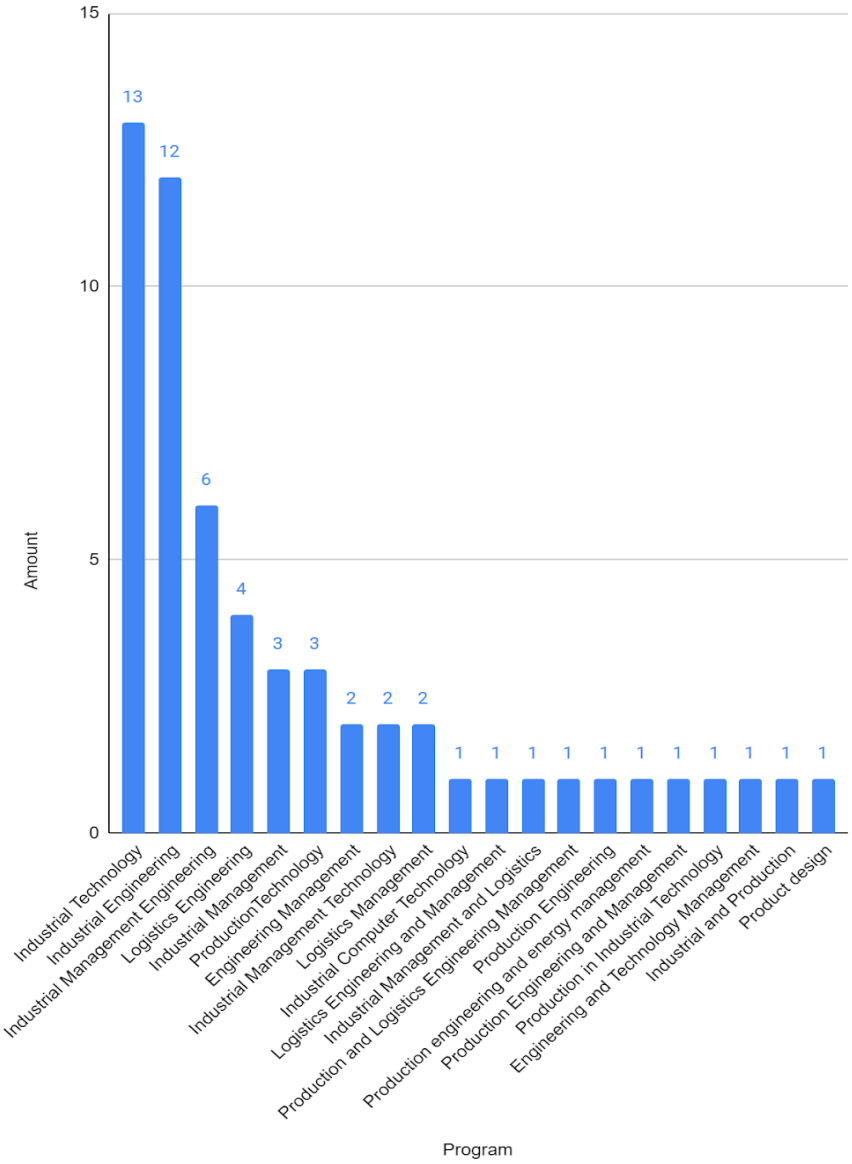

Figure 3. Amount of included programmes.

Table 7 presents the relative number of included programmes, according to the scope of the project.

Table 7. Relative number of programmes in the included areas, according to the scope of the project.

Program	Amount	%
Industrial Technology	13	22.41
Industrial Engineering	12	20.69
Industrial Management Engineering	6	10.34
Logistics Engineering	4	6.90
Industrial Management	3	5.17
Production Technology	3	5.17

Program	Amount	%
Engineering Management	2	3.45
Industrial Management Technology	2	3.45
Logistics Management	2	3.45
Industrial Computer Technology	1	1.72
Logistics Engineering and Management	1	1.72
Industrial Management and Logistics	1	1.72
Production and Logistics Engineering Management	1	1.72
Production Engineering	1	1.72
Production engineering and energy management	1	1.72
Production Engineering and Management	1	1.72
Production in Industrial Technology	1	1.72
Engineering and Technology Management	1	1.72
Industrial and Production	1	1.72
Product design	1	1.72
Total	**58**	**100.00**

4.3 Plan for WP1 - Task 1.4: Summarize, interpret results and recommendations

Content analysis using descriptive statistics and multivariate statistical tests will be performed. It is expected that the final data collected from the survey comprises between 60 to 200 respondents to the questionnaire. Lower number of respondents will have an impact on the type of analysis that will be possible to apply. If 200 respondents are achieved then Exploratory Factor Analysis (EFA) [7] and Principal Component Analysis (PCA) [8] will be also used to explore data and identify potential factors [9]. Individual items of the questionnaire may be correlated in some form. The inter-correlations among different sets of items of the questionnaire provide understanding and may allow to reduce survey data into components that account for the most variance. This analysis requires a sufficient sample size. It is expected that the number of responses in this survey permits to perform this multivariate factorial analysis.

Based on the collected data and the performed data analysis, an assessment report will be written. This assessment report will contain:

- a summary of methodology and procedure for collecting information and assessing the data;
- the list of assessed targets non-university sector at tertiary education level and their websites;
- a summary of the survey results; the assessment results;
- recommendations focused on the areas that the industry 4.0 competence development training program should put more emphasis to build the trainees' competence;
- annexes for survey form, and raw data.

5 WP 1 deliverables

From WP1 is expected a set of three deliverables/results/outcomes: O1.1 A capacity assessment execution plan, O1.2 A capacity assessment form, and, O1.3 An assessment report on non-university capacity.

The capacity assessment execution plan (O1.1) will define how the capacity assessment will be conducted and includes: (i) a list of WP1 members and their responsibilities, (ii) a list of target non-university sector at tertiary education level and their websites, (iii) a methodology and procedure for collecting information, (iv)

a methodology for assessing the data, (v) a methodology to verify and validate the results, (vi) a survey form, and, (vii) a work plan. The execution plan (O1.1) will be published on the project website after PEC approval.

The capacity assessment form (O1.2) will be used by WP1 members to assess the competence of targeted teaching staff. This instrument will be designed to ensure a consistent assessment, regardless of the WP1 member who applies it, by establishing a set of criteria, procedures and rules for the assessment process.

The assessment report on non-university capacity (O1.3) will consist of: (i) the summary of methodology and procedure for collecting information and assessing the data, (ii) the final list of assessed target non-university sector at tertiary education level and their websites, (iii) the summary of the survey results, (iv) the assessment results, (v) the recommendations and annexes for survey form, and (vi) the raw data. The recommendations will focus on the areas that the training program on industry 4.0 competence development should put more emphasis to build the trainees' competence. The assessment report (O1.3) will be published on the project website after PEC approval.

6 Concluding Remarks

The assessment of the capacity of the non-university sector at tertiary level in Thailand in the aspects of Industrial 4.0, teaching skills, and competency-based curriculum development, will be carried out by means of a questionnaire whose answers will provide the main output of WP1, namely, a set of recommendations on the specific training needs. Therefore, the WP1 consists of the following tasks: developing a capacity assessment execution plan, designing capacity assessment, conducting non-university capacity assessment and finally, summarize, interpret results and recommendations.

The designing capacity assessment will be performed through the following steps: development of critical knowledge about Industry 4.0, teaching skills and curriculum development, development of items, improvement of the questionnaire through the think-aloud procedure, and final validation with the test and retest procedure.

The survey will be administered in several ways, electronically on the Internet or with face-to-face interviews, and confidentiality of data will be guaranteed. The analysis of the results will be carried out using statistical tools such as Exploratory Factor Analysis (EFA) and Principal Component Analysis (PCA) to explore data and identify potential factors.

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