

IDENTIFICATION OF SIMILAR CURRICULA IN ASIA

FOR MSC FOOD PROCESSING AND
INNOVATION



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D1.1 Identification of Similar Curricula in Asia

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Table of Contents

	Page
Introduction	1
Methodology	1
2.1 Mapping of Programmes in Higher Education Institutes	1
2.2 Inventory of Programmes and Courses	1
2.3 Focal Group Discussion	2
2.4 Compilation of Data	2
Results	2
3.1 Profiles of Higher Education Institutes	2
3.1.1 Higher Education Institutes in Malaysia	2
3.1.2 Higher Education Institutes in Cambodia	3
3.1.3 Higher Education Institutes in Thailand	3
3.2 Existing Master Programmes in Food through Coursework	5
3.2.1 Four clusters: Entrepreneurship, Science and technology, Innovation, Engineering and Others	6
3.2.2 Courses in Sub-clusters of Entrepreneurship	7
3.2.2.1 Food Packaging Sub-cluster	9
3.2.2.2 Agribusiness and Management Sub-cluster	9
3.2.2.3 Food Marketing Sub-cluster	12
3.2.2.4 Food Management sub-cluster	13
3.2.2.5 Consumer Behaviour Sub-cluster	15
3.2.2.6 Intellectual Property Management Sub-cluster	16
3.2.3 Courses in the Sub-clusters of Science and Technology	16
3.2.3.1 Food Science and Technology Sub-cluster	21
3.2.3.2 Food Packaging Sub-cluster	23
3.2.3.3 Physico-Chemical Food Sub-cluster	24
3.2.3.4 Sensory Food Product Development Sub-cluster	24
3.2.3.5 Food Chemistry Sub-cluster	26
3.2.3.6 Industrial Food Production Sub-cluster	29
3.2.3.7 Food Analysis Sub-cluster	30
3.2.3.8 Food Development Sub-cluster	31
3.2.3.9 Postharvest Technology Sub-cluster	35
3.2.3.10 Functional Food Sub-cluster	35
3.2.3.11 Waste Management Sub-cluster	39
3.2.3.12 Food Nutrition Sub-cluster	40
3.2.3.13 Food Processing Sub-cluster	43
3.2.3.14 Food Microbiology Sub-cluster	45
3.2.3.15 Food Additives Sub-cluster	47

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3.2.3.16	Food Ingredients Sub-cluster	47
3.2.3.17	Food Safety and Quality Sub-cluster	48
3.2.3.18	Design Sub-cluster	51
3.2.3.19	Food Biotechnology Sub-cluster	52
3.2.3.20	Food Shelf Life Sub-cluster	53
3.2.3.21	Food Management Sub-cluster	54
3.2.4	Courses in Sub-clusters of Innovation	55
3.2.4.1	Food Science and Technology Sub-cluster	56
3.2.4.2	Food Packaging Sub-cluster	57
3.2.4.3	Physico Chemical Food Sub-cluster	58
3.2.4.4	Food Development Sub-cluster	58
3.2.4.5	Functional Food Sub-cluster	60
3.2.4.6	Agribusiness and Management Sub-cluster	60
3.2.4.7	Food Nutrition Sub-cluster	61
3.2.4.8	Food Ingredient Sub-cluster	61
3.2.4.9	Design Sub-cluster	61
3.2.4.10	Food Management sub-cluster	62
3.2.4.11	Consumer Behaviour Sub-cluster	63
3.2.4.12	Industrial Visit Sub-cluster	64
3.2.4.13	Intellectual Property Sub-cluster	64
3.2.5	Engineering Cluster	64
3.2.5.1	Physico Chemical Food Sub-cluster	65
3.2.5.2	Sensory Food Product Development Sub-cluster	66
3.2.5.3	Food Development Sub-cluster	66
3.2.5.4	Postharvest Technology Sub-cluster	67
3.2.5.5	Food Processing Sub-cluster	67
3.2.5.6	Computer Aid and Automation Sub-cluster	69
3.2.5.7	Design Sub-cluster	69
3.2.5.8	Food Engineering Sub-cluster	70
3.2.6	Others Cluster	73
3.2.6.1	Industrial Food Production Sub-cluster	75
3.2.6.2	Research Methodology Sub-cluster	75
3.2.6.3	Food Biotechnology Sub-cluster	78
3.2.6.4	Communication Skills Sub-cluster	78
4.	The Focus Group Discussion	79
4.1	The Focus Group Discussion from Malaysia	79
4.1.1	How important are the following modules in FOODI Program?	79
4.1.2	How important are the following courses in Entrepreneurship Module?	79
4.1.3	How important are the following courses in Food Innovation Module?	80
4.1.4	How important are the following courses in Food Innovation Module?	81

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4.1.5	How important are the following courses in Engineering Module?	82
4.1.6	The following are others courses other than the main modules. How important are the courses?	82
4.1.7	The following is the Technical Skill modules. How important are the courses?	82
4.1.8	Perception of Technical and Business Modules forming the major part of postgraduate programs for the Food Industry	83
4.1.9	Do you think the following are required as partial fulfilment for the program?	83
4.1.10	Which approach would you see as most desirable in the postgraduate programs for the Food Industry?	84
4.1.11	When is the most suitable time to conduct the postgraduate programme for the Food Industry?	85
4.1.12	What do you see as the competitive advantage/unique selling point of your own programme?	85
4.1.13	Who is the target group for your own MSc programme?	86
4.1.14	Which of the following mode of deliveries are suitable for the Food Industry postgraduate programs?	87
4.1.15	Industrial Stakeholders	87
4.1.16	Open-ended Focused Questions responses	88
4.1.17	Exit Questions	89
4.2	Focus Group Discussion from Cambodia	92
4.3	Focus Group Discussion from Thailand	100
4.3.1	As education providers, we would like to ask you to identify any gaps/deficits in your programme in the current skills provision for the food processing industry	101
4.3.2	As industry stakeholders, we would like to ask you to identify any gaps/deficits in the current skills provision in the current MSc/Professional training course offerings for the food processing industry	102
4.3.3	For the Industry	102
4.3.4	How important are the following modules in FOODI program?	103
4.3.5	How important are the following courses in Entrepreneurship Module?	104
4.3.6	How important are the following courses in Food Innovation Module?	104
4.3.7	How important are the following courses in Science and Technology Module?	105
4.3.8	How important are the following courses in Engineering Module?	106
4.3.9	The following are others courses other than the main modules. How important are the courses?	106
4.3.10	The following is the Technical Skill modules. How	107

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	important are the courses?	
4.3.11	Do you think Technical Modules should form the major part of postgraduate programs for the Food Industry?	107
4.3.12	Do you think that a business perspective is needed in postgraduate programs for the Food Industry?	108
4.3.13	Do you think Training/Internship / Industrial attachment; Graduate Project/Thesis and Publication are required as partial fulfilment for the programme?	108
4.3.14	Which approach would you see as most desirable in the postgraduate programs for the Food Industry?	108
4.3.15	Responses from Academics	108
4.3.16	Responses from Academics and Students	110
4.3.17	Responses from the Industrial Stakeholders, Academics And Students	110
4.3.18	Perception of Industrial Stakeholders on FOODI Graduates	111
5.	Conclusion	113

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List of Table	Page
Table	
3.1. Profiles of Higher Education Institutes in Asia	4
3.2. Programmes offered across Asia	5
3.3. Programmes offering the courses in the sub-clusters of Entrepreneurship	8
3.4. Courses in the Agribusiness and Management sub-cluster of the Entrepreneurship cluster offered across Asia	9
3.5. Courses in the Food Marketing sub-cluster of the Entrepreneurship cluster offered across Asia	12
3.6. Courses in Food Management sub-cluster of the Entrepreneurship cluster offered across Asia	13
3.7. Courses in Consumer Behaviour sub-cluster of the Entrepreneurship cluster offered across Asia	15
3.8. Programmes offering the courses in the sub-clusters of Science and Technology	16
3.9. Courses in the Food Science and Technology sub-cluster of the Science and Technology cluster offered across Asia	21
3.10. Courses in the Food Packaging sub-cluster of the Science and Technology cluster offered across Asia	23
3.11. Courses in the Physico-Chemical Food sub-cluster of the Science and Technology cluster offered across Asia	24
3.12. Courses in the Sensory Food Product Development sub-cluster of the Science and Technology cluster offered across Asia	25
3.13. Courses in the Food Chemistry sub-cluster of the Science and Technology cluster offered across Asia	26
3.14. Courses in the Industrial Food Production sub-cluster of the Science and Technology cluster offered across Asia	29
3.15. Courses in the Food Analysis sub-cluster of the Science and Technology cluster offered across Asia	30
3.16. Courses in the Food Development sub-cluster of the Science and Technology cluster offered across Asia	31
3.17. Courses in the Food Development sub-cluster of the Science and Technology cluster offered across Asia	35
3.18. Courses in the Functional Food sub-cluster of the Science and Technology cluster offered across Asia	36
3.19. Courses in the Waste Management sub-cluster of the Science and Technology cluster offered across Asia	39
3.20. Courses in the Food Nutrition sub-cluster of the Science and Technology cluster offered across Asia	40

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3.21	Courses in the Food Processing sub-cluster of the Science and Technology cluster offered across Asia	43
3.22	Courses in the Food Microbiology sub-cluster of the Science and Technology cluster offered across Asia	45
3.23	Courses in the Food Additives sub-cluster of the Science and Technology cluster offered across Asia	47
3.24	Courses in the Food Ingredients sub-cluster of the Science and Technology cluster offered across Asia	48
3.25	Courses in the Food Safety and Quality sub-cluster of the Science and Technology cluster offered across Asia	48
3.26	Courses in the Food Biotechnology sub-cluster of the Science and Technology cluster offered across Asia	52
3.27	Courses in the Food Shelf Life sub-cluster of the Science and Technology cluster offered across Asia	53
3.28	Courses in the Food Management sub-cluster of the Science and Technology cluster offered across Asia	54
3.29	Programmes offering the courses in the sub-clusters of Innovation	55
3.30	Courses in the Food Science and Technology sub-cluster of the Innovation cluster offered across Asia	57
3.31	Courses in the Food Packaging sub-cluster of the Innovation cluster offered across Asia	57
3.32	Courses in the Food Development sub-cluster of the Innovation cluster offered across Asia	58
3.33	Courses in the Functional Food sub-cluster of the Innovation cluster offered across Asia	60
3.34	Courses in the Agribusiness and Management sub-cluster of the Innovation cluster offered across Asia	60
3.35	Courses in the Food Nutrition sub-cluster of the Innovation cluster offered across Asia	61
3.36	Courses in the Design sub-cluster of the Innovation cluster offered across Asia	62
3.37	Courses in the Food Management sub-cluster of the Innovation cluster offered across Asia	62
3.38	Courses in the Consumer Behaviour sub-cluster of the Innovation cluster offered across Asia	64
3.39	Programmes offering the courses in the sub-clusters of Engineering Cluster	64
3.40	Courses in the Physico Chemical Food sub-cluster of the Engineering cluster offered across Asia	66
3.41	Courses in the Food Development sub-cluster of the Engineering cluster offered across Asia	66
3.42	Courses in the Food Processing sub-cluster of the Engineering cluster offered across Asia	67

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3.43	Courses in the Computer Aid and Automation sub-cluster of the Engineering cluster offered across Asia	69
3.44	Courses in the Design sub-cluster of the Engineering cluster offered across Asia	70
3.45	Courses in the Food Engineering sub-cluster of the Engineering cluster offered across Asia	71
3.46	Programmes offering the courses in the sub-clusters of Others Cluster	73
3.47	Courses in the Industrial Food Production sub-cluster of the Other cluster offered across Asia	75
3.48	Courses in the Research Methodology sub-cluster of the Other cluster offered across Asia	76
4.1.1	Important modules in FOODI programme	79
4.1.2	Important courses in Entrepreneurship Module	80
4.1.3	Important courses in Food Innovation Module	80
4.1.4	Important courses in Science and Technology Module	81
4.1.5	Important courses in Engineering Module	82
4.1.6	Other important courses in FOODI programme	82
4.1.7	Importance of Technical Modules	83
4.1.8	Perception of Technical and Business Modules	83
4.1.9	Requirement of Training, Internship or Industrial Attachment and Thesis Requirement	83
4.1.10	Most Suitable Time to Conduct the Postgraduate Programme	84
4.1.11	Competitive Advantage/Unique Selling Point of the Programme from three Perspectives: Educational, Academics and Operational	85
4.1.12	Role of FOODI graduates in Stakeholders' Company	87
4.1.13	Competences of Master Graduates	88
4.1.14	List of Stakeholders	88
4.1.15	Summarized Responses from Stakeholders	91
4.3.1	Profiles of Participants	100
4.3.2	Identifications of gaps and deficits in programmes available in the current skills provision for the food processing industry as industry stakeholders	102
4.3.3	Mean Score of the Importance of the Modules	104
4.3.4	Mean Score of the Importance of the Entrepreneurship Modules	104
4.3.5	Importance of Food Innovation Modules	105
4.3.6	Important courses in Science and Technology Module	105
4.3.7	Importance of Engineering Module	106
4.3.8	Importance of Other Courses other than the Main Modules	106
4.3.9	Importance of Technical Skill Modules	107
4.3.10	Technical Module as major part of postgraduate programs for the Food Industry	107

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4.3.11	Business Perspective needed Postgraduate Programs for the Food Industry	108
4.3.12	Most Desirable Postgraduate Programme Approach for the Food Industry	108
4.3.13	Competitive Advantage/Unique Selling Point	109
4.3.14	Target Groups	110
4.3.15	Mode of Delivery	110
4.3.16	Timing of Delivery	111
4.3.17	Role of FOODI Graduates	111
4.3.18	Competences of FOODI Graduates	112

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List of Figure

Figure		
3.1	Percent of courses in 4 clusters: Entrepreneurship, Science and Technology, Innovation, Engineering and Others	7
4.1.1	Approach of Postgraduate Programs in Food Industry	84
4.1.2	Target Groups	86
4.1.3	Suitability of Mode of Deliveries	87

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1. Introduction

In the Work Package 1.1 of the project related to developing the MSc course in Food Processing and Innovation/FOODI, Universiti Teknologi MARA (UiTM) from Malaysia was responsible in identifying similar curricula in the subject area in Asia. The aim of this work package was to survey and identify the existing Higher Education Institute (HEI) programmes in Asia in the cross-field between food, health and innovation, as well as similar lifelong-learning/Professional training training programmes.

Objective: Identification of similar curricula in Asia

Asian HEIs have to identify similar programmes from their countries and the wider region in order to identify the gaps and better assess the exact academic needs that have to be catered for by FOODI.

This report on similar curricula in Asia was compiled with the input of HEIs counterparts from Malaysia, Cambodia and Thailand.

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2. Methodology

To identify the similar curricula in master programme in food processing, two instruments were developed by UiTM.

2.1 Mapping of Programmes in Higher Education Institutes

The first instrument aimed to gather information of all higher institutions in Asia countries (Malaysia, Thailand and Cambodia) and to filter out the institutions which did not offer Master courses related to food processing. The instrument comprised of five items with two open-ended items and three structured items.

2.2 Inventory of Programmes and Courses

The second instrument was to gather the detail information on the Master courses related to food processing offered by institutions in Asian countries. The instrument comprised of two parts. The first part aimed to collect the general information of

the Master courses related to food processing offered by HEIs in Asian countries. This part consisted of ten items with four structured items and another six open-ended items. The second part of the instrument collect the detail of courses in each of the master programmes. The survey forms were distributed to each Asia partner during March 2019 and all data were collected and sent back to UiTM in May 2019.

2.3 Focal Group Discussion

One instrument was developed with the European partners using questionnaire and interview questions provided with ground rules lists for facilitators. Each respective Asian national coordinator was responsible for data collection. UiTM merged all the data.

2.4 Compilation of Data

The quantitative data was analysed using descriptive statistics and the qualitative data were coded based on the similarity of the courses offered.

3. Results

3.1 Profiles of Higher Education Institutes

Table 3.1 shows the profiles of HEIs in Malaysia, Cambodia and Thailand, the FOODI members of the project. Overall number of HEIs is 842 with 72.1 percent makes up the private HEIs. 36 percent offer Master programmes and only 4.2 percent offer coursework in food related programmes.

3.1.1 Higher Education Institutes in Malaysia

Malaysia has the highest number totalling to 466 HEIs which are registered with the Ministry of Education. This makes up 55 percent of the total recorded from the 3 countries. 95.7 of the HEIs are operated by private sector. Only 18 percent of the total HEIs either public or private offer Master Programmes. However, the public HEIs offer more Master Programmes than the private sector. The number of HEIs

offering Master Programmes either by research or coursework is 20 which is only 4.3 percent. There are 5 public HEIs and one private HEI that offer Master food programmes in coursework.

3.1.2 Higher Education Institutes in Cambodia

Cambodia registers a total number of 130 HEIs. 56.2 percent are from private sectors. 32.3 percent offers master Programme of which only 3 from the public sector are related with food. Only one offers coursework.

3.1.3 Higher Education Institutes in Thailand

Thailand has 297 HEIs. In contrast to Malaysia and Cambodia, the public HEIs make up of 67.7 percent which is more than private HEIs. 61.6 percent of the total HEIs either public or private offer Master Programmes. However, the public HEIs offer more Master Programmes than the private sector. Only the public HEIs offer Master Programmes either by research or coursework totalling to 16 which is only 5.4 percent. There are 15 public HEIs offer coursework Master food programmes.

Table 3.1 Profiles of Higher Education Institutes in Asia

Country	Total No of Universities	Public University		Private University		No of Master Programmes			No of Master Programmes related to food processing		
		Frequency	Percent	Frequency	Percent	Frequency		Percent	Frequency		Percent
						Public Uni	Private Uni		Public Uni	Private Uni	
Malaysia	466	20	4.3	446	95.7	64	20	18.0	13	7	4.3
Cambodia	130	57	43.8	73	56.2	35	7	32.3	3	0	2.3
Thailand	297	201	67.7	96	32.3	104	79	61.6	16	0	5.4
Total	893	278	31.1	615	68.9	203	106	34.6	32	7	4.4
						309			39		

3.2 Existing Master Programmes in Food through Coursework

Table 3.2: Programmes offered across Asia

No	Name of Programme	Total No	University
1.	MSci (Food Science and Technology)	6	Universiti Teknologi MARA
			Burapha University
			Chiang Mai University
			Mae Fah Luang University
			Naresuan University
			Prince of Songkla University
2.	MSci (Food Safety and Quality)	1	Universiti Malaysia Sabah
3.	MSci (Food Safety and Quality Assurance)	1	Universiti Putra Malaysia
4.	MSci (Food Technology)	6	Universiti Putra Malaysia
			Chulalongkorn University
			Khon Kaen University
			Maharakham University
			Silpakorn University
			Ubon Ratchathani University
5.	MSci (Agro-Industrial Product Development)	2	Chiang Mai University
			Kasetsart University
6.	MSci (Food Security and Climate Change (Policy Maker - Agro-Industrial Technology Management)	1	Universiti Putra Malaysia/ Kasetsart University
7.	MSci (Food Security and Climate Change (Researcher - Food Science)	1	Universiti Putra Malaysia/ Kasetsart University
8.	MSci (Food Security and Climate Change (Researcher - Biotechnology)	1	Universiti Putra Malaysia/ Kasetsart University
9.	MSci (Nutrition)	2	Universiti Kebangsaan Malaysia
			Universiti Sains Malaysia
10.	MSci (Food Biotechnology)	1	Universiti Putra Malaysia
11.	MSci (Food Management)	1	Universiti Putra Malaysia
12.	MSci (Food Service Management)	1	Universiti Putra Malaysia
13.	MSci (Technopreneurship and Innovation Management)	1	Chulalongkorn University
14.	MSci (Food Engineering)	1	Kasetsart University
15.	MSci (Food Technology) International Program	1	Suranaree University of Technology

16	MSci (Food Science)	3	Universiti Kebangsaan Malaysia
			Kasetsart University
			King Mongkut's Institute of Technology Ladkrabang
17	MSci (Food Science and Technology) International	1	Chulalongkorn University
18	MSc. (Food Engineering)	3	Chulalongkorn University
			Maejo University
			Thammasat University
19	Master Program in Agro-Industry and Environment	1	Institute of Technology of Cambodia
20	Master of Philosophy (Food Studies)	1	Taylor's University
	Total	36	

There are altogether 36 Master programmes in food through coursework being offered across Asia as shown in Table 3.2. Two programmes are offered at 6 universities: Masters in Science (Food Science and Technology) and Masters in Science (Technology) both in Malaysian universities and Thailand Universities. One programme, Masters in Science (Food Science) is offered in 1 university in Malaysia and 2 universities in Thailand. Another programme, Masters in Science (Food Engineering) is offered in 3 universities in Thailand. The Masters in Science (Agro-Industrial Product Development) is offered in 2 universities in Thailand while Masters in Science (Nutrition) is offered in 2 universities in Malaysia. The rest of the programmes are offered in single universities. Three programmes are offered in collaboration between one university from Malaysia and one university from Thailand.

The MSc. Coursework programme requires completion of 34 credits of core courses and 6 credits of elective courses with presentation and submission of dissertation in all countries from Malaysia. The programme from Institute of Technology of Cambodia requires 52 total credits. Chulalongkorn University, Thailand offered two programmes with 39 credits and another two with 42 total credits. Suranaree University of Technology also from Thailand require 48 total credits. Method of teaching includes lectures, laboratory practical, assignment, case study and mini project.

3.2.1 Four clusters: Entrepreneurship, Science and technology, Innovation, Engineering and Others

There are a total of 790 courses being offered. These courses are categorized into 4 clusters: Entrepreneurship, Science and Technology, Innovation, Engineering and Others.

Entrepreneurship	-	78
Science and Technology	-	529
Innovation	-	75
Engineering	-	48
Others	-	60

Sixty-seven percent of the courses fall under Science and Technology while the rest of the clusters are at 10 percent and below (Figure 1). Two programmes are entirely on entrepreneurship: MSci (Technopreneurship and Innovation Management) and MSci (Food Service Management). They do not offer courses on Science and Technology Cluster.

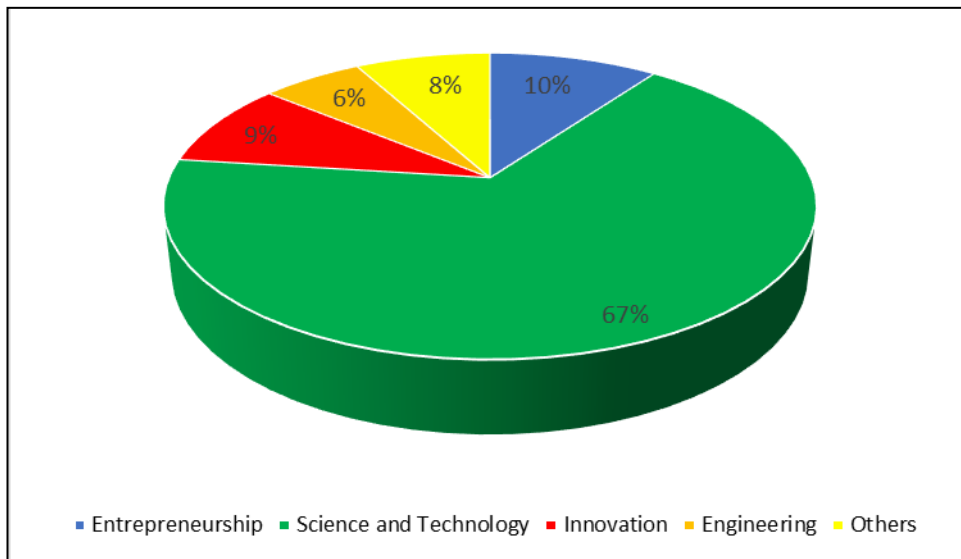


Figure 1: Percent of courses in 4 clusters: Entrepreneurship, Science and Technology, Innovation, Engineering and Others

3.2.2 Courses in Sub-clusters of Entrepreneurship

There are 78 courses under the Entrepreneurship Cluster mainly equivalent to 3 credits hours. Each of this course can be a core or elective. Table 3.3 shows 14 programmes offering the courses in the sub-clusters of Entrepreneurship.

Table 3.3: Programmes offering the courses in the sub-clusters of Entrepreneurship

No	Sub cluster	No of Courses
1.	MSci (Food Science and Technology)	
	Agribusiness and Management	5
	Food Marketing	5
	Food Management	1
	Consumer Behaviour	1
	Total	12
2.	MSci (Food Safety and Quality)	
	Agribusiness and Management	1
	Food Management	1
	Consumer Behaviour	1
	Total	3
3.	MSci (Food Safety and Quality Assurance)	
	Agribusiness and Management	1
4.	MSci (Food Technology)Food Science and Technology	
	Agribusiness and Management	3
	Food Marketing	6
	Food Management	4
	Total	13
5.	MSci (Agro-Industrial Product Development)	
	Food Packaging	1
	Agribusiness and Management	1
	Food Marketing	1
	Total	3
6.	MSci (Food Security and Climate Change (Policy Maker - Agro-Industrial Technology Management)	
	Agribusiness and Management	1
	Food Marketing	1
	Total	2
7.	MSci (Food Biotechnology)	
	Agribusiness and Management	1
8.	MSci (Food Management)	
	Consumer Behaviour	1

No	Sub cluster	No of Courses
9.	MSci (Food Service Management)	
	Food Management	6
10.	MSci (Technopreneurship and Innovation Management)	
	Agribusiness and Management	12
	Food Marketing	5
	Food Management	8
	Intellectual Property	2
	Total	27
11.	MSci (Food Science)	
	Food Management	3
12.	MSc. (Food Engineering)	
	Agribusiness and Management	1
13.	Master Programme in Agro-Industry and Environment	
	Agribusiness and Management	1
14.	Master of Philosophy (Food Studies)	
	Agribusiness and Management	1
	Food Marketing	1
	Food Management	1
		3

The courses are further categorized into 6 sub-clusters based on the syllabus of each of the courses and common elements in the contents.

3.2.2.1 Food Packaging Sub-cluster

There is one course under the Food Packaging sub-cluster - Advance Packaging Printing Technology. The syllabus consists of topics relating to design for printing of packaging, advance of printing systems, type of printing systems, prepress process and mold producing, type and regulation of packaging materials and the selection of printing systems for package, problems of printing systems and solutions, research of packaging printing, design with computer program 1, design with computer program 2, develop mockup for presentation, and present the packaging design with the internet network.

3.2.2.2 Agribusiness and Management Sub-cluster

The Agribusiness and Management sub-cluster has the most courses totalling to 23 related courses being offered in 29 programmes as shown in Table 3.4.

Table 3.4: Courses in the Agribusiness and Management sub-cluster of the Entrepreneurship cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Agribusiness and Food Industry Management	1
2.	Agro-Industry Management	1
3.	Biotechnology Entrepreneurship	1
4.	Business Research	2
5.	Digital Innovation Start-ups	1
6.	Electronic Commerce and Digital Enterprises	2
7.	Entrepreneurship and New Venture Creation	2
8.	Financial Analysis for Agro-Industry	1
9.	Food Innovation Towards Entrepreneurship Start-up	1
10.	Food Supply Chain Management	1
11.	Foundation of Financial Management	2
12.	Halal and Food Law	1
13.	Halal Food Production	1
14.	Halal Science Philosophy	1
15.	International Business Management	2
16.	International Food Legislation and Quality Assurance	1
17.	Law and Regulations in Food System	1
18.	Learning Organization and Knowledge Management	2
19.	Management industry and Food economic	1
20.	Measurement, Assessment and Analysis of Organization Performance	1
21.	Philosophy of Halal Science	1
22.	Supply Chain and Logistics Management for Agro-Industry	1
23.	Supply Chain Management and Logistics	1
24.	World Food Culture	1
		29

These courses collectively covers topics on characteristics of entrepreneurs; necessary skills for entrepreneurs; developing and evaluating entrepreneurial opportunities; roles and responsibilities of venture capitalists in creating new ventures; developing plan for new

ventures; processes of new venture creation; other important issues in entrepreneurial management; ethics of entrepreneurship. They also include management principles in food industry for planning, organizing, staffing, leading, productivity, motivation, communication and safety management, trends affecting management practices, e-business applications, business innovation and flexibility, quality management by kaisen and six-sigma. Similarly, in the field of biotechnology, agribusiness related courses are also available that cover significance and characteristics of biotechnology entrepreneurship; the biotechnology industry; basic business principles for biotechnologists; trends in biotechnology business at national and international levels. In addition, topics also emphasize on important process in biotechnology entrepreneurship and business initiation; business strategy and plan; biotechnology market development; case studies in biotechnology business; practice on developing biotechnology business plan and presentation, examples of biotechnology companies. Another course relates to the needs of technology and technological changes, technological innovation and technology opportunities. This entails commercial viability of technology, appropriate technology commercialization plans, product development and contracts relating to technology transfer.

The holistic agribusiness aspect is the supply chain concepts of agricultural materials and products. These topics cover the definition and classification of supply chains and networks, supply chain network design and planning, logistics management; the relationship between logistics and supply chain management scope, supply chain and logistics strategies in agro-industry. Some of the courses have specified in depth on topics like supply chain analysis, supply chain drivers and matrices, information technology and coordination in supply chain, demand and supply planning, modern production management and regulation and management for quality. Case study in supply chain management in agro-industry is included as the practical component.

From the organizational and financial management, the courses dwell into analysis of components in international business operations; constraints of cultures, education, politics, economics, and society in managing international business. The concepts of international business management are defined in terms of organizational strategy, marketing, finance, and management, ethics in international business. Leadership roles in change management process

in organizations; development of strategies of change management and innovation in organizations are also included. The objectives of financial management; concepts and applications of risk and return; analysis and forecast of financial statements; time value of money; working capital management; sources of funds; capital structure; capital budgeting under certainty and ethics in finance are the topics also included.

Information Technology (IT) and its roles in transforming organizations, markets, industries and the global economy is the growing trend in agribusiness towards the era of Industrial Revolution 4 (IR4). Thus these courses encompasses topics on electronic commerce, electronic business, digital economy, information and knowledge management and digital enterprise management. The fundamental enabling technologies including WorldWide Web, browsers, search engines, portals and internet service providers, HTML and web development tools, website metering tools are included. The introduction of design principles for electronic commerce provide the skill to develop business models in hypermarkets and auctions including topics like intelligent agents, trust, privacy and security, In addition, study on the social and ethical impacts of e-commerce are delivered. Market survey and competitive analysis using IT includes topics like lean digital startups; business model innovation; minimum viable digital product; digital product analytics; fund raising for digital startups; digital startups law and exit strategy for digital startups.

The Malaysian programmes offered courses related to Halal principles. The three courses provide a detailed examination of the major legislation, policies and initiatives in halal food and halal supply food chain. Additionally, these courses also provide a general overview of the laws, regulations, history and policies that govern food regulation in Malaysia and other countries.

3.2.2.3 Food Marketing Sub-cluster

The Food Marketing sub-cluster consists of 14 courses with 19 related courses being offered in 29 programmes as shown in Table 3.5.

Table 3.5: Courses in Food Marketing sub-cluster of the Entrepreneurship cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Agro-Industry Marketing	1
2.	Food Marketing	2
3.	Food Product Development and Marketing	1
4.	Food Product Marketing	1
5.	Foreign Market Entry Strategy	2
6.	Management and Marketing for New Products	1
7.	Marketing for Food Industry	1
8.	Marketing in Food Business	1
9.	Marketing Management	2
10	Marketing Research and Food Product Launching	1
11	Marketing Research in Food Industry	2
12	Product Management and Marketing Mix Strategies	1
13	Research & Development & Export Market Strategies for Food Products	1
14.	Technology Commercialization	2
		19

The Food Marketing sub-clusters generally covers topics on the perspective and importance of marketing in agro-industry, information systems and environmental marketing, market share, select target markets and market positioning. Fundamental topics like roles and functions of marketing in business; internal and external environment affecting marketing management; strategic market planning. The follow-ups topics include marketing research and evaluation, competition analysis consumers and consumer behavior, product strategy, designed pricing strategy, marketing channels and distribution, marketing promotion, export, development of agro-industry products, marketing control and ethics in marketing management. Specific and specialist topic is also available like health food product trend. Monitoring based topics covers analysis of foreign market entry modes; successful market entry mode plans; functional plans in marketing, production, logistics, and human resources management.

3.2.2.4 Food Management Sub-cluster

The Food Management sub-cluster consists of 20 related courses being offered in 24 programmes as shown in Table 3.6.

Table 3.6: Courses in Food Management sub-cluster of the Entrepreneurship cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Culinary And Gastronomic, Cultural Heritage	1
2.	Economic Analysis & Managerial Decision Making	1
3.	Food Culture	1
4.	Food Industry Management	2
5.	Food Laws and Certification System	1
6.	Food Legislation and International Trade	1
7.	Food Services	1
8.	Food Tourism	1
9.	Leadership and Change Management	2
10.	Learning Organization and Knowledge Management	1
11.	Management for Food Technology	1
12.	Menu Planning	1
13.	Productivity Management	1
14.	Purchasing Management and Warehouse Technology	1
15.	Restaurant Design and Layout	1
16.	Restaurant Management	1
17.	Standard and Law for Food Business	1
18.	Strategic Management	2
19.	Strategic Planning & Evaluation for Integrated Technopreneurship Research	2
20.	Strategic Planning in Agro-Industry	1
		24

The Food Management sub-cluster covers generally topics that include area on systematic product development process, prototype product development and marketing management of new products. Some courses begin with perspective and importance of strategy, strategic models, information and steps in strategic planning, defined strategic plan, controlling strategies and formulating, implementing strategies in agro-industry. Others cover the basic concepts and processes in strategy development; characteristics of efficient strategy; analysis of business environment, industry, and competitors. These lead to topics including generic forms of strategy used to enhance competitive advantage; application of basic concepts in strategic management; development and enhancement of specialization of business, mechanisms for integration of

functional strategies; techniques for promoting effective implementation of strategies; ethics in strategy implementation in organization; strategic control systems.

From the financial perspective, courses include financial management, account management and production management in agro-industry, marketing management for agro-industrial products, information system for agro-industry management. The practical component introduces topic covering project feasibility study, business plan writing and writing techniques for master plans. These include topics on system analysis, cost efficiency and cost effective analysis, feasibility study, SWOT analysis, policy analysis, business scanning, approaches and evaluation at various communication levels. The fundamental of agricultural materials purchasing, purchasing of fishery and seafoods, meat, rice and cereals, vegetables, fruits, fat and oil, spices and additives is also covered. Some courses cover cost concepts for decision making; engineering economic analysis and applications of optimization techniques in replacement analysis. Specific topics are capital budgeting, cost and profit relationship analysis, eEffects of inflation, exchange rate and taxation.

A different approach of the sub-cluster in the courses on food management covers topics on application of product systematic thinking. These include recent technological development analysis, recent market change analysis and recent financial system change analysis. The courses then follow up with topics on strategic planning for product development, executive principle for product development, application of advanced product development designs, evaluation of the success in product development by application of balanced scorecard and prototype product management.

The Food Management sub-cluster also looks into organization management involving leadership and strategic management and human resource management. These include characteristics and elements of learning organizations; concepts and approaches in developing an organization towards a learning organization; characteristics of knowledge in organizations, concepts, approaches, and roles of knowledge management within organizations, technologies for knowledge management. case studies related to learning organizations and knowledge management. The practical component requires case studies of food industry managerial

problem covering also industrial relations and psychology, analysis of risk, uncertainty and multiple criteria for managerial decision making.

A practical component involves case studies of product development and field trip.

3.2.2.5 Consumer Behaviour Sub-cluster

The Consumer Behaviour sub-cluster consists of 3 related courses being offered in 3 programmes as shown in Table 3.7.

Table 3.7: Courses in Consumer Behaviour sub-cluster of the Entrepreneurship cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Consumer Perception and Preference	1
2.	Consumer Study and Consumer Response Evaluation	1
3.	Food Marketing and Consumers Behaviour	1
		3

Consumer behaviour which covers concept and methodology in processing development and product life cycle is also embedded as subtopics in other sub-clusters particularly in Food Marketing and Food Management. However, these 3 courses also have introductory topics on market analysis, plan for product development; new product design, forecasting and production planning of new product, new product launch, logistics and supply chain management of new product. Then they focus in depth on principles of consumer science; consumer behavioral models; consumer perception, learning, memory, motivation, and attitude; consumer decision making process and group influence; effect of income, social class, subculture and culture on consumption. They also include consumer test procedures, ethics of consumer testing, qualitative consumer testing, quantitative consumer testing and customer relationship management. The practical component is a case study of new product success and failure with a consumer study design. This entails methods of data collection; application of qualitative, quantitative and mixed method for designing and planning of consumer data collection; use of consumer questionnaires.

3.2.2.6 Intellectual Property Sub-cluster

The Intellectual Property sub-cluster consists of only one course: Intellectual Property Management offered in 2 programmes intensively focus on intellectual property policies, intellectual property commercial exploitation and enforcement. The course is intended to explain the basic of Patents (Invention Patent, Petty patent, and Industrial Design Patent), trademarks, trade secrets, geographical indications, layout-design of integrated circuits and copyright. The major emphasis of this course is based on patent and petty patent, including what can be patented, the process of patent application and the remedies for patent infringement. This course also covers the protection of intellectual property and rights under national laws, and international treaties.

3.2.3 Courses in the Sub-clusters of Science and Technology

The Science and Technology sub-cluster forms the core of the 18 programmes as shown in Table 3.8. This is 90 percent of the total programmes offered across Asia. There are 22 sub-clusters identified under the Science and Technology cluster. There are overlapping topics among the sub-clusters, however, the courses are clustered based on the emphasis of the topics that falls into each sub-cluster. Each course consists 3 credits hours with almost all with practical components of an extra credit hour.

Table 3.8: Programmes offering the courses in the sub-clusters of Science and Technology

No	Sub cluster	No of Courses
1.	MSci (Food Science and Technology)	
	Food Science and Technology	17
	Food Packaging	3
	Physico Chemical Food	2
	Sensory Food Product Development	6
	Food Chemistry (Protein, Carbohydrates and Lipids)	31
	Industrial Food Production	2
	Food Analysis	7
	Food Development	13
	Postharvest Technology	2

No	Sub cluster	No of Courses
	Functional Food	11
	Waste Management	3
	Food Nutrition	10
	Food Processing	12
	Food Microbiology	12
	Food Additives	6
	Food Ingredients	2
	Food Safety and Quality	24
	Food Biotechnology	10
	Food Shelf Life	5
		178
2.	MSci (Food Safety and Quality)	
	Food Analysis	1
	Food Nutrition	1
	Food Processing	2
	Food Microbiology	1
	Food Safety and Quality	10
		15
3.	MSci (Food Safety and Quality Assurance)	
	Physico Chemical Food	1
	Food Chemistry (Protein, Carbohydrates and Lipids)	1
	Food Processing	1
	Food Microbiology	1
	Food Ingredients	1
	Food Safety and Quality	7
	Food Shelf Life	1
		13
4.	MSci (Food Technology)	
	Food Science and Technology	16
	Food Packaging	6
	Physico Chemical Food	5
	Sensory Food Product Development	6
	Food Chemistry (Protein, Carbohydrates and Lipids)	21
	Industrial Food Production	3
	Food Analysis	7
	Food Development	6
	Postharvest Technology	4
	Functional Food	11
	Waste Management	2
	Food Nutrition	4
	Food Processing	15

No	Sub cluster	No of Courses
	Food Microbiology	5
	Food Additives	3
	Food Safety and Quality	6
	Design	1
	Food Biotechnology	1
	Food Shelf Life	1
		123
5.	MSci (Agro-Industrial Product Development)	
	Physico Chemical Food	1
	Sensory Food Product Development	5
	Industrial Food Production	1
	Food Analysis	1
	Food Development	1
	Functional Food	1
	Food Shelf Life	2
		12
6.	MSci (Food Security and Climate Change (Policy Maker - Agro-Industrial Technology Management)	
	Food Science and Technology	1
	Food Management	5
		6
7.	MSci (Nutrition)	
	Food Chemistry (Protein, Carbohydrates and Lipids)	1
	Food Analysis	1
	Food Nutrition	20
	Food Additives	1
	Food Safety and Quality	2
		25
8.	MSci (Food Biotechnology)	
	Food Processing	3
	Food Safety and Quality	1
	Food Biotechnology	1
		5
9.	MSci (Food Management)	
	Food Management	1
		1
10.	MSci (Food Engineering)	
	Food Analysis	1
	Food Product Development	1
		2
11.	MSci (Food Technology) International Program	

No	Sub cluster	No of Courses
	Food Science and Technology	1
	Physico Chemical Food	1
	Sensory Food Product Development	2
	Food Chemistry (Protein, Carbohydrates and Lipids)	6
	Food Analysis	1
	Functional Food	5
	Food Nutrition	3
	Food Processing	2
	Food Microbiology	3
	Food Safety and Quality	1
	Food Biotechnology	1
	Food Shelf Life	1
		27
12.	MSci (Food Science)	
	Food Science and Technology	3
	Food Packaging	1
	Physico Chemical Food	1
	Food Chemistry (Protein, Carbohydrates and Lipids)	14
	Food Analysis	3
	Food Development	8
	Functional Food	8
	Food Nutrition	6
	Food Processing	3
	Food Microbiology	2
	Food Additives	3
	Food Safety and Quality	3
	Food Biotechnology	2
	Food Shelf Life	1
	58	
13.	MSci (Food Science and Technology) International	
	Food Packaging	1
	Physico Chemical Food	2
	Food Chemistry (Protein, Carbohydrates and Lipids)	1
	Food Analysis	1
	Functional Food	1
	Food Processing	3
	Food Microbiology	2
	Food Ingredients	1
	Food Shelf Life	1
	13	
14.	MSci. (Food Engineering)	

No	Sub cluster	No of Courses
	Food Science and Technology	1
	Food Development	1
	Food Processing	1
	Food Safety and Quality	1
	Food Shelf Life	1
		5
15.	Master Program in Agro-Industry and Environment	
	Food Analysis	1
	Postharvest Technology	1
	Waste Management	4
	Food Nutrition	1
	Food Processing	2
	Food Microbiology	2
	Food Additives	1
	Food Safety and Quality	2
	Food Biotechnology	2
	Food Shelf Life	1
		17
16.	Master of Philosophy (Food Studies)	
	Food Development	1
	Food Nutrition	1
		2
17.	MSci (Food Security and Climate Change (Researcher - Food Science))	
	Food Science and Technology	1
	Food Safety and Quality	2
	Food Management	2
		5
18.	MSci (Food Security and Climate Change (Researcher - Biotechnology))	
	Food Biotechnology	2
	Food Engineering	1
	Food Management	4
		7

3.2.3.1 Food Science and Technology Sub-cluster

The Food Science and Technology sub-cluster has a total 36 related courses as shown in Table 3.9. Some of the courses are offered to more than one programme totalling to 46.

Table 3.9: Courses in the Food Science and Technology sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advanced Cereal Science and Technology	1
2.	Advanced Drying Technology	1
3.	Advanced Food Science	3
4.	Advanced Food Science and Technology	1
5.	Advanced Food Technology	2
6.	Candy and Confectionary Technology	1
7.	Cereal Technology	1
8.	Concept of Food Science and Technology	1
9.	Creative Morphology	2
10.	Current Issues in Food Science	1
11.	Current Topics in Food Technology	1
12.	Dairy Technology	1
13.	Drying Technology	1
14.	Extraction Technology for Nutraceutical	1
15.	Extrusion Technology	1
16.	Feed Technology	1
17.	Fishery Product Technology	1
18.	Food Drying Technology	2
19.	Food Encapsulation Technology	1
20.	Fruit and Vegetable Technology	1
21.	Frying Technology	1
22.	Fundamental Knowledge in Food Technology	1
23.	Fundamental of Food Science and Technology	2
24.	Integration in Advanced Food Technology	1
25.	Optimization in Food Science and Technology	1
26.	Principles in Food Science and Technology	2
27.	Production Technology for Aerated Foods	1
28.	Research and Development in Food Science and Technology	1
29.	Selected Topics in Food Science	2
30.	Selected Topics in Food Science and Technology	1
31.	Selected Topics in Area of Food Science and Technology	2
32.	Science and Technology of Chocolate	1
33.	Special Problems	1
34.	Starch Technology	2
35.	Sugar Technology	1
36.	Sugar & Chocolate Confection Technology	1
		46

The Food Science and Technology sub-cluster has the most mixed and overlapping topics among the courses particularly in the introductory on concepts, fundamentals and principles. The food science components will evolved into technological aspects. Topics like introduction and fundamental of food chemistry related to food compositions, food chemical changes before and during processing and during storage in advanced postharvest technology and storage are covered. These lead to the technological aspects on principles of food processing (unit operation, pre-processing, thermal processing, chilling and freezing, drying, and other food processing), principles of food microbiology, microbial contamination, spoilage and prevention, usefulness of microorganisms in foods, principles of food engineering (mass and energy balance, psychochrometric chart, momentum transfer, and heat transfer).

Physical, chemical and biological properties of fruits and vegetables, meat and confectionaries that included aerated drinks, sugar and chocolates are among the topics in the related courses. These are followed with the application of advanced technique for their study, advanced postharvest technology and storage, advanced technique application for fruit and vegetable preparation and various product processing such as ozone, ohmic heating, high pressure, advanced fruit and vegetable quality analysis such as non-destructive analysis. The roles of food additives to a production process is also emphasized. Some examples of topics are food colloidal system, surfactant, surface and interface properties of food, methods assessing food surface and interface properties, food foams, foaming agent, proteins and their behavior at interfaces, aerated technology for food foams production, characterization of aerated food, case studies: aerated technology for production of ice cream, sorbet, mousse and whipped cream. The practical components are case study and field trips.

Specialised course like deep frying involved the study on frying fats and oils. This cover factors affecting the quality of frying fats and oils, fried food product qualities, heat and mass transfer in food during frying, oil absorption in fried food products, used oil management and storage and shelf-life of fried food products.

Introduction of extraction technology covers extraction solvents, liquid-liquid extraction, solid-liquid extraction, supercritical fluid extraction, optimization of extraction processes. The

pharmaceutical and nutraceutical aspects include medicinal plant extraction, aromatic plant extraction, distillation technology for essential oils.

The extrusion technology covers the principles, extruder types, extrusion parameters and measurements, raw materials for extrusion processes, rheological changes of foods during extrusion and applications of extrusion technology. The nutritional properties of extruded products is also studied.

Another specialized course is on the significance of encapsulation technology in food industry, composition of capsule, type, structure, property and production of core and encapsulating materials, single core encapsulation technology, multiple core encapsulation technology, encapsulation efficiency, properties of capsules and analysis, mechanisms and kinetics of release of core material, selection of encapsulation technology for application in food industry, novel encapsulation technology. Case study is also included.

3.2.3.2 Food Packaging Sub-cluster

The Food Packaging sub-cluster has a total 7 related courses as shown in Table 3.10. Some of the courses are offered to more than one programme totalling to 10.

Table 3.10: Courses in the Food Packaging sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Active Packaging Technology for Food Products	1
2.	Advanced Food Packaging	2
3.	Advanced Food Packaging	1
4.	Advancement in Packaging Technology	1
5.	Food Packaging	4
6.	Packaging of Food Products	1
7.	Polymeric Packaging Materials	1
		10

These courses relate to the role of active packaging in food chain; principles of active packaging technology; packaging configurations of active packaging system; intelligent packaging

techniques; integrating active and intelligent packaging systems to current and prospective packaging systems; mathematical models of mass transfer processes for design and optimizations of active packaging systems; legislative issues relating to active and intelligent packaging; current and future trends in research and commercial aspects. Minimally processed of fruits and vegetables, hurdle technique, high pressure technique and modified atmospheric packaging; quality and shelf-life of minimally processed fruits and vegetables are also included.

3.2.3.3 Physico-Chemical Food Sub-cluster

The Physico-Chemical Food sub-cluster has a total 10 related courses as shown in Table 3.11. Some courses are offered to more than one programme totalling to 12.

Table 3.11: Courses in the Physico-Chemical Food sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Chemical and Physical Changes in Food	1
2.	Chemical and Physical Changes in Food and Shelf Life Evaluation	1
3.	Physical and Engineering Properties of Biomaterials	1
4.	Physical Properties of Agro-Industrial Products	1
5.	Physical Properties of Food	3
6.	Physical Properties of Foods	1
7.	Physico-chemical Properties of Foods	1
8.	Properties of Water in Foods	1
9.	Super Critical Fluid Extraction.	1
10.	The Application of Physical Chemistry to Food Science	1
		12

The physico-chemical properties food and sources of food is included to enable understanding of extraction and purification of food chemical components; denaturation; functional properties and changes during processing and storage.

3.2.3.4 Sensory Food Product Development Sub-cluster

The Sensory Food Product Development sub-cluster has a total 19 related courses as shown in Table 3.12. Some of the courses are offered to more than one programme totalling to 20.

Table 3.12: Courses in the Sensory Food Product Development sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advanced Sensory Evaluation	1
2.	Colour and Colour Evaluation	1
3.	Descriptive Sensory Analysis	1
4.	Current Research in Sensory Science and Evaluation	1
5.	Food Rheology	2
6.	Food Texture and Rheology	1
7.	Rheology of Foods and Biomaterials	1
8.	Sensory and Consumer Research	1
9.	Sensory Evaluation	1
10.	Sensory Evaluation for Consumer Research & Food Production Dev	1
11.	Sensory Evaluation for Food Product Development	1
12.	Sensory Evaluation for Product Development	1
13.	Sensory Evaluation of Food	1
14.	Sensory Evaluation of Food Products	1
15.	Sensory Evaluation of Foods	1
16.	Sensory Evaluation Techniques for Agro-Industry	1
17.	Sensory Planning and Data Analysis	1
18.	Sensory Science of Food	1
19.	Texture and Texture Evaluation	1
		20

The collective courses introduce the physiological and psychological foundation of sensory system, principle and preparation of sensory practice, measurement of sensory thresholds, discrimination theories and testing, time-intensity sensorial methods, descriptive theories and analysis, texture evaluation in descriptive test, acceptance and preference test, consumer test for sensory evaluation, statistics in sensory evaluation. Some courses are described with topics that consisted of introduction, basic sensory attributes and human perception, principles of good practice in sensory evaluation, factors influencing sensory verdicts, measuring responses, discriminative tests, descriptive tests, advanced discriminative tests, selection and training panelists, preference and acceptance tests and consumer tests. Thus techniques used to evaluate the sensory characteristics of food; techniques used to measure, analyse and interpret the sensory reactions of a taste panel to food characteristics; sensory evaluation in quality control and consumer acceptance testing are introduced. All the tests are supported with questionnaire design, basic and advanced statistical methods used in sensory analysis. The

introduction and theory of signal detection, Thurstonian models, signal detection applied to discriminate products using the R-index, guessing models and discriminator theory, pairwise comparison-dependent & selected pairs, pairwise comparison-independent & selected pairs, multiple ranking - no ties allowed and multiple ranking ties allowed, instrument-sensory relationships relating consumer and trained panel data are also included.

The introduction and principle of rheology including stress and strain, solid and fluid behavior in steady shear flow, yield stress phenomena and extension flow include topics covering tube viscometry, rotational viscometry, extension flow, and viscoelasticity. These courses also study the deformation of foods and biomaterials under the action of force, relationship between stress and strain, flow behavior of Newtonian and Non-Newtonian fluids, theoretical analysis and mathematical models for flow behavior and deformation of foods and biomaterials, flow behavior and deformation of foods and biomaterials in rheological measuring devices, operational principle of rheological measuring devices and measurement of rheological properties, molecular theory of viscoelastic materials, rheological properties of complex foods and biomaterials, effects of rheological properties on food processing and sensory assessment and nano-rheology. Food texture and rheology, using objective and subjective evaluation, factors affecting food texture of liquids, gels, emulsions, and solids, and improving of food texture are included.

The practical component is a case study.

3.2.3.5 Food Chemistry Sub-cluster

The Food Chemistry (Protein, Carbohydrates and Lipids) sub-cluster has a total 48 related courses as shown in Table 3.13. Some of the courses are offered to more than one programme totalling to 73.

Table 3.13: Courses in the Food Chemistry sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advanced Biochemistry I	1

No	Name of Course	No of Programmes
2.	Advanced Food Chemistry	4
3.	Advancement in Fat and Oil Technology	1
4.	Applied Food Chemistry	1
5.	Applied Food Proteins Chemistry	1
6.	Basic Food Chemistry	1
7.	Carbohydrate in Foods	4
8.	Carbohydrates in Food	1
9.	Chemical Separations	1
10.	Chemistry and Biochemistry of Seafoods	1
11.	Chemistry of Food Macronutrients	1
12.	Chemistry and Technology of Starch	1
13.	Cereal and Legume Chemistry	1
14.	Colloidal Systems in Foods	1
15.	Enzyme and its application in Food Industry	1
16.	Enzyme in Foods	2
17.	Enzymes in Food Processing	1
18.	Fat and Oil Technology in Food Industry	1
19.	Fats and Oils	1
20.	Food Carbohydrates	5
21.	Food Chemistry and Analysis	1
22.	Food Colloids	2
23.	Food Enzyme Technology	1
24.	Food Enzymes	3
25.	Food Enzymology	1
26.	Food Gels and Colloids	1
27.	Food Hydrocolloids	1
28.	Food Lipids	3
29.	Food Macro Component	1
30.	Food Protein Technology	1
31.	Food Proteins	5
32.	Lipid in Foods	3
33.	Macro Component of Food	1
34.	Principles of Food Chemistry	1
35.	Protein Functionality and Application	1
36.	Protein in Foods	3
37.	Protein Product Technology	1
38.	Protein Technology	1
39.	Science and Technology of Edible Fat and Oil Products	1
40.	Science and Technology of Edible Fat And Oil Products	1
41.	Science and Technology of Fat and Oil	1
42.	Science of Fats and Oils	2
43.	Selected Topics in Food Chemistry	1
44.	Selected Topics in Food Chemistry and Food Analysis	1

No	Name of Course	No of Programmes
45.	Starch in Food	1
46.	Technology of Food Carbohydrates	1
47.	Technology of Food Lipids	1
48.	Technology of Food Proteins	1
		73

This course is designed to build up in-depth knowledge in the areas of major food components that include type, functional properties and application of carbohydrates, proteins and lipids or fats in food industry, extraction, separation and changes, nutritional quality assessment, modification and production of products in food industry, researching and presentation of published information relating development in science and technology of food. The functional properties of water, carbohydrate, protein and fat in foods, mode of action, interaction of food components, role of components in characteristics and quality improvement of foods are the major topics. Current issues and development in food chemistry are highlighted. Critical thinking skills and problem solving skills are demonstrated by conducting a case study on current issues in food chemistry evaluated based on presentation skills and written report.

In carbohydrate component, the types, sources and properties in foods; production technology and application of carbohydrates in food industry; chemical and physical changes in food carbohydrates during processing and storage; current topics in carbohydrate technology are emphasized. Special topics on starch structure and functionality cover factors affecting starch in food products; starch modifications; applications of starch and modified starch in foods; roles of starch in characteristics of starch-based food products and analysis methods of starch.

A large component is related to protein and enzymes. This covers advanced metabolisms and hormonal control, mechanisms of cellular control and signal transduction, interaction between nucleic acid and protein, RNA processing, post-translational processing, advanced structure and function of protein and enzyme. Protein solubility, water holding capacity of protein, role of protein in food system, protein in emulsion, foaming properties of protein, protein gelation, protein-lipid interaction, protein-carbohydrate interaction, protein and flavor compounds are the major topics related to protein. Specifically, enzyme and its classification and enzyme activities kinetics are included. This evolves to the study on major food enzymes and their application in food industries including enzymes for bread, pasta and noodles productions;

enzymes in brewing; enzymes in fruit and vegetable juice extraction; enzymic modification of food protein; enzymes in starch modification and enzymes in the manufacture of dairy products.

The lipids or fats component is contained in courses related to composition and structure of lipids; their physical and chemical properties in relation to their functions in food lipid separation, modification and application in food industry; deterioration of lipid and current topics in lipid technology.

There is one specific course covering the chemical composition of cereal and legume: proteins, amino acids, carbohydrates, lipids, enzymes and color; anti-nutritional factors and physico-chemical properties of cereals and legumes.

3.2.3.6 Industrial Food Production Sub-cluster

The Industrial Food Production sub-cluster has a total 6 related courses with 6 programmes offering the courses as shown in Table 3.14.

Table 3.14: Courses in the Industrial Food Production sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Aquatic Plant Processing Technology	1
2.	Emulsions and Colloids for Agro-Industrial Product	1
3.	Food Fermentation Technology	1
4.	Food Polymer and Its Application	1
5.	Industrial Food Fermentation	1
6.	Natural Polymers	1
		6

The Industrial Food Production sub-cluster covers topics on technology for microbial or inoculum selection, storage and collection of food fermentation processing. These include kinetic of fermentation processes; physical and chemical changes during fermentation; fermentation processes of various fermented foods; development of fermentation process from indigenous to industrial scale. Quality control of fermented foods topics consist of factors and control; safety in food fermentation processes, microbial isolation and strain improvement for industrial food fermentation. The fundamental aspects entail the microbiological and technical aspects of milk,

vegetable, meat, grain, and fruit fermentations, fermentation for food additive production. The facilities for the processes are also covered like fermenter and apparatus design. Food polymers are also included in this sub-clusters on the biochemical mechanisms relating to metabolites synthesis.

3.2.3.7 Food Analysis

The Food Analysis sub-cluster has a total 20 related courses as shown in Table 3.15. Some of the courses are offered to more than one programme totalling to 25.

Table 3.15: Courses in the Food Analysis sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advance Food Analysis and Instrumentation	1
2.	Advanced Analysis of Food	1
3.	Advanced Analytical Chemistry	1
4.	Advanced Analytical Techniques in Product Development	1
5.	Advanced Food Analysis	5
6.	Advanced Food Analytical Techniques	1
7.	Advanced Food Science and Food Analysis	1
8.	Advanced Near Infrared Spectroscopy	1
9.	Analysis of Food Components	1
10.	Biochemical Laboratory Techniques	1
11.	Food Analysis	2
12.	Food Quality and Analysis	1
13.	Food Research Techniques and Instrumentation	1
14.	Image Processing and Analysis for Food Industry	1
15.	Immunoassays in Food	1
16.	Instrumental Analysis of Food	1
17.	Instrumental Method of Food Analysis	1
18.	Instrumental Methods for Food Analysis	1
19.	Instrumentation and Physicochemical Measurement for Food	1
20.	Instrumentation Techniques in Food Research	1
	Total	25

The courses introduce the different types of analysis for volatile/semi-volatile components and solid particles. These include sample preparation, sampling, theory and principles of analysis. Elementary food analysis of carbohydrates, proteins and lipids (moisture content, total solid, Aw, ash, protein content, fiber content, crude fat content and pH are taught. The application of advanced instruments for food and food products analysis includes chemical analysis technique, spectroscopic technique, chromatographic technique, electrophoresis, microstructural analysis technique, x-ray diffraction technique. The principles of separation techniques, distillation, extraction, precipitation, centrifugation, ion-exchange, electrophoresis, electrolysis, gas chromatography, liquid chromatography, super critical fluid chromatography, other newly developed separation methods for chemical analysis are also included. The students are exposed to using HPLC, GC, cone-penetrometer, polarised light microscope, UV-Vis Spectroscopy and ICP-OES. Differential scanning calorimetry, atomic absorption spectroscopy, mass spectrometry and electron microscopy, computer image systems, image acquisition. light and color image systems and color value measurement from food images are taught. General image evaluation and measurement, image defect management. image quality enhancement are topics using image utilization in the food industry. More advance course like preparation of plasmids, DNA and RNA, real-time PCR are also included.

Case studies in the application of image processing and analysis for the food industry are the practical component.

Food analysis also include topics on source of hazards, risk assessment, good manufacturing practices, production layout design, hazard analysis and critical control points, assessment of production waste and control system and waste treatment system.

3.2.3.8 Food Development

The Food Development sub-cluster has a total 32 related courses as shown in Table 3.16. Some of the courses are offered to more than one programme totalling to 34.

Table 3.16: Courses in the Food Development sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
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No	Name of Course	No of Programmes
1.	Advanced Fermentation Technology	2
2.	Advanced Food Product Development	2
3.	Advanced Product Development	1
4.	Advanced Fruit and Vegetable Technology	1
5.	Advanced Physiology in Horticulture	1
6.	Anthropology and Sociology of Food	1
7.	Beverage Technology	1
8.	Biopolymer Films and Coatings for Food System	1
9.	Cereal Chemistry	1
10.	Cereal Technology	1
11.	Enzyme Technology for Food Products	1
12.	Fermentation Technology	1
13.	Fish Oil Processing Technology	1
14.	Food Fermentation Technology	1
15.	Food Research from Resources of Marine and Eastern Region	1
16.	Food Structure on Product Design	1
17.	Industrial Fermentation Technology	1
18.	Meat, Poultry and Fishery Products	1
19.	Minimally Processed Fruits and Vegetables	1
20.	Nutrigenomics and Nutricosmetics	1
21.	Objective Measurement for Product Development	1
22.	Pasta and Noodle Technology	1
23.	Science and Technology of Cereal and Legumes Products	1
24.	Science and Technology of Fishery Products	1
25.	Science and Technology of Meat	1
26.	Science and Technology of Pasta and Noodles	1
27.	Science and Technology of Starch	1
28.	Science in Bread	1
29.	Science of Meat and Egg Products	1
30.	Starch Technology	1
31.	Sugar & Chocolate Confection Technology	1
32.	Traditional Fermented Foods	1
		34

This sub-cluster has considerable overlapping topics particularly with Food Science and Technology sub-cluster and Industrial Food Production sub-cluster. However, the Food Development sub-cluster relates more to the classification and characterization of new food, new food development system, food constituents and their functionalities, food ingredient functions and selection, packaging for new food, new food development in the food service industry, ingredient development for the food industry, organizing for new food development

and the future trends of new food. It also includes application of product systematic thinking, recent technological development analysis, recent market change analysis, recent financial system change analysis, strategic planning for product development, executive principle for product development, application of advanced product development designs and evaluation of the success in product development by application of balanced scorecard and prototype product management.

Specialized courses on starch cover the chemical composition and molecular structure of starches, physico-chemical properties of starches, relationships between structure and physico-chemical properties of starches, starches production, chemical and physical modification of starches, applications of starches and modified starches in food industry. This is followed by topics on types of pasta and noodle products; chemical composition and properties of raw materials used for making pasta and noodle; processing technology of pasta and noodle products including pasta, wheat noodle, starch noodle and others; evaluation of pasta and noodle products; packaging technology; current issues on pasta and noodle technology.

The principles and new technologies in physiology to control growth and development in fruit trees, vegetables and ornamental plants emphasize on the application of methods to improve yield and quality. This entails the study on phytochemicals in fruits and vegetables, extraction and purification of phytochemicals, encapsulation of fruit and vegetable extracts, production of fruit and vegetable powders by advanced dehydration processes, processing of fruit and vegetable concentrates by freeze concentration, high pressure processing, vacuum frying of fruits and vegetables, probiotic impregnation in fruits and vegetables, processing effects on phytochemicals and biological assessment of phytochemicals. Market trends, raw materials and composition of indigenous food, key factors for product characteristics, role of herbs and spices for indigenous food, formulation and process development of indigenous food, production scaling up for industrial scale and product standard establishment. Relation of physiology to storage life, quality and their impacts due to food processing, various fruit and vegetable processing, utilization of waste from fruit and vegetable processes are included.

The history of chocolate and the culture of chocolate consumption covers topics on chocolate ingredients, cocoa bean processing, liquid chocolate processing, controlling the flow properties of liquid chocolate, fat crystallization in chocolate and non-cocoa vegetable fats used in chocolate. The manufacturing process of chocolate includes chocolate product varieties and their packaging. Technological case studies for manufacturing heat-resistant chocolate coatings is also included. Minor topics like compositions and kinds of beverages, manufacture of gas-compressed and non gas-compressed beverages, alcoholic beverage, powdered beverage, tea, coffee, cocoa and others are also included.

From the meat area, topics include chemical compositions and microstructure of muscle, biochemical changes during muscle conversion to meat, meat and poultry meat qualities, chemical, biochemical and physical factors affecting meat qualities, meat properties and meat product qualities, the measurement of qualities and properties, chemical, physical and sensory analyses and current topic in meat and poultry meat science research. In addition to an introduction to meat and poultry science, technological and manipulative skills in slaughtering and processing, muscle structure and function as indicators of meat quality and meat processing, advance technology applied in meat processing are also introduced.

In addition, the fishery area covers topics on type, sources of raw materials, morphology and chemical compositions of fish, quality and quality changes, quality control, shelf-life extension, quality inspection, packaging and transportation, quality specification and standard of fish products. The application of fish oil is also included. One course covers the relation of physiology of marine and fresh water fish to quality and deterioration, the effect of food processing, methods of fish meat processing and utilization of processing waste.

The importance of fermentation industry are covered including isolation and selection of microorganisms for fermentation industry, microbial strain improvement; fermenter and equipment; optimum conditions for fermentation; product recovery; kinetics of fermentation processes; bioprocess simulation and mathematic model; metabolic engineering; fermented products; case study in development of fermentation products;

Roles of microorganisms in traditional fermented foods, physical and chemical changes occurred during fermentation, fermentation processes and process control of various traditional

fermented foods. The practical component includes field trips to fermentation factories, and presentation of related topics field trips. Other courses in the fermentation area covers microbial interaction, flux control analysis, submerged fermentation, solid fermentation, mathematical model for fermentation, statistical analysis for fermentation, bioreactor design, optimization in fermentation processes, lactic acid fermentation processes, xylitol fermentation processes, oligosaccharides fermentation processes.

In the area of biopolymer, the topics covers structural elements of food; interaction of the basic structures; biopolymer and water relationship; structural system of food; creation of fibrous structures by electro spinning technique; evaluation of food structure; relations of food structure on control release of nutrients and bioactive compounds. Inclusive also are topics on biopolymer film and coating, biopolymer materials from plants and animals, film compositions, film formation, plasticizer, lipid, properties of biopolymer films; application of coating in vegetable, fruit and food; application of film as food packaging materials, modified atmosphere in packaging, active packaging, antimicrobial packaging and nanocomposite films.

3.2.3.9 Postharvest Technology Sub-cluster

The Postharvest Technology sub-cluster has a total 6 related courses as shown in Table 3.17 and the total programmes offering total to 6.

Table 3.17: Courses in the Food Development sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advanced Post-Harvest Physiology in Horticulture Crops	1
2.	Packaging Technology for Postharvest Horticulture	1
3.	Post-harvest Technology	1
4.	Post-Harvest Technology	1
5.	Postharvest and Minimal Processing of Fruits and Vegetables	1
6.	Postharvest Technology	1
		6

These courses touch on changes of horticultural postharvest physiology and quality attributes; packaging requirements; postharvest packaging and transportation; modified atmosphere packaging; applying techniques of food processing and preservations; mathematical modeling for packaging design; trend of packaging technology for horticultural products. Postharvest of fruits and vegetables also covers on minimal processing, current fresh-cut produce industry and processing, physiology of fresh-cut produce, minimal processing, quality control, analysis of quality, microbial contamination, hygienic production technology (GAP, GMP, HACCP) of fruits and vegetables, miscellaneous minimal processing of fruits and vegetables e.g. low temperature, thermal and non-thermal processing.

Some courses cover topics on quality of agricultural products other than plants that include eggs, dairy, meat, poultry and seafood, their post harvest loss, post harvest handling and storage, changes of the quality, deterioration and prevention of fresh products, packing and transportation.

3.2.3.10 Functional Food Sub-cluster

The Functional Food sub-cluster has a total 32 related courses as shown in Table 3.18. Some of the courses are offered to more than one programme totalling to 38.

Table 3.18: Courses in the Functional Food sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advanced Functional Foods	1
2.	Bioactive Substances in Food	1
3.	Cell-Based Assays for Functional Foods	1
4.	Chemistry and Technology of Food Flavour	2
5.	Chemistry of Food Colorants	1
6.	Chemistry of Food Flavour and Analysis	1
7.	Dairy Product Technology	1
8.	Functional Properties of Food Components	1
9.	Flavour and Flavour Evaluation	1
10.	Flavours in Food	1
11.	Flavours in Food Laboratory	1
12.	Food Colloidal and Emulsion Technology	1
13.	Food Flavour Chemistry	1
14.	Food Flavour Creation	1

No	Name of Course	No of Programmes
15.	Food Flavour Technology	1
16.	Food Flavours	2
17.	Food Phenolics	1
18.	Food Powder Technology	1
19.	Functional and Specialty Beverage Technology	1
20.	Functional Food and Nutraceuticals	1
21.	Functional Foods	1
22.	Functional Foods and Nutraceuticals	3
23.	Functional Foods Technology	1
24.	Health Foods and Nutraceuticals	1
25.	Lactic Acid Bacteria in Food Industry	1
26.	Meat and Poultry Meat Science	1
27.	Microbial Metabolites for Food Industry	1
28.	Nutraceutical and Functional Food from Plants and Medicinal Plants	1
29.	Nutraceuticals and Functional Foods	3
30.	Pigments and Colour Evaluation	1
31.	Research and Development of Functional Foods	1
32.	Science of Thai Food	1
		38

This sub-cluster relates to introduction and definition of functional food products, development and trend of functional foods; type of functional foods in market; functional foods processing technologies; microbial in functional foods; regulation in claim of bioactive compounds on human health; influence of processing on nutrients and substantial. Overview of functional foods; functional food from proteins, peptides, carbohydrates, lipids, polyphenols, probiotics, microbial metabolic, and enzymatic reactions; role of functional foods to prevent life-style related diseases, food poisoning, infectious disorder, aging, allergic symptoms, molecular alteration and modulate immune functions are the major topics.

Functional food has ingredients that have properties in anti-aging; antioxidant; bone and teeth; calm and sleepiness; brain and memory; dietary fiber and functional ingredients impact to digestive tract; energy balance; eyes and vision; impacts to cardiovascular diseases; involve in immunity system; for weight control; and for beauty; amount and dosage form; manufacturer and distributor; applications of functional ingredient in nutraceutical and functional food. The courses cover topics on introduction, bioavailability and safety of functional foods, probiotic and prebiotic, natural antioxidants and their effects on human health, natural anti-microorganisms and their applications in functional food, dietary fiber and effect on colon cancer, functional

foods for hyperlipidemia. Also included are the overview of nutrigenomics and nutrigenetics; mechanism of epigenetic modification; gene polymorphism and respond to diet; bioactives, their function and interaction of molecules with genes; anti-aging in cellular level and retardation of biological activity; nutricosmetics on skin, hair and figure; bioactive ingredients and control of gene expression; recent knowledge in nutrigenomics and nutrigenomics. They entails concept of cell culture, cell survival, cell proliferation, cell cycle, cell apoptosis, cell differentiation, cell autophagy, cell oxidative stress, anti-aging, anti-inflammation, anticancer and tumorigenesis, neuroprotection and neurogenesis.

The regulations and marketing of functional food products are also dealt with in the development of functional food products, properties and effects on health of dietary fiber, properties and effects on health of fatty acids, principles of vitamins and minerals, properties and effects on health of prebiotics and probiotics, properties and effects on health of phytochemicals.

Specialised courses relates to the different types of functional food. These are:

- Emulsion formation, structure and properties of emulsion, types and properties of emulsifiers, interaction between various components in emulsion system and application of emulsion system in product development;
- Type and structure of food powders, principles and technologies for food powder production, production of powdered microcapsules, food powder properties and analysis, powder transport and storage technology, problems during processing, transport and storage of food powders and solving approaches, design and control of food powder processing, transport and storage, case study of industrial food powder production;
- Functional and specialty beverage; ingredients selection of functional beverage; shelf-life extension of functional beverages; dairy-based functional beverages; plant-based functional beverages; probiotic beverages; consumer oriented-development of functional beverages; role of beverages in healthy diet; future trends of functional and specialty beverages.

- Nutritional and functional importance of marine-based foods; extraction and characterization of bioactive compounds with health benefits from marine resources; protective role of marine nutraceuticals; bioactivities of fish protein derived peptides; biomedical and nutraceutical applications of collagen and gelatin; fish oil and health-promoting roles of omega-3 fatty acids; bioactivities of chitin, chitosan and their oligomers; marine bacterial sources of bioactive compounds;
- Business potential of nutraceuticals and functional foods; bioactive compounds and their health benefits, fatty acids, proteins and peptides, phytochemicals, dietary fibres, pre and probiotics; technologies for extraction and production of bioactive compounds; technologies for production of functional foods and functional beverages; functional fermented foods; safety and efficacy evaluation; health claims; laws and regulations;
- Physiology and metabolism of lactic acid bacteria (LAB), their roles in the process of fermented milk products, cereal based products, meat and fish products and vegetable products; bacteriocin- producing LAB and their roles in food safety; LAB as probiotics in human gut and health; prebiotic substrates for probiotics and use of genetic engineering for classification, detection and strain improvement of LAB for food industry benefits;
- Microbial metabolites production in food industry. Primary and secondary metabolites production based on kinetic growth of microorganism in fermentation system. Traditional fermentations and genetics improvement of microorganisms. Design and preparation of media for bioprocess. Screening, development and storage for industrial level. Production of food ingredients, food additives or food biopreservatives and others metabolites related to food, health and agricultural products.
- Definition of flavors and physiochemical properties of flavor compounds. Chemistry of food flavors, natural and synthetic flavors, flavor enhancers. Off-flavors in foods. Extraction and production of food flavorings, chemical analysis techniques of flavors;
- Definitions and types of colloids in food industries, properties of materials and ingredients in food colloids and emulsions, production of colloidal and emulsion particles and their characteristics, colloidal and emulsion stability, interfacial properties and their characteristics, destabilization and structure formation of colloids and emulsions, multiple emulsion system, foams and their stability, gel, specific food colloid systems, colloidal and emulsion rheology.

In Thailand, there is a specialized course on the characteristics and classifications of Thai food. Consumer behavior regarding Thai food, and marketing and cultural features of Thai food are covered. The principles of Thai food recipes and cooking are included and entailed with chemical compositions, nutritional values and health benefits of Thai food ingredients and products. The physical, chemical, and microbial qualities and stability of Thai food ingredients and products are also covered. In addition, technologies for processing, packaging, and shelflife extension of Thai food products are covered in the research in the innovative development and improvement of Thai food.

The practical component is case studies in development of functional food products.

3.2.3.11 Waste Management Sub-cluster

The Waste Management sub-cluster has a total 9 related courses as shown in Table 3.19. Some of the courses are offered to more than one programme totalling to 46.

Table 3.19: Courses in the Waste Management sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Agricultural and Food Industrial Waste Utilization	1
2.	Biomass Conversion	1
3.	Environmental Management System	1
4.	Liquid and Solid Waste Management	1
5.	Utilization of By-Product from Food Industry	1
6.	Utilization of By-Products From Fishery Industry	1
7.	Waste Management in Food Industry and Environment	1
8.	Waste Utilization from Food Industries	1
9.	Wastewater Treatment	1
		9

These courses focus on sources and compositions of by-product from food industry; management and utilization of by-product from food industry. Topics covers types and characteristics of waste from food processing, effects on environment and public health, waste treatment and management. The production and properties of value-added products from by-products produced using different technologies including hydrolysis, extraction, drying,

fermentation, etc. applications of by-products and their products as food ingredients, functional food, food supplement, etc. are introduced.

3.2.3.12 Food Nutrition Sub-cluster

The Food Nutrition sub-cluster has a total 41 related courses as shown in Table 3.20. Some of the courses are offered to more than one programme totalling to 46. This sub-cluster provide the core group of msot programmes.

Table 3.20: Courses in the Food Nutrition sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advanced Food and Nutrition	1
2.	Advanced Food and Nutrition Toxicology	1
3.	Advanced Human Nutrition	1
4.	Advanced Nutrition and Nutrient Metabolism	1
5.	Advancement in Nutrition	1
6.	Applied Nutrition	1
7.	Clinical Nutrition	1
8.	Community Nutrition	1
9.	Developmental Nutrition	1
10.	Diet Therapy	1
11.	Food and Nutrition	1
12.	Food and Nutrition Microbiology	1
13.	Food and Nutritional Toxicology	3
14.	Food for Health	1
15.	Food Nutrition and Nutrient Enrichment Technology	1
16.	Food, Nutrition and Health	1
17.	Foods for Immune System	1
18.	Geriatric Nutrition	1
19.	Health food and assessment	1
20.	Human Nutrition	1
21.	Hygienic Problems of Foods	1
22.	Infant Nutrition	1
23.	Managing Food Allergy and Intolerance	1
24.	Medical Nutrition Therapy	1
25.	Molecular Nutrition	1
26.	Nutrient Metabolism	1
27.	Nutrition and Aging	1
28.	Nutrition and Product Quality	1

No	Name of Course	No of Programmes
29.	Nutrition and Public Health Issues	1
30.	Nutrition Education	1
31.	Nutrition in Food Processing	2
32.	Nutrition in Food Science	1
33.	Nutrition in Health and Disease	1
34.	Nutrition Labelling of Processed Food	1
35.	Nutrition Policies/Programmes	1
36.	Nutritional Anthropology	1
37.	Nutritional Biochemistry	2
38.	Nutritional Epidemiology	2
39.	Principles of Nutrition	1
40.	Science and Technology of Muscle Food	1
41.	Sports Nutrition	1
		46

This sub-cluster covers biochemistry of various nutrients essential for living, importance of each nutrient to human body functions and the principles of nutrition. The topics are on an overview of food, nutrition, and health in present lifestyle; nutrition guideline and assessment; human digestion and absorption system; functional properties of macronutrients micronutrients and trace elements; energy balance and body weight regulation; nutrition, exercise, and sport; nutrition application in life cycle; nutritional program designs and use of nutritional equipments. This entails the chemical, functional and nutritional properties of foods, natural antioxidants, phytochemicals, bioactive components, their roles as functional food, processing and identification techniques, important spices and herbs, health claims and validity of the claim.

The nutritional area on toxicology is also included with topics on introduction, toxicity of various foodstuffs, foodborne infection and intoxication, toxicity of excess nutrients, food safety evaluation, analytical methods in food and nutrition toxicology, short term and long term toxicity testing, testing of food toxicology in animal, molecular toxicology, term papers, presentation relating to current topics.

Regulations of nutrition labeling by food and drug administration are covered in compliance with regulations for nutrient claims, sources of ingredients used for nutrient claims, formulation for nutrient claims and product evaluation. Aspect on labelling related to consumer trends, serving size, energy limitation, dietary fiber and their role in human body, vitamins and minerals as

antioxidant, value-added processed foods, marketing strategies of food industry, new knowledge of nutrition labeling are included.

Specific courses offer topics on:

- Nutrient alteration during life cycle, gene structure and regulation and risk indicators for chronic diseases, ethics and social issues associated with chronic diseases, diet genotype interactions; coronary heart disease, body weight and obesity, foetal origin of adult disease, functional foods, nutrition and cognitive function, folate requirements, sports nutrition diet, genotype and cancer, case studies;
- Nutrition and digestive system, body composition, energy expenditure and energy balance, metabolism of nutrients; carbohydrates, lipids, protein and amino acids, relationship of nutrients in metabolic pathways, roles of vitamins and minerals in metabolism of nutrients, fiber in nutrition and health, influence of genetic defects and diseases on metabolic disorders, case studies;
- Positive and negative dietary influences on nutrition during the life cycle, how the dietary factors contribute to human health and healthy ageing, colonic health, nutrition and metabolic syndromes at risk for chronic disease;
- Application of nutrition principles in the dietary treatment of certain organic, functional, and metabolic diseases;
- Muscle structure and connective tissue, conversion of muscle to meat, physical and biochemical changes in muscle during storage and processing;
- Functional properties and myofibril and their measurement, colour of meats. Biochemical and functional properties of muscle from poultry and aquatic animals. Nutritional composition and value of meat and meat products.
- Integration of metabolism including general overview of all metabolism, protein metabolism, carbohydrate metabolism, lipids metabolism, and bioenergetics. Diet, health and diseases including diabetes and designed diets, coronary heart disease and designed diets, obesity and designed diets, childhood and adult gout under nutrition, protein/energy malnutrition, phenylketonuria (PKU) and designed diets, in born errors of metabolism and designed diets, allergy/food intolerance and designed diets, cancer and designed diets, cystic fibrosis multiple sclerosis anemia and designed diets, osteoporosis

and osteomalacia and designed diets, fad diets/modern day dieting trends, menu formulation and analysis of therapeutic diets. Nutrition research methodology including dietary assessment, biological marker, quantitative/qualitative, biological sample analysis;

- Study on the basic immune system of human, causes of changes in immune system and diseases related to changes in immune system, foods for maintaining the immune system and their mechanisms, trends in application of foods for treating diseases caused by changes in immune system.

3.2.3.13 Food Processing Sub-cluster

The Food Processing sub-cluster has a total 37 related courses as shown in Table 3.21. Some of the courses are offered to more than one programme totalling to 44 in particular Advanced Food Processing with 6 programmes.

Table 3.21: Courses in the Food Processing sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advance Food Processing	1
2.	Advance Processing and Biochemistry of Functional Foods	1
3.	Advanced Food Preservation and Processing (PRC)	1
4.	Advanced Food Processing	6
5.	Advanced Food Processing and Technology	1
6.	Advanced Food Processing I	1
7.	Advanced Food Processing II	1
8.	Advanced Fruits and Vegetables Processing Technology	1
9.	Advanced Science for Meat Processing	1
10.	Advancement in Food Drying Technology	1
11.	Basic Food Processing	1
12.	Bioprocessing Technology	1
13.	Biotechnology Processes in the Production of Foods	1
14.	Current Technology in Food Processing	2
15.	Drying Technologies in Food Processing	1
16.	Fluidization in Food Processing	1
17.	Fishery Product Technology	1
18.	Food Bioprocessing	2
19.	Food Biotechnology Processing	1

No	Name of Course	No of Programmes
20.	Food Commodity Processing Technology	1
21.	Food Engineering and Processing	1
22.	Food Process and Equipment Design	1
23.	Food Processing	1
24.	Food Processing (Thermal and Non-thermal)	1
25.	Food Processing Operations	1
26.	Interaction of Food Components during Processing	1
27.	Interaction of Food Components in Processing	1
28.	Fundamental of Food Processing	1
29.	Meat Science and Technology	1
30.	Minimally Processed Food	1
31.	Nonthermal Food Processing	1
32.	Organic Food Processing and Supply Chain	1
33.	Powder Technology in Food Processes	1
34.	Principles of Food Processing	1
35.	Separation in Food Processes	1
36.	Thermal Processing of Foods	1
37.	Fruit and Vegetable Technology	1
		44

These courses collectively cover topics on the theoretical and practical aspects of food production and processing related to mechanical separation, mixing and size reduction. The different types of processing are introduced including high pressure processing, pulsed magnetic fields processing, oscillating magnetic fields processing, light pulses processing, application of chemicals and biochemicals in food processing, irradiation processing, and hurdle processing. Advanced and novel food processing technologies including thermal processing (aseptic process and ohmic and microwave heating), non-thermal processing (high pressure processing, pulsed electric field, high intensity pulsed light and ultrasound), separation technique (membrane filtration and supercritical extraction), minimal processing (ozone, nanobubble, hurdle technique), texturization technique (extrusion technology) are included. Other courses cover topics that include fluidization principle, gas-solid fluidization, liquid-solid fluidization, minimum fluidizing velocity, heat and mass transfer in fluidized bed, applications of fluidization in food processing such as mixing, freezing, extraction and drying, granulation and fermentation.

Identification and solving certain problems relating to production of selected food commodities and the quality control of the food products from farm to fork are the practical component with case studies and field study. A specialized course on identification and morphology of aquatic

plants and seaweeds, culturing and harvesting, chemical composition and nutritional value, processing of aquatic plants and seaweed, applications of aquatic plants and their products is being offered. Source and health benefit of bioactive compounds, advance processing of functional food, machinery and advance technology in functional food processing, plant design for functional food production

Advance processing of functional food relates to source and health benefit of bioactive compounds, machinery and advance technology in functional food processing and plant design for functional food production.

Market research on the application of advanced techniques in process and food product development, i.e. product profile technique, optimization of formula and processing condition using commercial software; shelf-life evaluation using mathematical model; consumer acceptance research and production economic study are also part of this sub-clusters.

3.2.3.14 Food Microbiology Sub-cluster

The Food Microbiology sub-cluster has a total 16 related courses as shown in Table 3.22. Some of the courses are offered to more than one programme totalling to 28. There were 10 programmes offering Advanced Food Microbiology.

Table 3.22: Courses in the Food Microbiology sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advanced Food Microbiology	10
2.	Advances in Food Microbiology and Food Safety	1
3.	Applied Food Microbiology	2
4.	Basic Food Microbiology	1
5.	Dairy Chemistry and Microbiology	1
6.	Food Industrial Microbiology	2
7.	Food Micro Component	1
8.	Food Microbiology and Analysis	1
9.	Industrial Microbiology	2
10.	Microbial Management in Food Industry	1
11.	Principles of Food Microbiology	1
12.	Rapid methods in Food Microbiology	1

No	Name of Course	No of Programmes
13.	Research Techniques for Microbiology	1
14.	Selected Topics in Food Microbiology	1
15.	Taxonomy and Classification of Bacteria in Food	1
16.	Wine Microbiology and Chemistry	1
		28

Food microbiology consists of topics on principle of microbiological techniques to detect microorganisms in food. Three areas are identified.

One is relating to food and foodborne disease, factors affected on type and quantity of microorganisms, changes in food caused from microorganisms, food spoilage and effects of processing on microbial survival. Significance of microorganisms and their toxins in food, controlling microbial spoilage in important food commodities, comprehension of distinctive foodborne microorganisms, survival, injury and recovery of microorganisms after different processing methods, including thermobacteriology and advanced food processing, specific proposals for sampling and sampling plan, beneficial microorganisms, including starter culture and probiotic are offered. Some focus specifically on bacteria and their relationship on food spoilage, food safety and fermentation, factors affecting the growth and survival of bacteria in food, taxonomy, classification and nomenclature and criteria for classification of bacteria. The practical components are conducted in the laboratory and including presentation on advances in identification and analytical techniques in food microbiology.

Another area is the role of microorganisms in food development. The beneficial uses of microorganism include the food industry and preservation; fermented foods and health; fermentation microbiology; quality and safety of fermented foods; controlling formation of toxic compounds in fermented foods; approaches towards quality improvement and fermentation control of fermented products. One of the courses is about winemaking which study the kinetics of yeast during wine fermentation, factors affecting yeast growth during wine fermentation, enzymes in winemaking, sulfur dioxide in winemaking, chemical composition changes during wine fermentation and aging, and wine stabilization. Casein, fat globules, cholesterol, enzymes, flavour and sensory properties related to microbiology are also covered relating to the

antimicrobial systems in raw milk, chemical changes during processing and storage, human pathogens, major control points during processing, dairy starters, classification of dairy.

The third area is about microbial indicators of public health; microbial control in foods; methods for rapid and automatic detection of foodborne pathogens.

3.2.3.15 Food Additives Sub-cluster

The Food Additives sub-cluster has a total 6 related courses as shown in Table 3.23. Some of the courses are offered to more than one programme totalling to 14.

Table 3.23: Courses in the Food Additives sub-cluster of the Science and Technology cluster offered across Asia

No	Name of Course	No of Programmes
1.	Application of Food Additives	1
2.	Food Additive Substance	1
3.	Food Additives	9
4.	Food Additives and Functional Ingredients	1
5.	Food Additives and Ingredients	1
6.	Food Additives and Its Applications	1
		14

Definition and types of food additives; chemical and functional properties of food additives; natural food additives; general criteria to select suitable food additives for food products; regulations of food additive applications; safety evaluation of food additives are covered. The role, functions and application of various food additives, nutrient substituents, analysis and assessment of safety, standard and regulations of additives are discussed. Color additives, enzymes, vitamins, amino acids, antimicrobial food additives, antioxidants, acidulants, sequestrants, texturizers, stabilizers, surface active agents, odor and flavoring agents, toxicity of food additives, standards and regulations

Flavoring agents, character notes of flavor, flavor profile analysis, flavor blending, coloring agents, color space and color blending are included in some courses. This entails the principle

and methods of evaluation of color in food using visual and instrumental measurement including color differentiation, physiochemical properties, evaluation of toxicity, factors affecting color stability of artificial and natural food colorants, functional and nutraceutical properties for health aspect, advance techniques in food application, and regulation of food colorants.

3.2.3.16 Food Ingredients

The Food Ingredients sub-cluster has a total 4 related courses as shown in Table 3.24. offered to more than one programme totalling to 4.

Table 3.24: Courses in the Food Ingredients sub-cluster of the Science and Technology cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Food Bioingredients	1
2.	Food Ingredients Technology	1
3.	Food Pigments and Colours	1
4.	Interactions of Food Components	1
		4

The properties and functions of major and minor ingredients; changes of ingredient properties in food during processing; selection of suitable ingredients for new product development are the topics covered.

3.2.3.17 Food Safety and Quality Sub-cluster

The Food Science and Technology sub-cluster has a total 55 related courses as shown in Table 3.25. Some of the courses are offered to more than one programme totalling to 66.

Table 3.25: Courses in the Food Safety and Quality sub-cluster of the Science and Technology cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Advance Food Toxicology	1
2.	Contamination in Food Chain and Inspection	1

No.	Name of Course	No of Programmes
3.	Food Chain Quality and Safety Management System	1
4.	Food Microbiological Risk Assessment	1
5.	Food Quality	2
6.	Food Quality Assurance	2
7.	Food Quality Management	1
8.	Food Safety 1	1
9.	Food Safety 2	1
10.	Food Safety and Quality Assurance Seminar	1
11.	Food Safety and Quality Management	1
12.	Food Safety and Risk Assessment	1
13.	Food Safety Management	4
14.	Food Safety Management and Auditing	1
15.	Food Safety Management in Supply Chain	1
16.	Food Safety Management of Animal Products	1
17.	Food Safety Management of Fruits, Vegetables and Legumes	1
18.	Food Safety Risk Analysis	1
19.	Food Safety Standard and Regulation	1
20.	Food Safety System Management	1
21.	Food Safety Toxicology	1
22.	Food Toxicology	5
23.	Foodborne Disease Outbreaks	1
24.	Foodborne Pathogens	1
25.	Foodborne Pathogens and Controls	1
26.	Hazard Analysis and Risk Assessment in Food production	1
27.	Hygienic Problems of Foods	1
28.	Implementation of GMP and HACCP for Food Industry	1
29.	Instrumentation for Food Safety and Management	1
30.	Issues in Food Safety and Quality Assurance	1
31.	Management in Food Plant Operations for Food Safety Certification	1
32.	Managing Food Safety Crisis	1
33.	Microbial Foodborne Pathogens	1
34.	Microbiological and chemical food safety	2
35.	Microbiological Food Safety	1
36.	Molecular Toxicology	1
37.	Mycotoxins in Food	1
38.	Principles of Food Safety and Quality (PRC)	1
39.	Quality Assurance Design in Agro-Industry	1
40.	Quality and Safety Management System in Food Industry	1
41.	Quality Control Design in Food Industry	1
42.	Quality Control and Safety in Food Industry	1
43.	Quality Management System and Food Safety	1

No.	Name of Course	No of Programmes
44.	Quality Management and Improvement	2
45.	Quality Management in Food Industry	1
46.	Quality of Food Products	1
47.	Quality System for Product Development	1
48.	Regulations of Food Safety and Quality	1
49.	Risk Assessment	1
50.	Risk Assessment of Microbiological Safety in Food Industry	1
51.	Selected Topics in Food Safety	1
52.	Social-Economic Impact of Unsafe Food Supply	1
53.	Toxicants in Food	1
54.	Traceability in Food Supply Chain	1
55.	Water Quality Management	1
		66

This sub-clusters consists of courses with the knowledge required to protect public health in matters related to food safety and quality management. Essential information on foodborne illnesses, food safety hazards and effective management of food safety form the basis of the course. Different syllabi presented are:

- Aspects on microbiological, macrobiological, chemical contaminants and their mechanisms of toxicity necessary to understand the food safety issues are covered. The different food safety and quality management systems such as GMP, HACCP, ISO22000 and risk analysis pertaining to food safety are introduced;
- Procedure of traceability and product recall practised in food industry. include approaches for utilizing microorganisms in the food industry, roles of microorganisms in food applications, monitoring and assessing microbiological quality and safety of foods and food-associated environments, advanced rapid detection and subtyping techniques, functional genomics and bioinformatics in food safety and food microbiology, case studies and presentation related to advanced food microbiology and food safety;
- Biology and transmission of foodborne pathogens (bacterial and viral) in foods and food-associated environments, ecological niches and genetic factors for survival of pathogens, rapid detection and subtyping techniques, prevention and control approaches, epidemiological approaches in foodborne outbreak investigation, case studies, laboratory and presentation related to current topics;

- Case studies in foodborne outbreaks, significance of the cases in economic aspect, regulations for control, outbreak investigations and sources of contaminants, detection methods, cause of outbreaks, control measures and resolutions;
- Importance of global trade and quality management in global competition, agricultural and food production system, food safety risk analysis and evaluation in food chain, food safety management system from primary production to finished products, traceability in food chain;
- Food borne pathogens, chemical and physical hazards in foods, food toxicology, safety of genetic modified and organic foods, food traceability;
- Control of food borne microorganisms, safety in pre and post harvest processes, hygienic design of food processes, cleaning processes and validation, risk analysis and management, food safety standards and authorities;
- Concept and principle of risk analysis in food; including risk assessment, risk management, and risk communication, application of risk assessment and risk management models, use of risk software program for evaluating risk levels;
- Hazard analysis and safety management of meat chain and meat products, egg and egg products, milk and milk products, and aquatic animal products, starting from raw material receiving, processing, logistics until traceability;
- Hazard analysis and safety management of vegetables, fruits, cereals, legumes, and their products, starting from planting, harvesting, packing, processing, logistics until traceability;
- Introduction, organizational profile, leadership and communication, food safety system planning, food safety system establishment, risk management planning, food safety system assessment, food safety system improvement;
- Introduction to supply chain management, safety management in raw material sourcing, safety management in production, safety management in distribution, safety management in retail, traceability, reverse logistics, and case study in food safety management in supply chain;
- Future Trends in Food and Beverage Industry and Marketing Segments. International Hygiene Regulations and Minimum Requirements, Material selection and Sanitary Design in Construction of Food Plant, Hygienic design in food processing equipment and

instillation, Managing Airflow, Steam supply, lighting and Facilities in Food Industries, and, Cost estimation and Replacement Analysis for Food Processing Plant;

- Naturally occurring food toxins from plant and animal, microbial toxins, environmental toxins, food processing-or packaging derived toxins. Food allergens, and food toxin, law and regulation related. Principles and analysis methods of food toxicants and allergens.

The practical component consists of preparation and presentation group assignments on topics related to food safety, quality management system or risk analysis.

3.2.3.18 Design

The Design sub-cluster has only one course which is very specific: Laboratory for Food Technology. This covers topics on the procedure and maintenance of laboratory used for food development and quality assessment.

3.2.3.19 Food Biotechnology Sub-cluster

The Food Biotechnology sub-cluster has a total 15 related courses as shown in Table 3.26. Some of the courses are offered to more than one programme totalling to 19.

Table 3.26: Courses in the Food Biotechnology sub-cluster of the Science and Technology cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Bioactive Compounds from Marine Products	1
2.	Experimental for Molecular Functions of Food	1
3.	Extraction and Separation Technology of Bioactive Compounds	1
4.	Food Biotechnology	5
5.	Food Biotechnology and Environment	1
6.	Food Nanotechnology	1
7.	Gene Technology	1
8.	General Biotechnology	1
9.	Genetically Modified Foods	1
10.	Molecular Biology	1
11.	Molecular Functions of Food	1

12.	Phytochemicals	1
13.	Selected Topic in Molecular Functions of Food	1
14.	Selected Topics in Biotechnology	1
15.	Selected Topics in Food Biotechnology	1
		19

This course covers theoretical and practical aspects of Food Biotechnology. Topics covered include molecular biology, gene cloning and recombinant proteins, cell and tissue culture, industrial cell culture and applications in food processing. Ethics, safety and regulations in food biotechnology are also covered. The effects of biotechnology on quality of raw materials, nutrition, and process in food industry are some of the topics. These entails the application of biotechnology methods and techniques in fermentation technology, enzyme technology, genetic engineering, protein engineering, and bioprocess engineering for modifying food components to improve or get new valued products, methods to increase effective production process and analyze food components. Introduction of extraction technology, extraction solvents, liquid-liquid extraction, solid-liquid extraction, supercritical fluid extraction, optimization of extraction processes, medicinal plant extraction, aromatic plant extraction, distillation technology for essential oils.

More specific courses involve topics on isolation, purification, and analysis for protein, peptide, carbohydrate and lipid; isolation, culture and identification of lactic acid bacteria; culture of mammalian cells; quantitative analysis of immunoglobulin by ELISA; preparation of extracts from food; training of animal experiments; isolation and culture of lymphocytes.

At the end of the study, most courses requires presentation relating to current topics.

3.2.3.20 Food Shelf Life Sub-cluster

The Food Shelf Life sub-cluster has a total 13 related courses as shown in Table 3.27 with 14 programmes offering these courses.

Table 3.27: Courses in the Food Shelf Life sub-cluster of the Science and Technology cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Air Condition and Refrigeration for Food Products	1

2.	Food Chilling and Freezing	1
3.	Food Preservation by Pulsed Electric Fields	1
4.	Food Stabilization Methods	1
5.	Shelf Life Evaluation of Agro-Industrial Product	1
6.	Shelf Life Evaluation of Agro-Industrial Products	1
7.	Shelf Life Evaluation of Food and Agro-Industrial Product	1
8.	Shelf Life Evaluation of Food Products	1
9.	Shelf Life of Food	2
10.	Shelf Life Prediction of Food Products	1
11.	Shelf-Life Evaluation of Biological Products	1
12.	Shelf-life Evaluation of Food Products	1
13.	Shelf-Life Evaluation of Food Products	1
		14

This sub-cluster covers topic on definition and important of shelf life, the basic knowledge of kinetic reactions, order of reactions, effect of temperature on the reaction rate, factors affecting shelf life, accelerated shelf life testing and principle of shelf life evaluation from case study. It also included the relationship between packages and product qualities; principles of shelf-life assessment or evaluation of food products in accelerated conditions. More specifically, it covers pulsed electric field principle, electrical properties of foods, equipments in food preservation by pulsed electric fields, kinetics of inactivation of microorganisms and enzymes in the presence of high intensity of electric fields, quality and safety of foods treated by pulsed electric fields, use of hurdle technology combined with pulsed electric fields, application of pulsed electric fields in various food processes.

Another set of topics relating to packaging protection function begin with major causes of food deterioration and strategies for shelf-life extension, packaging and food quality, assessment of shelf-life by using chemical and microbial kinetics. It includes the methodology of shelf-life determination, shelf-life predictive modeling and application to biological products.

Some courses cover specifically on the principle of refrigeration and refrigeration system design. The topics entails components of refrigeration system, nature of air and psychrometrics, ventilation in refrigeration system, types of refrigeration load and its estimation. In addition, air condition system control and equipments, ducting system and improvement of performance for

refrigeration and air conditioning system that involve in heat removal for food processing are included.

3.2.3.21 Food Management Sub-cluster

The Food Management sub-cluster has a total 9 related courses as shown in Table 3.28. Some of the courses are offered to more than one programme totalling to 15.

Table 3.28: Courses in the Food Management sub-cluster of the Science and Technology cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Agricultural Systems and Development	2
2.	Bioindustry	1
3.	Food Management	1
4.	Food System and Food Security	3
5.	Global Change Science	2
6.	Man and Ecosystem	2
7.	Mechanisms of Climate Change and Impact on Agriculture	2
8.	Mechanisms of Climate Change and Impact on Agriculture and Forest	1
9.	Quantitative Analysis for Agro-Industry	1
		15

The Food Management sub-cluster covers generally topics that include perspective and importance of production and productivity management in agro-industry. These entails production systems, production management, production planning and control, productivity management, productivity improvement techniques and management strategies to increase production efficiency. Techniques and simulation models of productivity improvement are part of the courses. Specifically, the management of raw materials and warehousing, storage of dried foods, chilled foods and frozen foods, warehouse technology are covered.

3.2.4 Courses in Sub-clusters of Innovation

There are 75 courses under the Innovation Cluster mainly equivalent to 3 credits hours. Each of this course can be a core or elective. Table 3.29 shows 8 programmes offering the courses in the

sub-clusters of Innovation. Two programmes offer 13 and 15 courses respectively while two other programmes offer 24 and 25 courses respectively in this cluster.

Table 3.29: Programmes offering the courses in the sub-clusters of Innovation

No.	Sub-cluster	No of Courses
1.	MSci (Food Science and Technology)	
	Food Packaging	2
	Food Development	5
	Functional Food	1
	Food Nutrition	1
	Food Processing	3
	Food Microbiology	1
	Food Ingredients	1
	Consumer Behaviour	1
		15
2.	MSci (Food Technology)	
	Food Science and Technology	1
	Physico Chemical Food	1
	Food Development	8
	Food Product Development	1
	Food Processing	1
	Design	1
		13
3.	MSci (Agro-Industrial Product Development)	
	Food Packaging	1
	Food Chemistry (Protein, Carbohydrates and Lipids)	1
	Industrial Food Production	3
	Food Development	10
	Functional Food	4
	Waste Management	1
	Food Nutrition	2
	Design	1
	Consumer Behaviour	2
	25	
4.	MSci (Technopreneurship and Innovation Management)	
	Food Science and Technology	10
	Food Packaging	1
	Agribusiness and Management	1
	Design	2
	Food Management	8

No.	Sub-cluster	No of Courses
	Industrial Visit	2
		24
4.	MSci (Food Technology) International Program	
	Food Processing	1
		1
5.	MSci (Food Science)	
	Food Development	1
	Intellectual Property	1
		2
6.	MSci (Food Science and Technology) International	
	Food Development	1
		1
7.	MSc. (Food Engineering)	
	Food Packaging	1
		1
8.	Master Program in Agro-Industry and Environment	
	Food Development	1
		1

3.2.4.1 Food Science and Technology Sub-cluster

The Food Science and Technology sub-cluster has a total 5 related courses as shown in Table 3.30. Some of the courses are offered to more than one programme totalling to 14.

Table 3.30: Courses in the Food Science and Technology sub-cluster of the Innovation cluster offered across Asia

No	Name of Course	No of Programmes
1.	Creative Morphology	2
2.	Innovative Food Science and Technology	1
3.	Optimization in Food Science and Technology	1
4.	Innovation Syntheses I	5
5.	Innovation Syntheses II	5
		14

Innovation synthesis from simple sciences and technologies, product discussion and analysis, field trips, seminar and workshops for feasibility studies are covered. This entails exploration and study of formal elements of 2 and 3 dimensional form transition to develop visual awareness, imagination and creative insight considering all possible alternatives and ideas through developing techniques that enhance the creative process.

3.2.4.2 Food Packaging Sub-cluster

The Food Packaging sub-cluster has a total 4 related courses as shown in Table 3.31. One course is offered to two programmes totalling to 5.

Table 3.31: Courses in the Food Packaging sub-cluster of the Innovation cluster offered across Asia

No	Name of Course	No of Programmes
1.	Innovations in Food Packaging	1
2.	Innovative Food Packaging Technology	1
3.	Innovative Packaging	2
4.	Packaging Design and Development	1
		5

The course gives an overview on the chemical and physical properties of the conventional packaging materials: plastics, glass, metal and cellulosic materials. The innovative packaging technologies such as active and intelligent packaging, biodegradable and edible packaging, biosensors and bioactive packaging, microwavable packaging, space food packaging as well as nanocomposite and nanotechnologies in food packaging are also covered. Inclusive are the design and production concepts; and production; types of packaging and packaging functions; packaging materials and processes considering design, marketing, legal and environmental aspects; concepts of package innovation and variations through assignments. This also entails the evaluation and analysis of commercial design, life cycle assessment of product and packaging.

New technologies cover topics on food packaging; mass transfer of gas and solute through packaging materials; quality of packed foods; active packaging research and development; smart

packaging technologies; edible and biodegradable coating and films; commercial aspects of new packaging technologies.

3.2.4.3 Physico Chemical Food Sub-cluster

In this sub-cluster, the only course offered is Physico-chemical Changes for Food Innovation which has topics covering the physico-chemical changes in food systems during processing and storage for food innovation, water activity, phase transition, rheology, fat crystallisation and emulsions innovation.

3.2.4.4 Food Development Sub-cluster

The Food Development sub-cluster has a total 22 related courses as shown in Table 3.32. Three courses are offered twice in three programmes totalling to 27.

Table 3.32: Courses in the Food Development sub-cluster of the Innovation cluster offered across Asia

No	Name of Course	No of Programmes
1.	Advanced Food Product Innovation	1
2.	Comprehensive Studies of Product Development Technology	1
3.	Current Trends in Food Industry	1
4.	Development of Agro-Industrial Products	1
5.	Development of Fruit and Vegetable Products	1
6.	Development of Snack Products	1
7.	Food Innovation and Development	1
8.	Food Innovations	1
9.	Food Product Design	1
10.	Food Product Development	2
11.	Food Product Development and Consumer Research	2
12.	Food Product Research and Development	2
13.	Frying Technology and Innovation	1
14.	Indigenous Food Product Development	1
15.	Innovations in Food Processing	1
16.	Innovative Food Products	1
17.	Modelling for Product Development	1
18.	New Food Development	1
19.	Process Development and Control	1

No	Name of Course	No of Programmes
20.	Product Development from Grains and Tubers	1
21.	Product Development Technology	1
22.	Selected Topics in Food Product Development	1
		27

The overall goal is to provide opportunity and challenge for students to integrate their training in food science and technology courses and related disciplines to gain experience in the theory and practice of developing new food products. Lectures and project involves understanding and applying practices to develop food products with novel food ingredients and/or using emerging technology. Regulatory, nutritional health implications relating to food products are covered. Business plan for the development and commercialisation of the new food product are included.

The recent advances and developments in emerging technologies relevant to food processing and preservation, membrane processes, high hydrostatic pressure, superheated steam drying, manufacture of minimally processed foods, and food nanotechnology are available in this sub-cluster in innovation. New food products like types of snack, development of snack products, raw materials and processes for snack products, qualities and quality changes of snacks and shelf life. This entails quality of grains and tubers, improvement and changing properties of starch and protein in grain and tubers by physical, chemical and biological means and their applications, new products from grains and tubers. Field trip is the practical component.

In the agro-industrial product, the courses cover topics on natural and synthetic substances used in household chemical products, production and instruments, formulation development, quality evaluation and specification establishment, standard, legislation and safety and consumer testing. It also includes the production of natural perfume, odor classification, properties of perfume and analysis, factors affecting the change of perfume properties, development of perfume formulation, consumer testing and package design.

3.2.4.5 Functional Food Sub-cluster

The Functional Food sub-cluster has a total 5 related courses as shown in Table 3.33 with 5 programmes offering these courses.

Table 3.33: Courses in the Functional Food sub-cluster of the Innovation cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Antioxidant for Product Development	1
2.	Development of Functional Food	1
3.	Development of Functional Food Products	1
4.	Emulsion Product Development	1
5.	Flavour and Colour in Product Development	1
		5

This sub-cluster covers topics on antioxidant and stability, lipid oxidation in agro-industrial products, synthetic and natural antioxidants used in products, measurement of antioxidant activity, technological aspects of antioxidant as primary and secondary antioxidants in products, antioxidants activity in oil and emulsion systems for product development.

3.2.4.6 Agribusiness and Management Sub-cluster

The Agribusiness and Management sub-cluster has two courses as shown in Table 3.34

Table 3.34: Courses in the Agribusiness and Management sub-cluster of the Innovation cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Digital Innovation Start ups	1
2.	Agricultural and Agro-Industrial Waste Product Development	1
		2

Two differing courses are in this sub-cluster. The first one is more on IT related covering market survey and competitive analysis; lean digital startups; business model innovation; minimum viable digital product; digital product analytics; fund raising for digital startups; digital startups law and exit strategy for digital startups

The second course in on waste management on types and quality of wastes from agriculture and agro-industry; products from some types of wastes; utilization of wastes and their processes. Field trip is required.

3.2.4.7 Food Nutrition Sub-cluster

The Food Nutrition sub-cluster has a total 2 related courses as shown in Table 3.35 with 2 programmes offering these courses.

Table 3.35: Courses in the Food Nutrition sub-cluster of the Innovation cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Product Development for Nutritional Claims	1
2.	Specialty Nutritional Product Development	1
		2

In the first listed course, it is related to nutrition labeling, regulations for nutrient claims, sources of ingredients used for nutrient claims, formulation for nutrient claims and product evaluation. The second course is on status and nutritional problems involving people in developed, developing, and under-developing countries; role and needs of nutritional food products by the infants, children, teenage, adults, old person and patients; standard, regulations and quality of specialty nutritional products; quality of raw materials; formulation and processing of specialty nutritional products of target consumers. Field trip is required.

3.2.4.8 Food Ingredient Sub-cluster

The Food Ingredient sub-cluster only has one course entitled Ingredient in Food Product Design and Development which covers on the properties and functions of major and minor ingredients; changes of ingredient properties in food during processing; selection of suitable ingredients for new product development.

3.2.4.9 Design Sub-cluster

The Design sub-cluster has a total 3 related courses as shown in Table 3.36 with 4 programmes offering these courses.

Table 3.36: Courses in the Design sub-cluster of the Innovation cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Food Plant and Process Design	1
2.	Process Design for Agro-Industrial Product Development	2
3.	Innovations From Institute-Industry Co-Design	1
		4

The courses in this sub-cluster cover the practice of creating innovation; innovation from real industrial problems; integration of emerging technologies; forum discussion; brain storming; market gap finding; and feasibility study based on emerging technologies. It involves topics covering the principles of food process design, food process flowsheets, material and energy balances, mechanical processes and food packaging processes, hygienic food process design, size selection and cost of process equipment; general and economic aspects of food plant design, plant location and site selection, systematic plant layout, flow relationship diagram, selection of plant layout and project evaluation and cost estimation. Significance of process design uses mathematical modeling approach and process control system.

3.2.4.10 Food Management Sub-cluster

The Food Management sub-cluster has a total 4 related courses as shown in Table 3.37 with 8 programmes offering these courses.

Table 3.37: Courses in the Food Management sub-cluster of the Innovation cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Product Planning and Development	2

2.	Technology and Innovation Management	2
3.	Technopreneurial Incubator Laboratory I	2
4.	Technopreneurial Incubator Laboratory II	2
		8

Key issues and core concept of technology and innovation management, develop a framework for innovation strategy, in search of innovation, technology and innovation selection, techniques and tools for effective implementation of innovation, the management of operations, execution of innovation, manufacturing and commercializing science and technology based ideas are in the topics. An overview of the product development process from identifying market opportunity and consumer needs, product design methodology, idea and concept generation to design-for-manufacturing are also included. Projects are based on developing a design or feasibility study of product opportunities identified with emphasis on product definition, corporate strategy for product planning, innovation, and early concept development of new product design.

Incubating actual practice of technological-based business that include the development of researches to new products or services, application and integration of design, technology, intellectual property, engineering techniques, and management to feasibility study and innovation development are provided to start up technological based business. Good-governance and sustainable practices in technological-based business, awareness of stakeholders' rights; risk assessment and risk minimization in technological- based business and manufacturing; intellectual property management of technological-based business are introduced.

3.2.4.11 Consumer Behaviour Sub-cluster

The Consumer Behaviour sub-cluster has a total 3 related courses as shown in Table 3.38 with 3 programmes offering these courses.

Table 3.38: Courses in the Consumer Behaviour sub-cluster of the Innovation cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Advanced Consumer Research for Product Development	1

2.	Consumer Technology and New Product Management	1
3.	Consumer Trends and Technology	1
		3

These courses cover topics on the importance of consumer research for product development, psychology of consumer, theories of choice, trends of consumer behavior and consumer research, qualitative and quantitative consumer research methods, questionnaire design and reliability testing, sampling, data analysis, applied analysis of variance (ANOVA) and multivariate of variance (MANOVA), applied correlation and regression analysis, conjoint analysis and its application, preference mapping and its application, emerging techniques and its applications in product development.

3.2.4.12 Industrial Visit Sub-cluster

Three programmes offer industrial visits referred to as International Innovation Field Trip. This entails overseas field trips relating to innovation at organizations: governmental, educational, industrial, and business sectors; presentation of and discussion on the learning outcomes from the field trips. It includes innovation syntheses from simple sciences and technologies, product discussion and analysis, field trips, seminars and workshops for feasibility studies.

3.2.4.13 Intellectual Property Sub-cluster

The course relating to this sub-cluster in Intellectual Property of Research and Development in Agro-Industry Innovation. The course explains the basic of patents (Invention Patent, Petty Patent, and Industrial Design Patent), Trademarks, Trade Secrets, Geographical Indications, Layout-Design of Integrated Circuits and Copyright. The major emphasis of this course is based on patent and petty patent, including what can be patented, the process of patent application and the remedies for patent infringement.

3.2.5 Engineering Cluster

There are 48 courses under the Engineering Cluster each with 3 credits hours. Each of this course can be a core or elective. Table 3.39 shows 8 programmes offering the courses in the sub-clusters of Innovation. Two programmes offer 13 and 15 courses respectively while two other programmes offer 24 and 25 courses respectively in this cluster.

Table 3.39: Programmes offering the courses in the sub-clusters of Engineering Cluster

No.	Sub-cluster	No of Courses
1.	MSci (Food Science and Technology)	
	Physico Chemical Food	4
	Food Development	2
	Postharvest Technology	1
	Food Processing	12
	Design	4
		23
2.	MSci (Food Technology)	
	Computer Aid and Automation	1
	Design	3
	Food Engineering	3
		7
3.	MSci (Agro-Industrial Product Development)	
	Computer Aid and Automation	1
		1
4.	MSci (Food Engineering)	
	Food Processing	1
	Food Engineering	1
		2
5.	MSci (Food Technology) International Program	
	Food Processing	2
	Food Engineering	1
		3
6.	MSci (Food Science)	
	Sensory Food Product Development	1
	Design	1
		2
7.	MSc. (Food Engineering)	
	Food Marketing	1
	Design	2
	Food Engineering	8
		11
8.	Master Program in Agro-Industry and Environment	

No.	Sub-cluster	No of Courses
	Design	1
		1

3.2.5.1 Physico Chemical Food Sub-cluster

The Physico Chemical Food Sub-cluster consists of two courses being offered in four programmes as shown in Table 3.40.

Table 3.40: Courses in the Physico Chemical Food sub-cluster of the Engineering cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Physical and Engineering Properties of Food and Biomaterials	2
2.	Physical and Engineering Properties of Foods	2
		4

The structure and composition of foods, physical characteristics of foods, mechanical properties of foods, thermal properties of foods, electrical properties of foods, and optical properties of foods are the fundamental topics being covered. The theories and principles of physical characteristics, rheological, thermal and surface properties of biomaterials are explained. Effects of processing parameters on these properties and relationship of these physical properties and product quality as well as acceptability with case studies are also covered.

3.2.5.2 Sensory Food Product Development Sub-cluster

Only one course entitled Biosensor Technology in Food Industry is in this cluster offered in one programme. It consists topics on principles of biosensor monitoring, biosensor fabrication, immobilization of biological components, transducer types and transduction mechanism, flow injection analysis and on-line measurement and design of biosensor system in food industry.

3.2.5.3 Food Development Sub-cluster

The Food Development Sub-cluster consists of two courses being offered in two programmes as shown in Table 3.41.

Table 3.41: Courses in the Food Development sub-cluster of the Engineering cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Membrane Technology	1
2.	Operations Research in Food Product Development	1
		2

Potentials of membrane processing, type of membrane, membrane properties, membrane modules, fouling and cleaning, microfiltration, ultrafiltration, reverse osmosis, pervaporation, gas separation, membrane distillation, liquid membrane, electrodialysis and application in industries

Role and importance of postharvest systems, internal and external factors affecting quality of fresh produce, engineering aspects of postharvest handling systems for cereal and horticultural crops, psychrometrics and postharvest operations, design of aeration and cooling systems for fresh produce, low temperature storage, controlled atmosphere and modified atmosphere storage, energy management in postharvest systems, developments and trends in postharvest technology

Momentum, heat and mass transports; mechanisms of transport, balances, equations of change, interphase transport and macroscopic balances

3.2.5.4 Postharvest Technology Sub-cluster

The only course in this sub-cluster entitled Postharvest System Engineering of Agricultural Products consists of topics on role and importance of postharvest systems, internal and external factors affecting quality of fresh produce, engineering aspects of postharvest handling systems for cereal and horticultural crops, psychrometrics and postharvest operations, design of aeration and cooling systems for fresh produce, low temperature storage, controlled atmosphere and modified atmosphere storage, energy management in postharvest systems, developments and trends in postharvest technology.

3.2.5.5 Food Processing Sub-cluster

The Food Processing Sub-cluster consists of 14 courses being offered in 15 programmes as shown in Table 3.42.

Table 3.42: Courses in the Food Processing sub-cluster of the Engineering cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Advanced Food Process Engineering	1
2.	Advanced Kinetic Analysis in Food Process Engineering	1
3.	Food Process Engineering	1
4.	Food Processing and Engineering	1
5.	Mathematical Modelling and Simulation in Food Process Engineering	1
6.	Momentum, Heat and Mass Transport Phenomena	1
7.	Numerical Computation in Food Process Engineering	1
8.	Principles of Food Process Engineering 1	1
9.	Principles of Food Process Engineering 2	1
10.	Selected Topics in Food Process and Engineering	1
11.	Selected Topics in Food Processing and Engineering	1
12.	Transfer Processes in Food and Bioprocess	1
13.	Transport Phenomena in Food Processing	2
14.	Water Activity in Food Process Engineering	1
		15

This sub-cluster covers topics on the principle of food engineering, mass and energy balances, momentum transfer, heat transfer, mass transfer, food processing and unit operations in food processing, food processing by adding heat, food processing by removing of heat and food processing at ambient temperature, changing in food properties during food processing. In addition, some courses include topics that cover the law of mass action, order of reaction, history of kinetic study, construction of kinetic equations based on King and Altman's method, construction of kinetic curves based on Euler's and fourth-order Runge-Kutta's methods, analysis of coefficients for rate of reaction, applications of computer programming in the analysis of constants from kinetic curve, analysis of lactic acid production kinetic, analysis of ethanol production using various sugars as substrates, analysis of biotransformation kinetic.

Mathematical modeling, model classification and modeling method, application and case study are prominent in this sub-cluster. Mathematical models for food processing include system analysis of balance equation: numerical solution and systematic problem analysis for numerical models, macrobalances of complex system, simultaneous heat and mass transfer, basic laws for microbalances, and systematic problem analysis of microbalances. Principles of systematic approach and modeling to from transport governing equations molecular at micro and macro scale are also explained including relationship and interaction of synchronous transport phenomena in the application of transport phenomena in food unit operation. The transport phenomena in multi-phase system, transport phenomena in the important food processes such as drying, frying, microwave processing, extraction, cooling by forced-convective heat transfer and separation by membrane are also available.

Importance of water and water activity in foods, relationship between water activity and glass transition, sorption isotherms of foods, relationship between water activity and microbial growth, relationship between water activity and chemical changes, diffusion of water and water adsorption kinetics of foods, desorption of water in drying and application of water activity in food industry are also included.

3.2.5.6 Computer Aid and Automation Sub-cluster

The Computer Aid and Automation Sub-cluster consists of 14 courses being offered in 15 programmes as shown in Table 3.43.

Table 3.43: Courses in the Computer Aid and Automation sub-cluster of the Engineering cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Computer Aid and Automation in Food Industry	1
2.	Development of Mathematical Modelling and Simulation in Food Process Engineering with Visual Basic Applications Programming	1
3.	Operation Research in Agro-Industry	1
		3

Application of computer and instrument such as controllers, indicators and sensors for the process automation in food plants are related to computer programming based on assumptions for mathematical modeling. Development of mathematical modeling, selection of mathematical model, numerical integration method are the important topics. This entails visual basic for applications programming, iteration techniques, linear regression, non-linear regression, differential equations system and applications of residual sum of square method. The application of mathematics and statistics, probability theory, linear programming techniques, transportation problems, assignment problem, project planning, decision theory, game theory and queuing theory to solve the problem in agro-industry are included.

3.2.5.7 Design Sub-cluster

The Design sub-cluster consists of 10 courses being offered in 10 programmes as shown in Table 3.44.

Table 3.44: Courses in the Design sub-cluster of the Engineering cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Biological Engineering Design	1
2.	Design and Analysis of Experiments in Food Process Engineering	1
3.	Equipment Design in Food Industry	1
4.	Food Machinery Design and System Control	1
5.	Food Plant and Process Design	1
6.	Food Process and Plant Design	1
7.	Food Processing Plant Design	1
8.	Hygiene in Food Engineering Design	1
9.	Laboratory in Design and Analysis of Experiments in Food Process Engineering	1
10.	Physical Unit Operation	1
		10

This sub-cluster covers the general principles of strength of materials, design of power transmission systems, operational characteristics and design features associated with processing equipment for food products, and computer software tools to aid designs. The conceptual framework for machinery design related to food processing is included with computer

application for conceptual design for food machinery. Specifications of food machinery components and their selection, instrument control and monitoring are studied.

The design of food processing plant including plant layout, machine installation, water treatment and plant maintenances are other areas in this sub-cluster.

From the food hygiene and safety perspective, it entails regulation and organization related to hygienic engineering. This involves in hygienic design of plant facility and food machinery.

A student project with food processing plant related to identifying problems and solutions of non-conformed hygienic plant and machine design is the practical component.

3.2.5.8 Food Engineering Sub-cluster

The Food Engineering sub-cluster consists of 14 courses being offered in 14 programmes as shown in Table 3.45.

Table 3.45: Courses in the Food Engineering sub-cluster of the Engineering cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Advanced Biochemical Engineering	1
2.	Applied Numerical Methods in Food Engineering	1
3.	Energy Management in Food-Industrial Plant	1
4.	Engineering Properties of Food and Biological Materials	1
5.	Food Engineering-	1
6.	Microwave Technology for Food Engineering	1
7.	Optimization in Food Engineering	1
8.	Physical and Engineering Properties of Biomaterials	1
9.	Principles of Food Engineering	1
10.	Reaction Kinetics in Food	1
11.	Reaction Kinetics in Food Engineering	1
12.	Selected Topic in Food Engineering 1	1
13.	Selected Topic in Food Engineering 2	1
14.	Selected Topics in Food Engineering	1
		14

As this is a very specific sub-cluster, the various courses have topics with similarity and some overlapping with food processing in engineering. Most courses cover the principle of food engineering, mass and energy balances, momentum transfer, heat transfer, mass transfer, food processing and unit operations in food processing, food processing by adding heat, food processing by removing of heat and food processing at ambient temperature, changing in food properties during food processing mass and energy balances, fluid flow, mechanical separation, mixing, size reduction and fluidization.

It also uses application of mathematic for solving of food engineering problem taht include error approximation, interpolating polynomial, and numerical method for complex variable solution such as Taylor series, numerical differentiation, roots of linear and nonlinear equations. Exact solutions to linear algebraic equation, curve fitting, and ordinary differential equations, numerical solution of integral equation, ordinary differential equations, partial differential equations and finite differential equations are also included.

Another area introduces principle of energy and the act of legislation for energy conservation, energy management and audit in electrical devices e.g. reduction for maximum electrical demand and energy saving for air conditioning and refrigeration, energy saving in boiler and waste heat recovery. Technique of energy usage analysis and energy account development are explained. Knowledge of computer software is introduced for building envelope and energy saving in food industry. Case study of design for appropriate thermal system for food industry and clean technology are part of the practical component.

Some of the variation of courses in this sub-clusters are:

- Important engineering properties in storing and processing of foods and biological materials; design and usage of measuring equipment to assess engineering properties, application of engineering properties in food and biological systems such as loss improvement in agricultural produce handing system or efficiency improvement in food processing system and non-destructive technologies applied to engineering properties of food and biological materials;
- Basic concept of microwave technology based on Maxwell's equations, dielectric properties of foods, heat generation by microwave, application of microwave in food

engineering e.g., drying, pasteurization, heating, non-destructive moisture content prediction, and prediction of food properties and design of microwave equipment and sensor in food engineering;

- Statistical theory of optimization including model development, model optimization, and mathematical method in optimization, data management and design of experiment in full and fractional factorial, e.g, Box-Behnken design, central composite design (CCD), Plackett-Burman design, statistical model development, Response Surface Methodology (RSM) and using computer program in optimization and application in food engineering;
- Unit and Dimension, principles of momentum transfer, fundamental of fluid dynamics, flow in pipe: Newtonian fluid and non-Newtonian fluid, Thermodynamics and Psychrometric chart, principles of heat transfer; steady state and unsteady state heat transfer, heat exchanger based on the principles of mass transfer; diffusion law and convective mass transfer;
- Introduction of reaction kinetics in food engineering, kinetics of reaction, order of reaction, reaction rate, type of reactions, effect of temperature and pressure, collection and analysis of reaction rate data, vitamins kinetics, pigments kinetics, non-enzymatic browning kinetics, water activity and food stability kinetics, kinetics associated with alternative processing technologies;
- Treatment of engineering data, mathematical formulation of engineering problems, roots of equations, linear equations, least-squares regression, numerical integration, solution of ordinary differential equations and solution of partial differential equations;
- Model construction, assumptions and model assessment, linear regression, nonlinear regression, iterative techniques, multiresponse parameter estimation, systems of differential equations, numerical methods, and application of residual sum of squares minimization method.

3.2.6 Others Cluster

There are 60 courses in this Cluster each with 3 credits hours. Each of this course can be a core or elective. Table 3.39 shows 22 programmes offering the courses in the sub-clusters of Others Cluster. Research Methodology is the main course.

Table 3.46: Programmes offering the courses in the sub-clusters of Others Cluster

No.	Sub-cluster	No of Courses
1.	MSci (Food Science and Technology)	
	Food Science and Technology	1
	Food Development	1
	Research Methodology	10
	Food Safety and Quality	2
	Food Biotechnology	1
	Industrial Visit	1
		16
2.	MSci (Food Safety and Quality)	
	Research Methodology	1
		1
3.	MSci (Food Safety and Quality Assurance)	
	Research Methodology	1
		1
4.	MSci (Food Technology)	
	Research Methodology	9
		9
5.	MSci (Agro-Industrial Product Development)	
	Industrial Food Production	1
	Research Methodology	7
	Food Safety and Quality	2
		10
6.	MSci (Food Security and Climate Change (Policy Maker - Agro-Industrial Technology Management)	
	Research Methodology	2
		2
7.	MSci (Nutrition)	
	Research Methodology	3
		3
8.	MSci (Technopreneurship and Innovation Management)	
	Research Methodology	2
	Food Safety and Quality	1
		3
9.	MSci (Food Engineering)	
10.	Research Methodology	2
		2
11.	MSci (Food Technology) International Program	
12.	Research Methodology	1
		1
13.	MSci (Food Science)	

No.	Sub-cluster	No of Courses
	Research Methodology	6
	Food Safety and Quality	1
	Communication	1
		8
14.	MSci (Food Science and Technology) International	
	Research Methodology	2
		2
15.	MSc. (Food Engineering)	
16.	Research Methodology	1
	Food Safety and Quality	1
		2
17.	Master Program in Agro-Industry and Environment	
	Research Methodology	3
		3
18.	Master of Philosophy (Food Studies)	
20.	Research Methodology	1
		1
21.	MSci (Food Security and Climate Change (Researcher - Food Science)	
	Research Methodology	5
		5
22.	Msci (Food Security and Climate Change (Researcher - Biotechnology)	
	Research Methodology	2
		2

3.2.6.1 Industrial Food Production Sub-cluster

This sub-cluster consists of two courses being offered in two separate programmes as indicated in Table 3.47.

Table 3.47: Courses in the Industrial Food Production sub-cluster of the Other cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Pulp and Paper Technology	1
2.	Fresh Product Management	1
		2

Pulp and Paper Technology is basically on biomass management covering topics on the physical and chemical properties of fiber, pulping process, stock preparation and paper properties development, papermaking process, paper properties testing, classification of paper types and clean technology for pulp and paper industry.

The Fresh Product Management can actually fall into Food Development sub-cluster in the in the Science and Technology Cluster. It covers topics on production planning, primary raw material handling, sanitation in fresh product manufacturing, packing and storage, quality assurance and control, quality changes during storage, supply chain of fresh food, logistics of raw materials and fresh food, inventory management with a case study.

3.2.6.2 Research Methodology Sub-cluster

This sub-cluster consists of 41 courses being offered in 55 programmes as indicated in Table 3.48. The course name of Research Methodology is commonly used in the three Asian countries with some variations of topics.

Table 3.48: Courses in the Industrial Food Production sub-cluster of the Other cluster offered across Asia

No.	Name of Course	No of Programmes
1.	Advanced Research Methods in Food Engineering	1
2.	Advanced Statistics and Experimental Design for Agro-Industry	1
3.	Advanced Statistics for Product Development	1
4.	Applied Multivariate Statistical Analysis	1
5.	Applied Statistics	1
6.	Applied Statistics for Food Science Research	1
7.	Applied Statistics for Product Development	1
8.	Applied Statistics for Product Development I	1
9.	Applied Statistics for Product Development II	1
10.	Data Analysis and Management for Agro-Industrial Product Development	1
11.	Data Analysing in Fundamental and Advance	1

No.	Name of Course	No of Programmes
12.	Descriptive Analysis Techniques	1
13.	Experimental Design for Food Technologists	1
14.	Experimental Design for Research in Food Science and Technology	1
15.	Experimental Design for Technologists	1
16.	Experimental Design in Food Product development	1
17.	Experimental Design in Food Product Development	1
18.	Experimental Design in Food Research	1
19.	Experimental Design in Product Development	1
20.	Experimental Designs in Food Research	1
21.	Experimental Technique in Food Science	2
22.	Food Research Statistics	1
23.	Research and Development of Functional Foods	1
24.	Research Methodology	9
25.	Research Methodology and Statistics in Food science and Technology	2
26.	Research Methodology for Food Engineering	1
27.	Research Methodology for Food Industry	2
28.	Research Methodology for Food Technology	1
29.	Research Methodology in Biotechnology in Agro-Industry	1
30.	Research Methodology in Food Science and Technology	1
31.	Research Methodology in Food Technology	2
32.	Research Methodology in Science and Technology	1
33.	Research Methodology in Technopreneurship	2
34.	Research Methods in Agro-Industrial Product Development	1
35.	Research Methods in Agro-Industrial Technology Management	1
36.	Research Methods in Food Science	2
37.	Research or Professional Projects	1
38.	Research Techniques in Nutrition	1
39.	Statistical Methods for Food Research	1
40.	Statistics for Agro-Industry Research	1
41.	Statistics for Product Development	1
		55

These courses are described to provide students with knowledge and exposure required on methods and ethics to carry out a scientific research. Basically, it involves in concepts and methods for preparing research project in food science and technology, planning and managing of scientific research, research process and techniques, research ethics, collection and organization of research data, design of experiments, statistical methods for research, process of

preparing proposal, analysis and assessment of research results, research reporting and technology transfer to industry. Students will be introduced to different experimental design and components involved in research proposal writing. The student will perform a systematically research project and present the research proposal at the end of semester. It is designed for biological experiments and advanced product development analysis using appropriate statistical tests with computer software.

The topics generally cover specifically as follows:

- Definition, components of descriptive analysis, selection and training of panel members, the flavor profile method, the texture profile method, the quantitative descriptive analysis method, the spectrum™ descriptive analysis method, time-intensity descriptive analysis, freechoice profiling method, ideal ratio profile method, generic descriptive analysis and application of descriptive analysis;
- Application of non-parametric statistics, multivariate analysis, conjoint analysis, logistic regression and discriminant analysis, factor analysis and cluster analysis, principal component analysis and preference mapping, optimization technique, transformation technique for product development;
- Application of experimental design for product development, response surface design, empirical equation establishment techniques, advanced product optimization techniques, scaling techniques and multidimensional analysis, component and factor analysis and statistical program;
- Application of experimental designs in food research using analysis of variance, regression and correlation analysis, response surface analysis, optimization of food formulation and processing condition;
- Simple comparative experiments, experiments with a single factor, experiments with randomized blocks and latin squares, factorial designs, factorial experiments with random factors, nested and split-plot design, regression models, and response surface methods.

3.2.6.3 Food Biotechnology Sub-cluster

This sub-cluster has only one course called Researcher ethnic which is about an overview of research ethic; research misconduct; main ethical issues in scientific research; data fabrication; data falsification; plagiarism; conflicts of interest; data management; mentor and trainee responsibilities; collaborative research; authorship and publication; peer review; animal experiment and human experiment.

3.2.6.4 Communication Skills Sub-cluster

This sub-cluster also consists of one course entitled Techniques in Scientific Communication that covers topics on an overview of techniques for finding out science information, presentation of oral, written and poster for scientific presentation, emphasis on oral presentation delivery, content development and organizing and good audience perspective by using appropriate computer software and integration the knowledge to solve the problem or development in food science.

4. The Focus Group Discussions

4.1 Focal Group Discussions in Malaysia

The first two questions used the Likert Scale as below:

1	2	3	4	5
Not important	Slightly important	Important	Fairly important	Very important

4.1.1 How important are the following modules in FOODI Program?

Responses showed that Food Innovation, Science and Technology and Entrepreneurship courses are close to very important in that order of ranking (Table 4.1.1).

Table 4.1.1: Important Modules in FOODI program

	Important	Fairly important	Very important	Mean
Entrepreneurship	0	4	6	4.60
Food Innovation	0	1	9	4.80
Science and Technology	0	3	7	4.70
Engineering	2	5	3	4.10

4.1.2 How important are the following courses in Entrepreneurship Module?

Among the fourteen courses listed in Entrepreneurship Module, the respondents emphasized Halal and Food Law as very important as Malaysia is establishing itself as a halal hub (Table 4.1.2). Entrepreneurship and Innovation; and Food Legislation and International Trade are also close to very important indicating move towards global direction. On the other end, the traditional Agri-food marketing and Agricultural Sector and Policy Analysis are considered fairly important. Food services and World Food Culture are also considered the scope of the FOODI programme.

Table 4.1.2: Important Courses in Entrepreneurship Module

	Not important	Slightly important	Important	Fairly important	Very important	Mean
Food supply chain management	0	0	2	4	4	4.20
Consumer preferences and behaviour	0	0	1	6	3	4.20
Agri-food marketing	0	0	4	4	2	3.80
Entrepreneurship and innovation	0	0		3	7	4.70

Halal and Food Law	0	0			10	5.00
Food packaging and Labelling	0	0	1	4	5	4.40
Food Legislation and International Trade	0	0	1	2	7	4.60
Social-Economic Impact of Unsafe Food Supply	0	0	2	2	4	4.20
Food Services	0	0	5	3	2	3.70
World Food Culture	0	0	3	5	2	3.90
Agricultural Sector and Policy Analysis	0	0	4	4	2	3.80
Financial Management	0	0	3	3	4	4.10
Corporate Social Responsibility and Ethics	0	0	3	4	3	4.00
Bio-analysis for Industry and Eco-farming	0	0	3	4	3	4.00

4.1.3 How important are the following courses in Food Innovation Module?

The word “Innovation” plays a key role in the respondents’ perception of relevance of FOODI programme as an indicator of “newest” technology to be introduced (Table 4.1.3).

Table 4.1.3 Important Courses in Food Innovation Module

	Important	Fairly important	Very important	Mean
Innovative Food Packaging Technology	0	1	5	4.83
Innovative Food Products	1	2	7	4.60
Innovation in industrial food processing	0	1	9	4.90

4.1.4 How important are the following courses in Science and Technology Module?

Two courses on Food Commodity Processing Technology and Food Safety and Quality Management were indicated to be close to very important (Table 4.1.4). Advanced Food Preservation and Processing was between fairly important and very important. The other courses were perceived as already embedded in the Food Safety and Quality Management.

Table 4.1.4: Important Courses in Science and Technology Module

	Slightly important	Important	Fairly important	Very important	Mean
Food Commodity Processing Technology	0	0	3	7	4.70
Advanced Food Analysis	0	3	4	3	4.00
Food Safety and Quality Management	0	0	3	7	4.70
Food Ingredients Technology	0	1	4	5	4.40
Advanced Food Chemistry	0	2	5	3	4.10
Food Biotechnology	0	1	4	5	4.40
Virtualization for R&D in the food industry	0	3	4	3	4.00
Microbial Foodborne Pathogens	0	1	5	4	4.30
Interaction of Food Components during Processing	0	1	4	5	4.40
Traceability in Food Supply Chain	0	2	4	3	4.11
Managing Food Allergy and Intolerance	0	3	3	4	4.10
Advanced Food Preservation and Processing	0	1	3	6	4.50
Food and Nutrition Microbiology	0	1	5	4	4.30
Food and Nutrition Toxicology	0	1	4	5	4.40
Nutrition Education	0	1	5	4	4.30
Science of Fats and Oils	0	2	6	2	4.00
Food Additives	0	1	6	3	4.10
Sugar and Chocolate Confection Technology	1	1	5	3	4.00
Nutritional Anthropology	0	3	4	3	4.00
Probiotics, Functional Foods and Nutraceuticals	0	2	3	5	4.30
Food Waste and Loss	0	2	7	1	3.90

4.1.5 How important are the following courses in Engineering Module?

Although the Engineer Module was not considered to be important, one course was ranked as very important was the Units Operation and Food Engineering (Table 4.1.5).

Table 4.1.5: Important Courses in Engineering Module

	Important	Fairly important	Very important	Mean
Units Operation and Food Engineering	0	0	5	5.0
Industrial process control	2	2	6	4.40
Food Process Engineering	1	4	5	4.40
Postharvest Engineering	3	5	2	3.90
Waste Vaporization, Green Technology and Bioeconomy	1	6	2	4.11
Controlled Environment Agriculture	4	4	2	3.80

4.1.6 The following are others courses other than the main modules. How important are the courses?

Research Methodology was considered close to very important (Table 4.1.6) .

Table 4.1.6: Other Important Courses in FOODI programme

	Important	Fairly important	Very important	Mean
Research Methodology	1	2	7	4.60
Sports Nutrition	5	4	1	3.60
Diet Therapy	3	6	1	3.80

4.1.7 The following is the Technical Skill modules. How important are the courses?

Two courses were considered as very important: Food-processing Principles and Production Development Skill (Table 4.1.7). The other two suggested courses could be perceived as subtopics of the two important courses.

Table 4.1.7: Important of Technical Modules

	Important	Fairly important	Very important	Mean
Food-processing principles skills	0	1	9	4.90
Microbiological Skills	1	5	4	4.30
Chemistry Skills	2	3	5	4.30
Product Development Skills	0	2	8	4.80

4.1.8 Perception of Technical and Business Modules forming the major part of postgraduate programs for the Food Industry

Table 4.1.8 shows the perception of technical and business modules forming the major part of postgraduate programs for the food industry were very important in the food industry.

Table 4.1.8: Perception of Technical and Business Modules

	Important	Fairly important	Very important	Mean
Do you think Technical Modules should form the major part of postgraduate programs for the Food Industry?	3	3	4	4.10
Do you think that a business perspective is needed in postgraduate programs for the Food Industry?	0	4	6	4.60

4.1.9 Do you think the following are required as partial fulfilment for the program?

Ninety percent of the respondents expressed that training, internship or industrial attachment was required (Table 4.1.9). There was also a general consensus that a graduate thesis should be part of the programme.

Table 4.1.9: Requirement of Training, Internship or Industrial Attachment and Thesis Requirement

	Required		Not Required	
	No	%	No	%
Training/Internship / Industrial attachment	9	90	1	10
Graduate Project/Thesis	10	100	0	0
Publication	6	67	3	33

4.1.10 Which approach would you see as most desirable in the postgraduate programs for the Food Industry?

A split suggestion in mode of postgraduate programme being mainly academic and a programme consisting of 50% Academic and Practical was obtained (Figure 4.1.1). Nobody opted for the 75% Academic and 25% Practical approach.

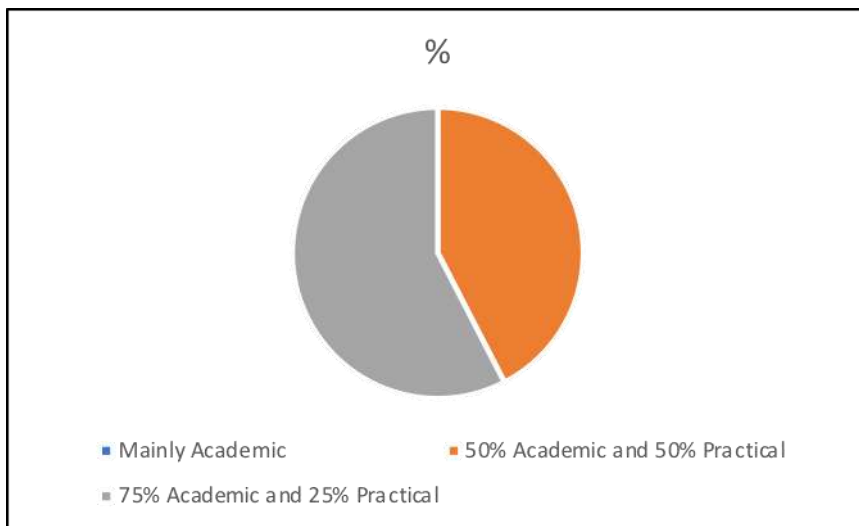


Figure 4.1.1: Approach of Postgraduate Programs in Food Industry

4.1.12 When is the most suitable time to conduct the postgraduate programme for the Food Industry?

All the respondents came to the consensus that the preference to conduct the programme in the daytime during the office hours. This indicates that postgraduate students should be able to given study leave from their employers as shown in Table 4.1.11.

Table 4.1.11: Most Suitable Time to Conduct the Postgraduate Programme

Time of Delivery	No	%
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Daytime (Office Hours)	5	100
Evening	0	0
Weekends	0	0
Block Release	0	0
Flexible (on-line)	0	0

4.1.13 What do you see as the competitive advantage/unique selling point of your own programme?

Table 4.1.12 shows the response pertaining to competitive advantage/unique selling point of the programme from three perspective, Educational, academics and operational. From the educational perspective, the highest mean of 4.67 was obtained three courses: Food Quality; Food and Health and Entrepreneurship in Food Industry.

From the academic perspective, Cooperation with other universities/institutes scored a mean of 5.0.

From the operational perspective, the course should be offered Full time course (1 year) indicating the preference.

Table 4.1.12: Competitive Advantage/Unique Selling Point of the Programme from Three Perspectives: Educational, Academics and Operational

Educational

	Small				Great	Mean
The industrial food processing	0	0	0	2	1	4.33
Food packaging and labelling	0	0	0	3	0	4.00
Food quality	0	0	0	1	2	4.67
Logistics and Transportation	0	0	1	2	0	3.67
Traditional foods – Superfoods	0	0	1	2	0	3.67
Food and Health	0	0	0	1	2	4.67
Entrepreneurship in Food Industry	0	0	0	1	2	4.67
Innovation in Foods	0	0	0	2	1	4.33

Marketing in Food Products	0	0	0	3	0	4.00
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Academics

	Small				Great	Mean
Staff	0	0	0	2	1	4.33
Links with Research programmes	0	0	0	1	2	4.67
Cooperation with other universities/institutes	0	0	0	0	3	5.00
Laboratories	0	0	0	1	2	4.67
Research/Publications	0	0	0	3	0	4.00

Operational

	Small				Great	Mean
Distance Learning	0	0	2	0	0	3.00
E-class/Moodle platforms	0	0	0	1	1	4.50
Libraries	0	0	0	1	1	4.50
Full time course (1 year)	0	0	0	0	3	5.00
Part time course (2 years)	0	0	0	1	1	4.50
Fees	0	0	0	1	1	4.50

4.1.13 Who is the target group for your own MSc programme?

Figure 4.1.2 shows that the professions related to Agriculture/Science Employees; Entrepreneurs and Food Business Employees are the target groups.

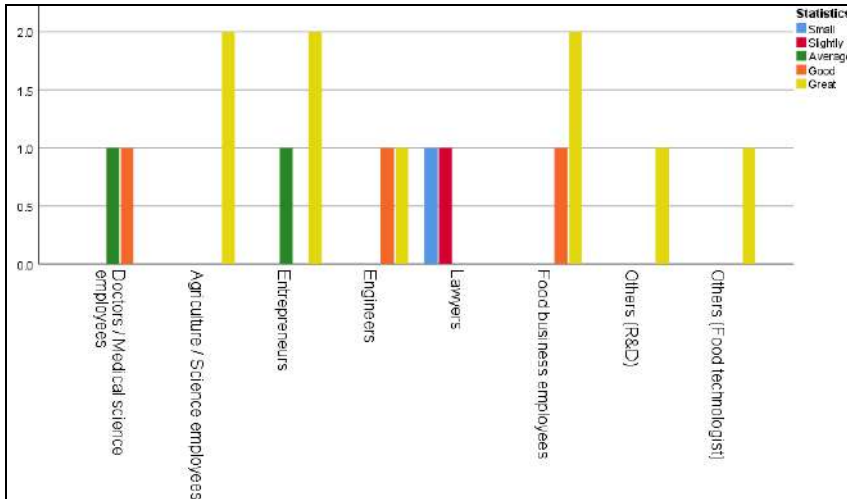


Figure 4.12: Target Groups

4.1.14 Which of the following mode of deliveries are suitable for the Food Industry postgraduate programs?

Figure 4.1.3 indicates that projects and blended learning were the preference of mode of deliveries. Work experience was also suggested as a prerequisite.

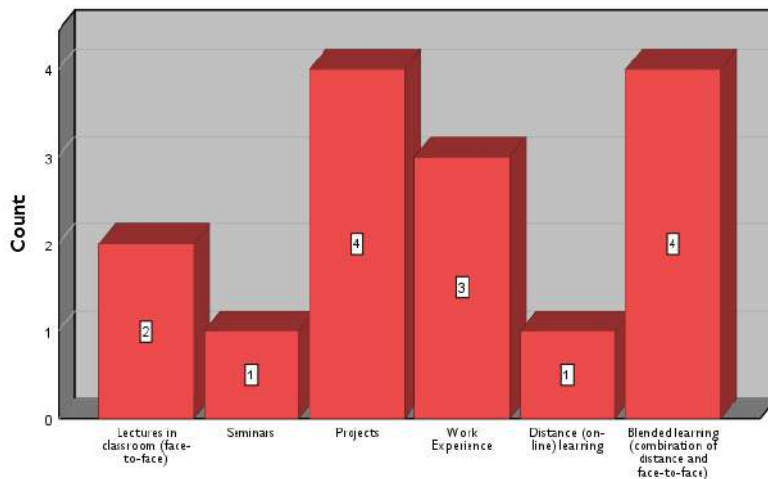


Figure 4.1.3: Suitability of Mode of Deliveries

4.1.15 Industrial Stakeholders

Responses from the industrials stakeholders were summarized.

4.1.15.1 Are you employing Masters graduates whose position might be potentially taken by FOODI Graduates?

Out of the ten responses, 90% indicated that they would employed FOODI graduates.

4.1.15.2 What is their role in your company?

Based on the outcome shown in Table 4.1.13, the FOODI graduates would be placed as product developer.

Table 4.1.13: Role of FOODI Graduates in Stakeholders' Company

	Total
Product developer	6
Laboratory expert	2
Responsible for a brand	2
Innovation manager	3
Process developer	2
Others (Academic lecturer)	1
Others (Dietician)	1
Marketing of new products	0
Production line designer	1
Production line operator/manager	0

4.1.15.3 Which of the following competences are not possessed by your Master graduates, but you think would be useful?

Table 4.1.14 indicates that innovation is a very important competence sought after by the companies.

Table 4.1.14 Competences of Master Graduates

Useful competences for Master graduates	Entrepreneurship	4
	Innovation	7
	Fundamental of process/equipment design	3
	Management	3
	Fundamental of process/equipment operation	3

Marketing	1
Food relevant law	1
Fundamentals of food science	1
Fundamentals of food processing	1

4.1.16 Open-ended Focused Questions responses

4.1.16.1 The Profile of the Participants in the Focus Group Discussions

The list of representatives of the Stakeholders is listed in Table 4.1.15: five from West Malaysia and three from Sarawak.

Table 4.1.15: List of Stakeholders

Participant 1	Director of Operation for BERNAS Malaysia, a leading company in the paddy and rice industry. BERNAS and its group of companies are involved in the procurement and processing of paddy; as well as the importation, warehousing, distribution and marketing of rice in Malaysia. Prior experience includes companies like Danone Dumex and Cadbury.
Participant 2	Chief Executive Officers for Malaysia College of Hospitality and Management. The college is focusing on Courses related to food preparation including culinary skills. Prior experience include being CEO for leading private hospitals in Malaysia
Participant 3	Deputy General Manager for KARA Holdings Sdn Bhd a leading operator for Ayama eatery outlets in Malaysia. The company runs more than 40 eatery outlets and expanding aggressively through a franchise scheme targeting 100 outlet in next five years. Prior experience include managing KFC and many other hospitality services.
Participant 4	Lecturer in Nutritional Science in Universiti Kebangsaan Malaysia, one of the leading research universities in Malaysia
Participant 5	Human Resource Business Partner for McDonalds Malaysia.

Participant 6	Human Resource Manager, Nestle Manufacturing Sdn Bhd, Sarawak Branch
Participant 7	General Manager, Sarawak Flour Mill, Sarawak
Participant 8	Managing Director, Fezul Foodtech Sdn. Bhd, Sarawak

4.1.17 Exit Questions

There were three sections and Exit Question to the focus group discussion:

1. Introduction

Q1: Food industry is rapidly changing. What are the characteristics of the new model that is being shaped according to your point of view and professional experience?

Q2: How do you think your organisation/company will be affected by the changes in the near future?

Q3: What changes do you see in the Sector?

Q4: What is the role of your country's educational institutions in equipping young graduates with the required skills and competences? What do you think is missing?

Q5: How well prepared do you think you are to meet the market needs?

2. Sector Skills Gap Explanatory Questions

Q1: Recruitment of skilled employees in the growing Food innovation sector is an increasing problem. What do you think should be the ideal profile of an employee in the Sector?

Q2: What do you think are the main skills missing from the current employees?

Q3: Are you familiar with the term "soft skills"? Can you name some of them?

Q4: Are you satisfied by the soft skills and competences of your employees?

Q5: Are you satisfied with the number of employees your organisation/company employs?

Q6: What actions do you take as an organisation/company to train your employees?

Q7: How do you assess the performance of your employees in terms of soft skills?

Q8: Would you please let us know, what is your opinion on the current offered curricula in the Food innovation sector? What do you think is missing?

Q9: What changes have you brought as an organisation/company to meet Food industry needs?

Q10: What is your opinion on career days? Do you find them useful?

3. Internship Demand & Curricula design input

Q1: Would you please let us know, what is your opinion on the current offered curricula in Food Industry sector?

Q2: Would you please let us know, what is your opinion on the teaching methods and educational structures in the food industry sector?

Q3: Do you think current teaching methods are innovative, promote creative thinking and autonomous learning?

Q4: Do you think that current learning material equips the learner with adequate knowledge to meet labour market needs?

Q5: What type of food professionals do you believe the sector needs and lacks mostly? i.e. engineers, managers etc.

Q6: Would you like to assist the FOODI Partnership in the design of training curricula via offering your input during their design?

Q7: Would you be willing to host an internship for a FOODI learner during the delivery of the learning programme?

Exit Questions - “Profile of a successful employee”

Q1: What solutions do you propose for the Sector to meet current needs?

Q2: If you could summarize in three words the challenges your Sector is facing, what would they be?

Q3: If you could summarize in three words the profile of a successful employee, what skills would you put first?

A summary of focused questions is shown in Table 4.1.16

Table 4.1.16: Summarized Responses from Stakeholders

1	Introductory – 5 Questions	<ul style="list-style-type: none"> • more new technology will come out, where cost and efficiency of the new technology will be the key areas to look at. • sustainable source of raw materials from local suppliers, stringent requirement for Halal and Safety of food and rapid change of technology to cope with – suitable employee • soft skill as significant as the paper requirement
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2	Sector Skills Gap Explanatory Questions – 10 Questions	<ul style="list-style-type: none"> • graduates from food programs are of “food science” area; not many from “food technology” area • Lack of communication skill • Lack of soft skill particularly in problem solving; • Lack in teamwork and efforts in understanding the integration between departments • Retraining through in house training where employee are put into various section for few months – providing some management skill training, communication skill training, time management skill training, supervisory and coaching skills training • Lacking food technologist
3	Internship Demand & Curricula design input - 7 Questions	<ul style="list-style-type: none"> • demand for internship at their organizations • agreeable to potential sponsorship such as sponsoring students and guest lecturers • also considers to allow students to have access to their facilities • good background knowledge on food processing after graduating but need to go through training in the food industry • lecturers also should have the industrial background. • Curricula design must include the followings: Halal Certification Regulatory Requirements Specific module for major food sectors in the country such as rice processing, poultry management and so on. • Negotiation Skills
4	Exit questions – 3 Questions “profile of a successful employee”	<ul style="list-style-type: none"> • good knowledge on updated or current food technology • Character: possessing good attitude; resilient and committed • Not calculative

4.2. Focal Group Discussion from Cambodia

The Focus Group Discussion was organized by Svay Rieng University at the General Department of Higher Education, Ministry of Education, Youth and Sport, from 12th to 13th June 2019 under the facilitating of Dr. Nith Bunlay, General Department of Higher Education, and with the participants from:

A. Academics:

1. HE. Pin Vannaro, Rector of University Heng Samrin Tbongkhmum (UHST)
2. Mr. Loek Virak, Vice rector of Svay Rieng University (SRU)
3. Dr. Serey Mardy, Deputy Head of Research and Development Office, SRU
4. Mr. Khun Rottana, Lecturer, SRU
5. Mr. Sort Tit, Lecturer, SRU
6. Mr. Khoeun Sokun, Lecturer, SRU
7. Mr. Pin Chanda, Vice Dean of Agriculture, Chea Sim University of Kamchaymear
8. Dr. Mith Hasika, Head of Master Program, ITC
9. Dr. Ngoun Samnang, Vice Dean of Agro-industry, Royal University of Agriculture

B. Industries:

1. Ms. Thun Sotheany, Quality Assurance, Aprati Foods (Cambodia) Ltd.
2. Mr. Sear Borin, Operation & Development Manager, Confirel Co., Ltd.

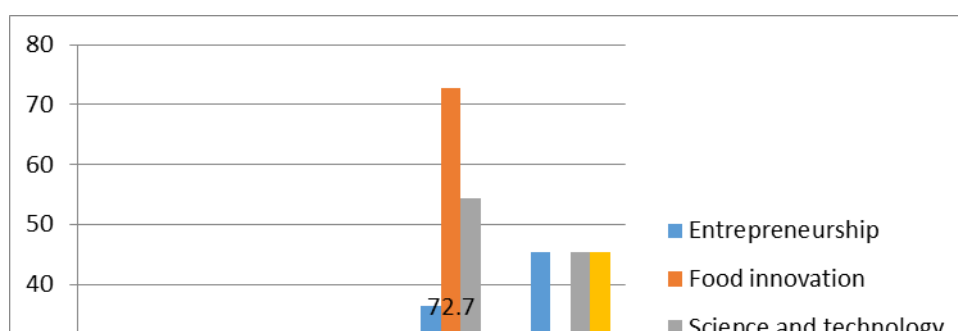
C. Students:

1. Mr. Ham Menghor, Year-5 student of Agro-industry, ITC
2. Ms. Siev Huyloem, Year-5 student of Agro-industry, ITC
3. Mr. Huon Rinoy, Year-5 student of Agro-industry, ITC

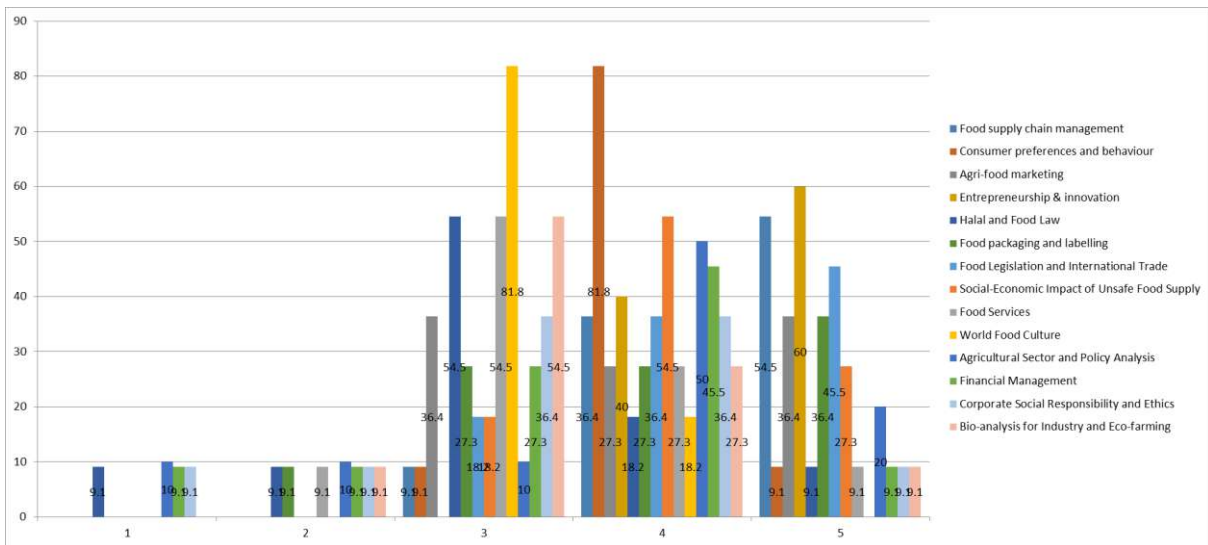
The agenda and the list of attendance of this FGD have been attached.

The result found as follows:

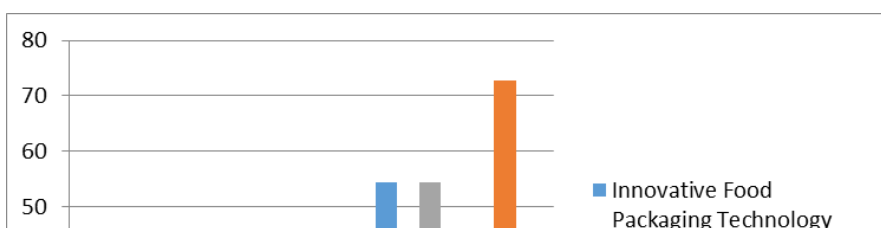
1. Concerning four main modules, the most importance module are Entrepreneurship, Science and technology and Engineering, at 45.5% accordingly. However, Food innovation is also an important module at 72.7%.



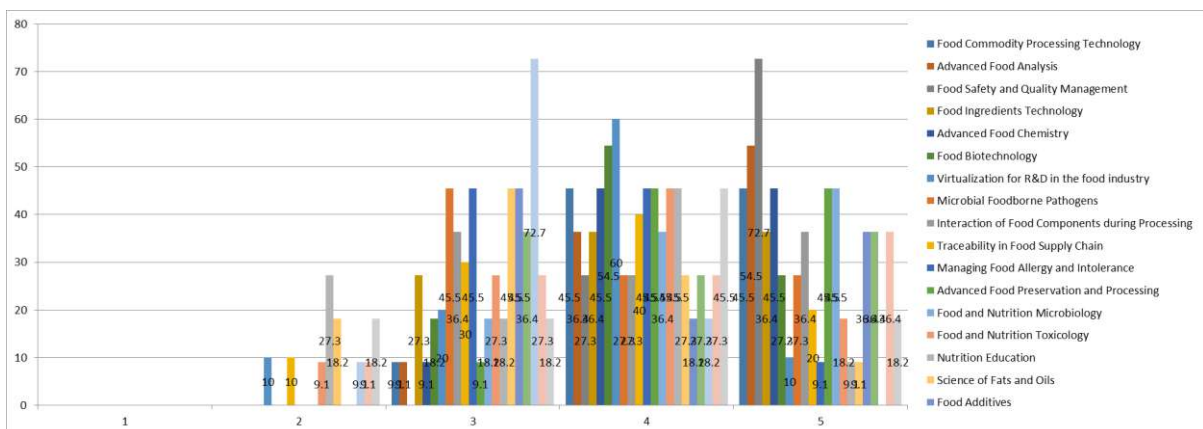
2. Concerning the Entrepreneurship Module, the importance of the courses are Entrepreneurship and innovation (60%), Food supply chain management (54.5%) and Food legislation and international trade (45.5%). However, the Consumer preferences and behaviour is also importance (81.8%).



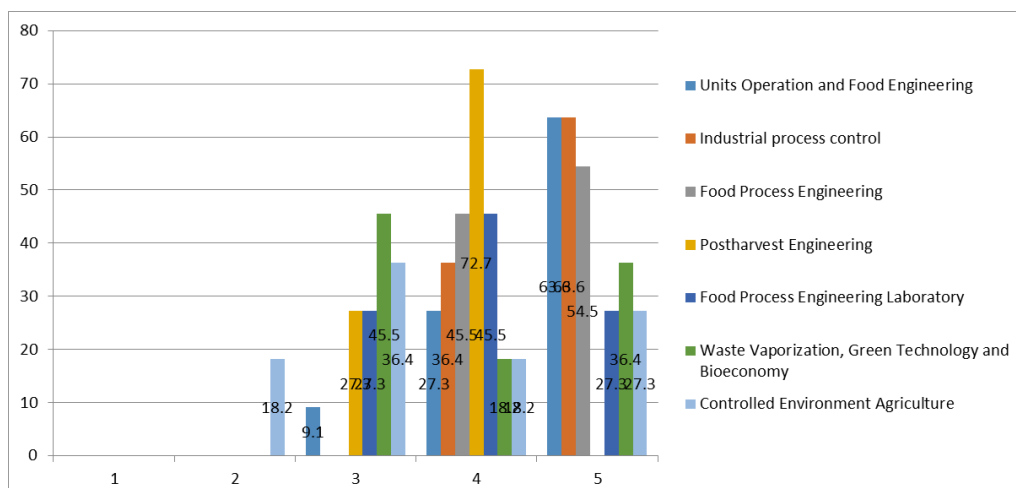
3. Concerning the Food Innovation Module, the importance of the course is Innovative food products (72.7%), followed by Innovation in industrial food processing (45.5%).



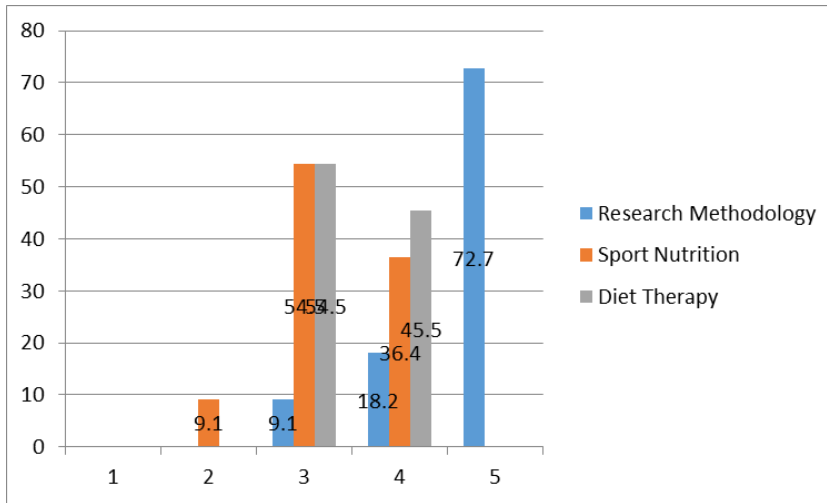
4. Concerning the Science and Technology Module, the importance of course is Food safety and quality management (72.7%), followed by Advanced food analysis (54.5%).



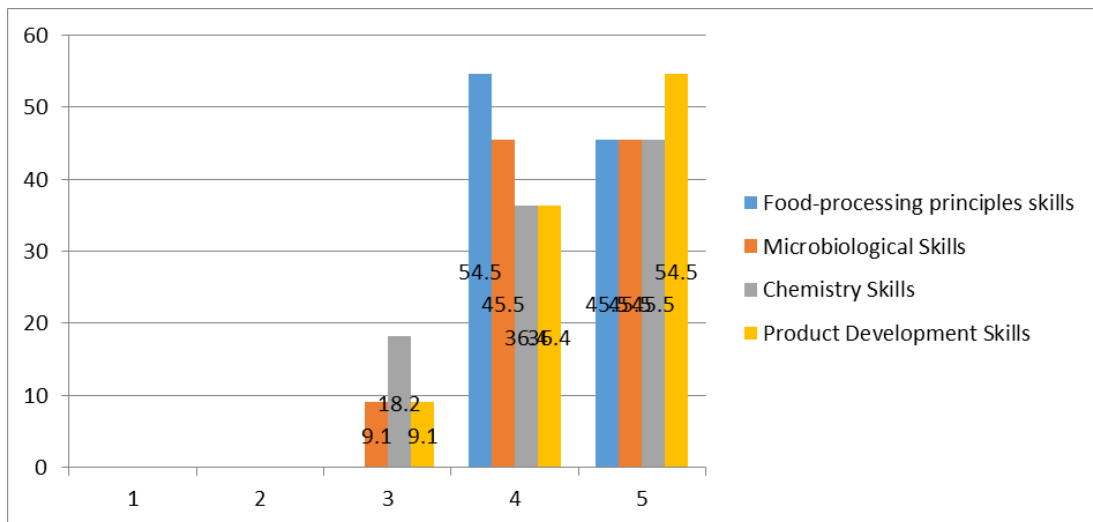
5. Concerning the Engineering Module, the importance of the courses are Unit Operation and Food Engineering and Industrial Process Control, accounting 63.6% accordingly.



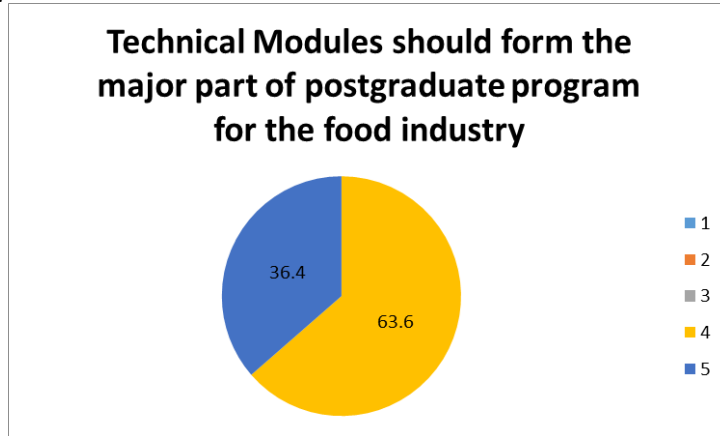
6. Concerning other courses other than the main modules, the important module is Research Methodology which is accounted for 72.7%.



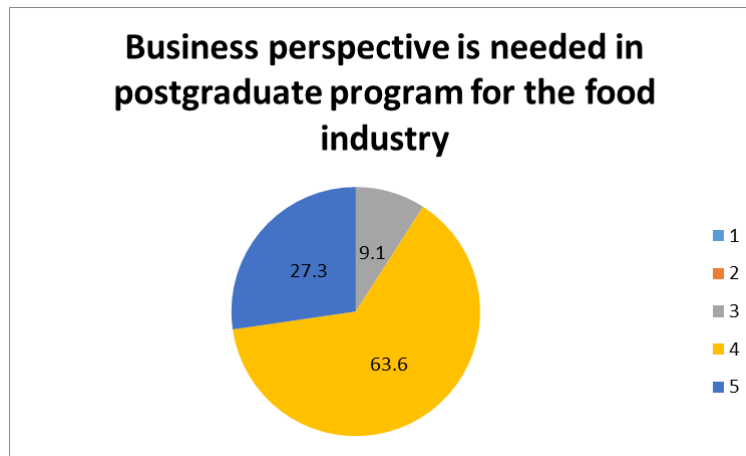
7. Concerning on the technical skills, the important skill is the Product Development Skills which is accounted for 54.5%.



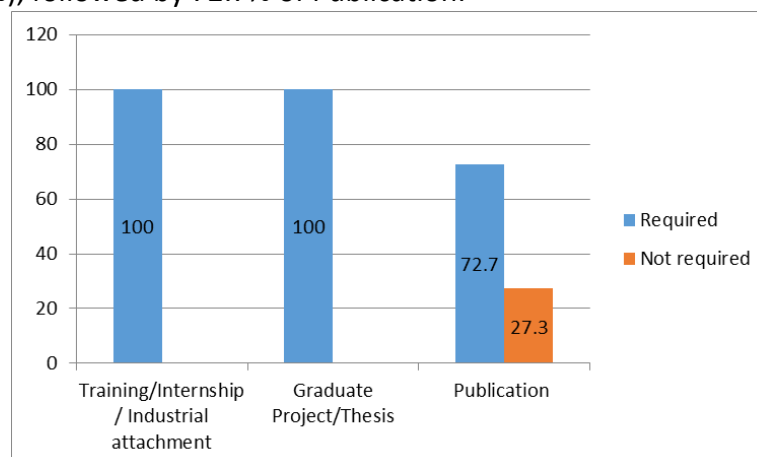
8. By the idea from the group discussion, the Technical Modules, which is accounted for 63.6%, should be formed the major part of postgraduate programs for the Food Industry.



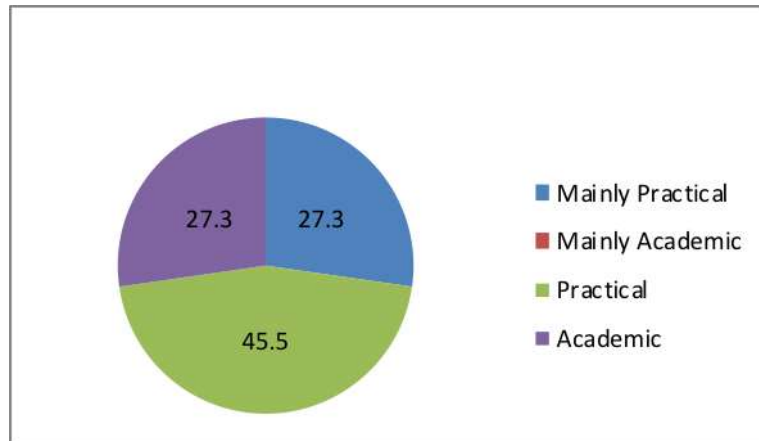
9. By the idea from the group discussion, the business perspective, which is accounted for 63.6%, is importantly needed in postgraduate programs for the Food Industry.



10. The requirements as partial fulfilment for the program is mostly done by Training/Internship/Industrial attachment (100%) and Graduate project/Thesis (100%), followed by 72.7% of Publication.

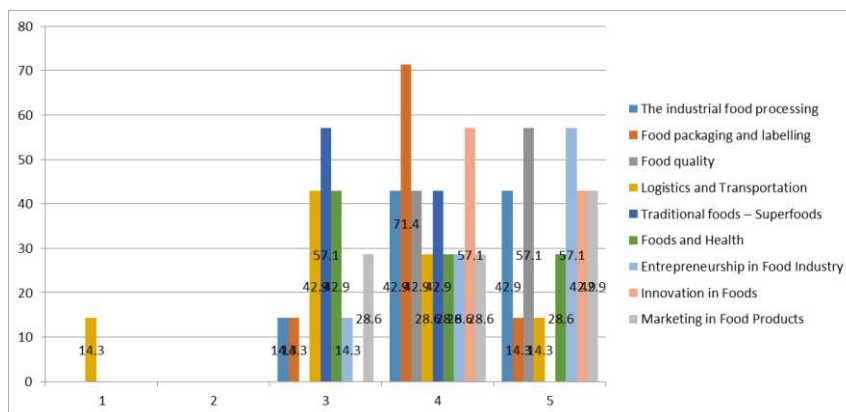


11. Practical approach, which is accounted for 45.5%, is the most desirable in the postgraduate programs for the Food Industry.

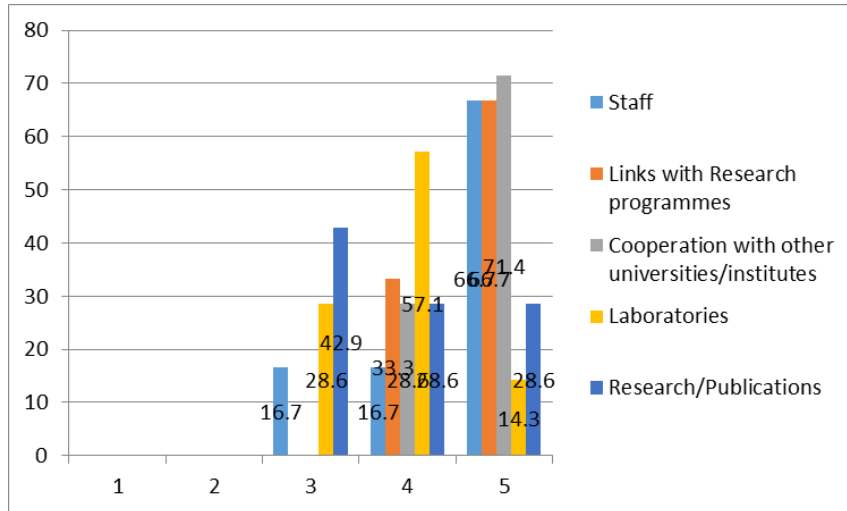


12. The competitive advantage/unique selling point of our program is indicated by each part as follows:

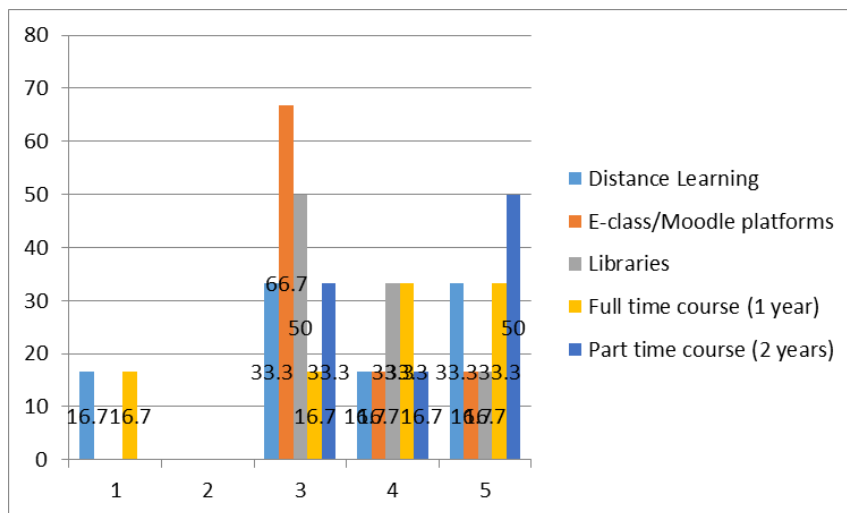
a. **Educational:** It is mainly focused on Food quality and Entrepreneurship in Food industry.



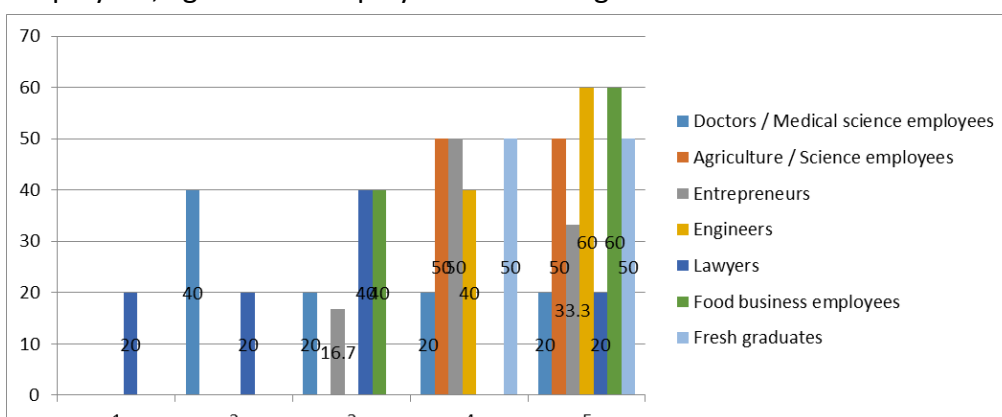
b. **Academic:** It is mainly focused on Cooperation with other universities/ institutions, Staff, and Links with Research programmes.



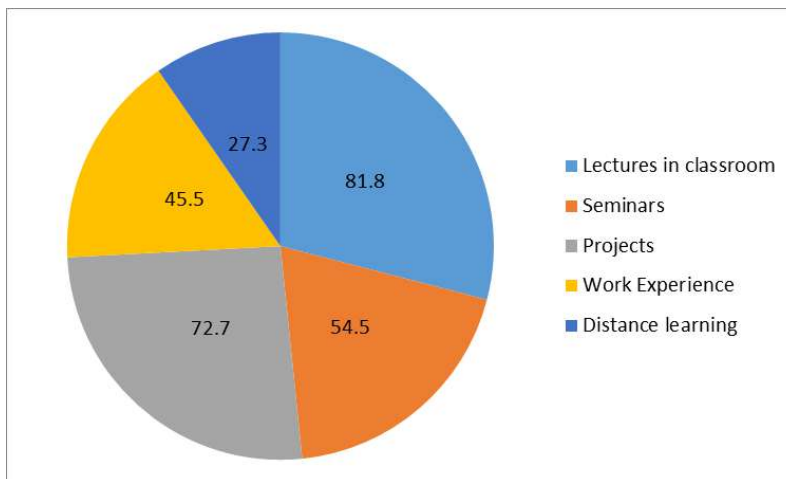
c. **Operational:** It is mainly focused on Part time course (2 years).



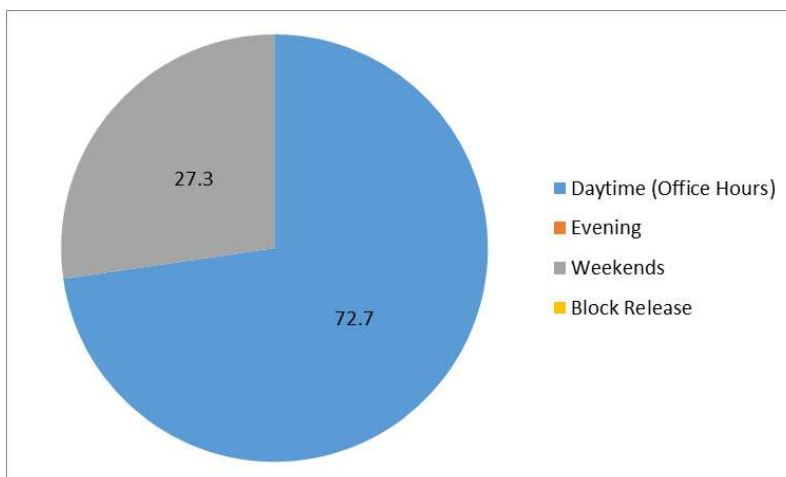
13. The target group for our own MSc program is mainly engineers, food business employees, agriculture employees and fresh graduates.



14. Lectures in classroom (81.8%) and Projects approaches (72.7%) are the mode of delivery as most desirable in the postgraduate programs for the Food Industry in our country.

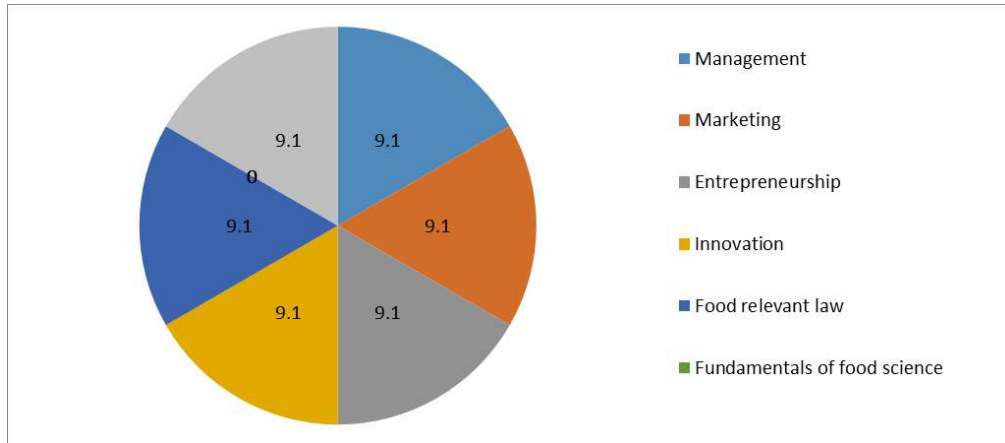


15. The daytime is the most desirable in the postgraduate programs for the Food Industry. However, weekend class should also be considered.



16. For industries, the Master graduates from FOODI will be fully employed (100%). Their role in the company will be fully Marketing of new products (100%). The competences which will be not possessed by the Master graduates are Management,

Marketing, Entrepreneurship, Innovation, Food relevant law and Fundamentals of food science.



4.3 Focus Group Discussion from Thailand

The focus group composed of four academics, two students and four representatives from food industry companies.

4.3.1 Profile of the participants

Table 4.3.1 shows the profile of the participants.

Table 4.3.1: Profiles of Participants

No.	Name	Profession/Designation	Organisation
Academics			
1.	Dr. Phanat Kittiphattanabawon	Assistant professor in Food Science and Technology	Faculty of Agro-Industry, Thaksin University
2.	Dr. Benjamas Cheirsilp	Professor in Food Engineering	Faculty of Agro-Industry, Prince of Songkla University

3.	Dr. Rajnibhas Sukeaw Samakradhamrongthai	Lecturer in Product Development	Faculty of Agro-Industry, Prince of Songkla University
4.	Dr. Thavorn Juntachote	Dean/ Assistant professor in Food Science and Technology	Faculty of Agro and Bio Industry, Thaksin University
Students			
5.	Mr. Kasidate Chantakun	Ph.D. Student	Faculty of Agro-Industry, Prince of Songkla University
6.	Mr. Nattavong Fuangpaiboon	Ph.D. Student	Faculty of Agro-Industry, Prince of Songkla University
Representatives from Food Industries			
7.	Mr. Chongkasam Wanitsuwan	Senior Production manager	Chotiwat Manufacturing Co., Ltd
8.	Mr. Athirat Rerngnarong	Innovation Promotion and Development officer	Prince of Songkla University Science Park
9.	Mr. Paotep Premchai	R&D/ Innovation manager	Songkla Canning PCL

4.3.1 As education providers, we would like to ask you to identify any gaps/deficits in your programme in the current skills provision for the food processing industry.

Table 4.3.1 shows the responses of education providers to identifications of gaps and deficits in programmes available in the current skills provision for the food processing industry.

Table 4.3.1: Identifications of Gaps and Deficits in Programmes Available in the Current Skills Provision for the Food Processing Industry As Education Providers

No	Topic	Description	Importance of Topic (please ☑)		
			High	Medium	Low
1.	Food Innovation	Definition of innovation, innovation creation, creative thinking. Product, process and service innovations	/		

2.	Entrepreneurship	Business plan, finance, internet marketing, consumer's need, foresight for food technology, commercialization	/		
3.	Processing and Engineering	Equipment and process design, feasibility study, cost reduction and process efficiency	/		
4.	Virtualization for R&D	Formula simulation, software for R&D	/		
5.	Super food and food for elderly			/	
6.	Quality system	Quality system and food law		/	
7.	Marketing	Online marketing	/		

4.3.2 As industry stakeholders, we would like to ask you to identify any gaps/deficits in the current skills provision in the current MSc/Professional training course offerings for the food processing industry.

Table 4.3.2 shows the responses of industry stakeholders to identifications of gaps and deficits in programmes available in the current skills provision for the food processing industry.

Table 4.3.2: Identifications of Gaps and Deficits in Programmes Available in the Current Skills Provision for the Food Processing Industry as Industry Stakeholders

No	Skill	Description	Importance of Topic (please ☑)		
			High	Medium	Low
1.	Food Innovation	Definition of innovation, innovation creation, creative thinking. Product, process and service innovations, foresight for food industry	/		
2.	Entrepreneurship	Business plan, finance, internet marketing, consumer's need, commercialization.	/		

		Project evaluation			
3.	Processing and Engineering	Process design, up scaling from laboratory to pilot plant scale, process efficiency	/		
4.	Marketing	Internet marketing	/		
5.	Intellectual management			/	
6.	Quality system	Quality system and food law		/	

4.3.3 For the Industry

The responses of the respondents from the industry pertaining to the following questions were:

1. Which needs/challenges in food processing are you currently facing?
 - Processing techniques and process design (4)
 - Unit operation (3)
 - Productivity (4)
 - Cost reduction (ingredients and process efficiency) (4)

2. What do you want students to know and do (discipline and non-discipline) at the end of the programme?
 - Practical and research skill (4)
 - Food and Process Innovation (4)
 - Engineering (up scaling and process design) (4)
 - Marketing/ Entrepreneurship (3)
 - Quality system, food law and Intellectual property rights (2)

3. What are the Graduate Attributes for the MSc programme/Professional training courses?
 - Life long-learning skill (1)
 - Integrative thinking skill (4)
 - Knowledge integration (4)
 - Responsibility (2)
 - Problem solving (4)
 - Questioning skill (4)
 - Morality and ethics (2)
 - Relationship and communication skills (4)
 - Environment Ethic (1)
 - Social and communication skills (3)
 - Technology transfer skills (4)

- Practical skills (4)
 - Computer skills (2)
4. Will your industry provide industry mentoring?
 - Yes (for all 4 participants)
 5. Will your industry provide industry sponsorship?
 - Yes for all 4 participants but in the different conditions such as research grant, compensation for the students who worked in the company, in-kind supporting (raw material, staffs for mentoring, providing equipment).

* Note: Numbers in the bracket indicate frequency of answers.

4.3.4 How important are the following modules in FOODI program?

Table 4.3.3 indicates the mean score of the importance of the modules proposed. Food innovation was ranked the highest.

Table 4.3.3: Mean Score of the Importance of the Modules

FOODI Modules	<i>Not important</i>					<i>Very Important</i>	<i>Mean Score</i>
	1	2	3	4	5		
Entrepreneurship	0	0	1	3	6	4.5	
Food innovation	0	0	0	0	10	5.0	
Science and Technology	0	0	0	3	7	4.7	
Engineering	0	0	3	5	2	3.9	

4.3.5 How important are the following courses in Entrepreneurship Module?

Table 4.3.4 indicates the mean score of the importance of the Entrepreneurship modules. Entrepreneurship & innovation was ranked the highest.

Table 4.3.4: Mean Score of the Importance of the Entrepreneurship Modules

Entrepreneur Modules	<i>Not important</i>					<i>Very Important</i>	<i>Mean Score</i>
	1	2	3	4	5		
Food supply chain management	0	0	1	6	3	4.2	
Consumer preferences and behaviour	0	0	0	2	8	4.8	
Agri-food marketing	0	0	0	5	5	5.5	
Entrepreneurship & innovation	0	0	0	2	8	4.8	
Halal and Food Law	0	0	3	3	4	4.1	
Food packaging and labelling	0	0	3	2	5	4.2	
Food Legislation and International Trade	0	0	2	5	3	4.1	
Social-Economic Impact of Unsafe Food Supply	0	0	3	6	1	3.8	
Food Services	0	0	3	5	2	3.9	
World Food Culture	0	0	5	3	2	3.7	
Agricultural Sector and Policy Analysis	0	0	2	6	2	4.0	
Financial Management	0	0	2	5	3	4.1	
Corporate Social Responsibility and Ethics	0	0	1	7	2	4.1	
Bio-analysis for Industry and Eco-farming	0	1	2	5	2	3.8	

4.3.6 How important are the following courses in Food Innovation Module?

Table 4.3.5 indicates that all the three courses of the Food Innovation Modules scored towards scale of 'Very Important'.

Table 4.3.5: Importance of Food Innovation Modules

Food Innovation Modules	<i>Not important</i>					<i>Very Important</i>	<i>Mean Score</i>
	1	2	3	4	5		
Innovative Food Packaging Technology	0	0	0	4	6	4.6	
Innovative Food Products	0	0	0	1	9	4.9	
Innovation in industrial food processing	0	0	0	2	8	4.8	

4.3.7 How important are the following courses in Science and Technology Module?

Table 4.3.6 shows the important courses in Science and Technology Module. Advanced Food Preservation and Processing ranked the highest followed by Food Commodity Processing Technology.

Table 4.3.6: Important Courses in Science and Technology Module

Science and Technology Modules	Not important					Mean Score
	1	2	3	4	5	
Food Commodity Processing Technology	0	0	0	3	7	4.7
Advanced Food Analysis	0	0	2	4	4	3.8
Food Safety and Quality Management	0	0	1	3	6	4.5
Food Ingredients Technology	0	0	0	5	5	4.5
Advanced Food Chemistry	0	0	2	4	4	3.2
Food Biotechnology	0	0	0	6	4	4.6
Virtualization for R&D in the food industry	0	0	1	3	6	4.5
Microbial Foodborne Pathogens	0	0	4	2	4	4.0
Interaction of Food Components during Processing	0	0	0	6	4	4.6
Traceability in Food Supply Chain	0	0	4	3	3	3.9
Managing Food Allergy and Intolerance	0	0	4	2	4	4.0
Advanced Food Preservation and Processing	0	0	0	2	8	4.8
Food and Nutrition Microbiology	0	0	3	4	3	4.0
Food and Nutrition Toxicology	0	0	3	5	2	3.9
Nutrition Education	0	0	1	6	3	4.2
Science of Fats and Oils	0	0	4	6	0	3.6
Food Additives	0	0	1	4	5	4.4
Sugar and Chocolate Confection Technology	0	0	6	4	0	3.4
Nutritional Anthropology	0	0	2	5	3	4.1
Probiotics, Functional Foods and Nutraceuticals	0	0	3	0	7	4.4
Food Waste and Loss	0	0	2	5	3	4.1

4.3.8 How important are the following courses in Engineering Module?

Table 4.3.7 indicates that Food Process Engineering of the Engineering Modules scored towards scale of 'Very Important'.

Table 4.3.7: Importance of Engineering Modules

Engineering Modules	Not important					Mean Score
	1	2	3	4	5	
Units Operation and Food Engineering	0	0	0	4	6	4.6
Industrial process control	0	0	1	4	5	4.4
Food Process Engineering	0	0	0	1	9	4.9

Postharvest Engineering	0	0	3	3	4	4.1
Waste Vaporization, Green Technology and Bioeconomy	0	0	1	4	5	4.4
Controlled Environment Agriculture	0	0	4	3	3	3.9

4.3.9 The following are others courses other than the main modules. How important are the courses?

Table 4.3.8 indicates that Research Methodology of the Other Courses other than the main modules scored in between scales of 'Important' and 'Very Important' among four courses. The rest of the courses were from the opinion of an individual.

Table 4.3.8: Importance of Other Courses other than the Main Modules

Other Courses	Not important					Mean Score
	1	2	3	4	5	
Research Methodology	0	0	0	4	6	4.6
Sports Nutrition	0	0	3	4	3	4.0
Diet Therapy	0	0	1	5	4	4.3
Other...Functional Food	0	0	0	2	0	4.0
Other...Food Processing (according to commodities)	0	0	0	1	0	4.0
Other...Food for Anti-aging	0	0	0	1	0	4.0
Other...Food Product Simulation	0	0	0	1	0	4.0
Other...Design Thinking and Project Evaluation	0	0	0	0	1	5.0
Other...Intellectual Property Management	0	0	0	0	1	5.0
Other...Culture Foods	0	0	0	1	0	4.0

4.3.10 The following is the Technical Skill modules. How important are the courses?

Table 4.3.9 shows that Product Development Skills scored towards 'Very Important' followed closely by Food-processing principles skill. The rest of the courses were from the opinion of an individual.

Table 4.3.9: Importance of Technical Skill Modules

Technical Skill	Not important					Mean Score
	1	2	3	4	5	

Food-processing principles skills	0	0	0	3	7	4.7
Microbiological Skills	0	0	2	6	2	4.0
Chemistry Skills	0	0	1	6	3	4.2
Product Development Skills	0	0	0	1	9	4.9
Other...Problem Solving and Critical Thinking	0	0	0	0	1	5.0
Other...Innovation Skills	0	0	0	0	1	5.0
.	0	0	0	0	1	5.0
Other...Intellectual Management Skills	0	0	0	0	1	5.0
Other...Project Evaluation Skills	0	0	0	0	1	5.0
Other...Market Evaluation Skills	0	0	0	0	1	5.0
Other...Technology Transfer Skills	0	0	0	0	1	5.0

4.3.11 Do you think Technical Modules should form the major part of postgraduate programs for the Food Industry?

A mean score of 4.8 indicated that the Technical Module should form the major part of postgraduate programs for the Food Industry (Table 4.3.10).

Table 4.3.10: Technical Module as major part of postgraduate programs for the Food Industry

<i>Little</i>					<i>Much</i>
1	2	3	4	5	
0	0	1	5	4	

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4.3.12 Do you think that a business perspective is needed in postgraduate programs for the Food Industry?

A mean score of 4.1 indicated that a business perspective is needed in postgraduate programs for the Food Industry (Table 4.3.11).

Table 4.3.11: Business Perspective Needed Postgraduate Programs for the Food Industry

<i>Not needed</i>					<i>Very much needed</i>
1	2	3	4	5	
0	0	2	5	3	

4.3.13 Do you think Training/Internship / Industrial attachment; Graduate Project/Thesis and Publication are required as partial fulfilment for the programme?

There was a 100% consensus that Training/Internship / Industrial attachment and Graduate Project/Thesis are required as partial fulfilment for the programme. However, for publication, only 60% indicated it was required.

4.3.14 Which approach would you see as most desirable in the postgraduate programs for the Food Industry?

Fifty percent supported the approach of 50% Academic and 50% Practical and another 50% was in favour of 75% Academic and 25% Practical as most desirable in the postgraduate programs for the Food Industry (Table 4.3.12).

Table 4.3.12: Most Desirable Postgraduate Programme Approach for the Food Industry

Approach	Please tick (✓) only once
Mainly Academic	0
50% Academic and 50% Practical	5
75% Academic and 25% Practical	5

4.3.15 Responses from Academics

Two specific targeted at the Academics were as follows.

1. What do you see as the competitive advantage/unique selling point of your own program?

Table 4.3.13 shows the competitive advantage/unique selling point from three perspectives.

From the educational perspective, the academics ranked the course on Innovation in Foods will provide the competitive advantage/unique selling point.

From the academic perspective, the academics ranked Staff, Links with Research programmes and Cooperation universities/institutes with others; will provide the competitive advantage/unique selling point.

From the operational perspective, the academics ranked a one year full time course will provide the competitive advantage/unique selling point.

Table 4.3.13: Competitive Advantage/Unique Selling Point

Unique selling point	Small					Great	Mean Score
	1	2	3	4	5		
Educational							
The industrial food processing	0	0	2	1	1	3.75	
Food packaging and labelling	0	0	3	0	1	3.50	
Food quality	0	0	2	1	1	2.75	
Logistics and Transportation	0	0	1	3	0	3.75	
Traditional foods – Superfoods	0	0	0	2	2	4.50	
Food and Health	0	0	0	2	2	4.50	
Entrepreneurship in Food Industry	0	0	1	1	2	4.25	
Innovation in Foods	0	0	0	1	3	4.75	
Marketing in Food Products	0	0	1	2	1	4.00	
Academic							
Staff	0	0	1	1	2	4.25	
Links with Research programmes	0	0	1	1	2	4.25	
Cooperation universities/institutes with other	0	0	1	1	2	4.25	
Laboratories	0	0	1	2	1	4.00	
Research/Publications	0	0	1	2	1	4.00	
Operational							
Distance Learning	0	1	1	1	1	2.50	
E-class/Moodle platforms	0	1	0	3	0	3.50	
Libraries	0	0	2	2	0	3.50	
Full time course (1 year)	0	1	0	1	2	4.00	
Part time course (2 years)	0	1	0	3	0	3.50	
Fees	0	0	1	3	0	3.75	

2. Who is the target group for your own MSc program?

Food business employees, Entrepreneurs and Entrepreneurs were identified as the target group (Table 4.3.14).

Table 4.3.14: Target Group

Target Students	Small					Great	Mean Score
	1	2	3	4	5		
Doctors / Medical science employees	1	0	2	0	1	3.00	
Entrepreneurs	0	0	1	2	1	4.00	

Entrepreneurs	0	0	1	1	2	4.25
Engineers	0	0	3	1	0	3.25
Lawyers	1	0	3	0	0	2.50
Food business employees	0	0	0	2	2	4.50

4.3.16 Responses from Academics and Students

Which of the following mode of deliveries are suitable for the Food Industry postgraduate programmes?

Projects and work experience were identified as most suitable for the Food Industry postgraduate programmes (Table 4.3.15).

Table 4.3.15: Mode of Delivery

Mode of Delivery	Frequency
Lectures in classroom (face-to-face)	2
Seminars	4
Projects	6
Work Experience	6
Distance (on-line) learning	3
Blended learning (combination of distance and face-to-face)	4

4.3.17 Responses from the Industrial Stakeholders, Academics And Students

When is the most suitable time to conduct the postgraduate programs for the Food Industry?

Generally making references to the industry, it would mean as training for existing staff. Two options were identified: either to be conducted during office hours or daytime or flexible (on-line) (Table 4.3.16)

Table 4.3.16: Timing of Delivery

Timing of Delivery	Frequency
Daytime (Office Hours)	3
Evening	1
Weekends	2

Block Release	1
Flexible (on-line)	3

4.3.18 Perception of Industrial Stakeholders on FOODI Graduates

Three questions were posed to the Industrial Stakeholders on the employability aspects of FOODI graduates.

1. Are you employing Masters graduates whose position might be potentially taken by FOODI Graduates?

All the four respondents indicated that they would employed FOODI graduates.

2. What is their role in your company?

They will be employed as either Innovation Manager, Process Developer or Production line operator/manager indicating innovation as common skills.

Table 4.3.17: Role of FOODI Graduates

Role	Frequency
Responsible for a brand	0
Marketing of new products	0
Innovation manager	1
Laboratory expert	0
Product developer	0
Process developer	2
Production line designer	0
Production line operator/manager	1

3. Which of the following competences are not possessed by your Master graduates, but you think would be useful?

The competences as listed in Table 4.3.18 indicated that Food Relevant Law is not useful.

Table 4.3.18: Competences of FOODI Graduates

Competences	Frequency
Management	2
Marketing	2
Entrepreneurship	2
Innovation	2
Food relevant law	0
Fundamentals of food science	2
Fundamentals of food processing	2
Fundamental of process/equipment operation	1
Fundamental of process/equipment design	3

5.0 Conclusion

There are 893 HEIs in the three countries with 68.9 percent under the private HEIs. 34.6 percent offer Master programmes in various areas, however, only 4.4 percent offer coursework in food-related programmes. There are altogether 36 Master programmes in food through coursework being offered across Asia. Generally, the MSc. Coursework programme requires completion of 34 credits of core courses and 6 credits of elective courses with presentation and submission of dissertation in all countries from Malaysia, while the only programme in Cambodia from Institute of Technology of Cambodia requires 52 total credits. MSc Coursework programme in Thailand are similar to Malaysia with the exception of Chulalongkorn University, Thailand offering two programmes with 39 credits, two with 42 total credits. And Suranaree University of Technology with 48 total credits. Method of teaching includes lectures, laboratory practical, assignment, case study and mini project.

The courses were categorized into 4 clusters based on their related topics on Entrepreneurship, Science and Technology, Innovation, while unrelated courses are categorized into Others. There are altogether 790 courses with 67 percent of the courses under Science and Technology while the rest are under clusters: Entrepreneurship, Innovation and others with around 10 percent. Two programmes are entirely on entrepreneurship: MSci (Technopreneurship and Innovation Management) and MSci (Food Service Management) which do not offer courses on Science and Technology Cluster.

The courses are further categorized into sub-clusters within the clusters based on description of topics of similarities but slight variation in names of the courses. The Agribusiness and Management sub-cluster has the most courses in the Entrepreneurship Cluster. In the Science and Technology cluster, sub-clusters on Food Science and Technology, Food Chemistry, Functional Food, Food Development, Food Nutrition, Food Processing and Food Safety and Quality are most prominent with over 30 courses. The Food Safety and Quality sub-cluster has the most with 55 courses. The Engineering clusters focus on Food Processing and Food Engineering sub-clusters. In the others, all programmes have the Research Methodology sub-cluster courses.

Food innovation is the most important module in the FOODI program. Innovation in Industrial Food Processing is regarded as the most important course in this Food Innovation module,

followed by Innovative Food Packaging Technology and Innovative Food Products. The top three important courses for the Entrepreneurship Module are (i) Halal and Food Law (ii) Entrepreneurship & Innovation and (iii) Food Legislation and International Trade. While the top three important courses in Science and Technology Module are (i) Food Commodity Processing Technology (ii) Food Safety and Quality Management and (iii) Food Ingredients Technology. As for the engineering module, it was found that Food Process Engineering was perceived to be the most important, followed by Industrial Process Control and Waste Vaporization, Green Technology and Bio-economy. Besides the main modules, other modules that are found to be important are Research Methodology, followed by Diet Therapy and Sports Nutrition.

As for the technical skill modules, it was found that the top two courses are Food-processing Principles Skills and Product Development Skills. Majority of the respondents somehow agree that Technical Modules to form the major part of postgraduate programs for the Food Industry. Nevertheless, all respondents are in the view that business perspective is very much needed for FOODI. All respondents agree that Training/Internship / Industrial attachment and Graduate Project/Thesis are required as partial fulfilment for the program. However, their views differ for the publication requirement. Majority opine that publication should not be required as partial fulfilment for the program. 42.9 percent of respondents suggested for the approach to be 50% Academic and 50% Practical, while the remaining respondents suggested for 75% Academic and 25% Practical.

The academicians gave their opinion on the unique selling point of their programs, the target group for their own MSc program and the suitable mode of deliveries for FOODI. The unique selling point of program offered at the academicians' university can be divided into three categories namely educational, academic and operational. The top three unique selling point for educational are (i) Food quality (ii) Food and Health and (iii) Entrepreneurship in Food Industry. While the top three unique selling point related to academic are (i) Cooperation with other universities/institutes (ii) and (iii) Links with Research programmes Laboratories. Full time course (1 year), Fees and E-class/Moodle platforms are regarded as the three top unique selling point for operational category. The top three target group for their MSc program are (i) Food business employees (ii) Entrepreneurs and (iii) Agriculture / Science employees. All mode of deliveries

listed are suitable for FOODI with Projects, blended learning and work experience as the top three found to be the most suitable.

The most suitable time to conduct the postgraduate programs for the Food Industry is on weekends. Respondents from the industry are willing to employ FOODI graduates and the graduates will play a role as product developer, laboratory expert, Responsible for a brand, Innovation manager, Process developer and Dietician. The respondents from the industry also suggested for FOODI graduates to be competent in Entrepreneurship, Innovation, Fundamental of process/equipment design, Management, Fundamental of process/equipment operation and Marketing.

