

Curriculum Development in Data Science and Artificial Intelligence

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Needs analysis on professional training courses, certificates and internships in the area of Data Science and Artificial Intelligence

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*We teach today's students
With yesterday's knowledge
For a future we don't know.*



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Abstract

In this report we survey and identify existing professional training courses in data science and artificial intelligence in Thailand, Sri Lanka and Indonesia, and the demand for internships in the Asian countries related to the project.

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1. Introduction

The average introduction to almost any book is somewhat of a bore

--- Boris Karloff

Across many industry sectors, including retail, agriculture, healthcare, banking, finance, and telecommunications, companies in South Asia are launching initiatives to improve their operations and offerings through data-driven techniques¹. One of the main success factors in this digital transformation is having the right talent with critical skills in data science and artificial intelligence, with the ability to understand both data processing techniques and the business they are operating in.

1.1 Context

Thailand, Indonesia, and Sri Lanka are middle-income countries within the South Asia region. While data science and artificial intelligence based technologies are gaining traction and becoming strategic priorities these countries are still falling behind regional leaders in the technological market, such as Singapore and Malaysia, while the region as a whole is far behind China. Thailand, Indonesia, and Sri Lanka have well-established and growing higher education systems; increasingly focused on quality improvement. However, they fail in educating people who design, develop, deploy, and train data science and artificial intelligence-based technology, as evident from the acute shortage of data analysts in public and private companies^{2,3}.

These trends make clear that development of talent and capabilities is needed if data science and artificial intelligence are to reach their full potential throughout the region. The success of political and economic initiatives by governments in the south Asian region to transform the current export based economy into an innovation and knowledge based economy will critically depend on the readiness of the labour force for ICT in general and data-driven technologies in particular.

This document focuses on the identification of existing professional training courses in data science and artificial intelligence and on the demand for internships in the Asian countries related to the project.

Data science is concerned with the extraction of useful domain knowledge from large, complex data sets. Drawing on the fields of machine learning and data mining, it provides critical support to decision makers in many professions, allowing them to make decisions based on statistically significant patterns

¹ *The age of analytics: competing in a data driven world*, McKinsey Global Institute, 2016.

² *Artificial intelligence and South-East Asia's Future*, McKinsey Global Institute, 2017.

³ Mathur, Aneja, Anwar, Shridhar, and Sanchez, *Future of Work in Sri Lanka: Shaping technology transitions for a brighter future*, TANDEM research report, International Labour Organization, pp. 1—98, 2019.

in data. Applications include business intelligence, the detection of anomalies in patterns of behaviour, and for example the analysis of services in cloud computing.

Artificial intelligence is an even broader field concerning the theory and development of computational systems able to perform tasks inspired by human intelligence. We can distinguish three main paradigms within the field of Artificial Intelligence:

1. *symbolic AI* – consisting, among others, of inductive logic programming, robotic process automation and expert and fuzzy systems,
2. *statistical AI* – consisting of decision networks, probabilistic programming (including Bayesian program synthesis), computer vision (activities and image recognition as well as machine vision), natural language processing, and machine learning, and
3. *subsymbolic AI* – consisting of distributed artificial intelligence (including agent-based modelling, swarm intelligence and multi-agent systems), ambient computing, natural computing, multi-objectives optimization, affective computing, embodied intelligence, and autonomous systems.

Today the most widely applied discipline within AI is machine learning, a method of data analysis that automates analytical model building without being explicitly programmed. Machine learning comes in at least three “flavours”: supervised learning, unsupervised learning, and reinforcement learning. Supervised learning refers to methods for learning a model from a set of training data containing both input and output results. Regression and classification are typical examples of supervised learning techniques. Unsupervised learning consists of building a model from a set data, via for example visualization or clustering. Reinforcement learning is about taking actions in an environment so as to maximize some notion of cumulative reward, as for example used in robot navigation and games (including chess, Go, and business games).

1.2 Methodology

The high-level methodology of this report consists of two steps, each described in a separate chapter of the report:

1. investigating existing professional training programmes;
2. assessing industry labour needs.

The first step concentrates on **professional training programmes** on data science and artificial intelligence in the Asian partners’ countries. Previous studies on professional training in general have shown that Indonesia, Malaysia, Philippines, Thailand and Sri Lanka have a ‘fairly developed’ system of professional training characterized by low enrolment, high drop-outs, poor-quality of teachers, inequitable access for women and rural populations, limited private sector involvement, and very inadequate budgetary allocations. In other words, technical training in South Asia is neither supporting a high economic growth rate, nor expanding global markets, nor increasing employment opportunities.⁴

⁴ Ul-Haq, M., & Haq, K. (Eds.). (1998). *Human Development Report in South Asia 1998*. Delhi, India: Oxford University Press, page 100.

Using a desktop search, we identified professional training courses specific to data science and artificial intelligence offered by either universities or private companies in south Asia. The goal is not to see if the situation is improved with respect to the above study, but to identify what are the topic offered by these professional training.

In the second step we identify the **labour needs from industry**. We proceed via a systematic process by gathering information through a questionnaire sent to several companies in Thailand, Indonesia, and Sri Lanka. We differentiate between the needs of the companies by their size in terms of employees, and we try to cover several sectors including both public and private companies. The questions concern both the needs of the companies for training courses for their own employees, as well as the needs they have in educating new students through internships. The requirements that company would like to have on the topic areas of the training courses and on the desired knowledge students should have before starting the internships reveals the difference (gap) between current knowledge/practices as described in the third step and current evidence based requirements revealed in this step. Most importantly we consider labour needs not only concerning knowledge but also those that can occur in skills (programming) or practice (tools).

2. Professional Training Courses through South Asia

*Practice is the hardest part of learning, and
training is the essence of transformation*

--- Ann Voskamp

2.1 Introduction

Professional training courses focus on transferring specific knowledge and practical skills which allow individuals to engage in a specific occupational activity. Those courses are not only important in providing employment opportunities to individuals but also helps in enhancing the productivity of companies. In this chapter we provide an (absolutely not complete) review on challenges, outcomes and present situation in professional training courses on data science and artificial intelligence provided in some Asian countries (Thailand, Indonesia and Sri Lanka).

In recent years, artificial intelligence and data science technologies have been massively adopted particularly in manufacturing, financial services, and transportation and logistics industries. Many countries all over the world are tasked with the creation of a skilled labour force consisting of data scientists, business analysts or experts in machine learning. Universities fill the gap on the increasing demand by creating new specialised and attractive curricula on the area while business companies look for shorter professional training courses specialised to their own needs.

2.2 Thailand

In Thailand, the only university providing professional courses on data science is the Khon Kaen University (KKU). KKU offers a 3-day course on Big Data and Data Analytics, focused on the use of the programming language Python and on the tools Hadoop and Tableau. No formal certification is released.

Other professional courses are provided by private companies, with a duration between 2 and 3 days. The main topics covered are Data Modelling and Management; Machine Learning; Data engineering; Database; Management of information systems, Big Data and Data Analytics. The programming languages used are the expected ones (Python, R, Pytorch, Tensorflow), and as tool they all use the most common in the field (Hadoop Tableau, Spark, MongoDB, Amazon Web Services, Google Cloud Platform, Azure). The table below present a summary of the courses we analysed.

Company	Course name	Duration	Subject area	Certification
Intelligist Company Limited	Big data and Data Analytics	2 days	– Big Data and Data Analytics	–
IMC Institute	1. Machine Learning for Data Science	3 days	– Machine learning	Yes
	2. Advanced Analytics using Deep Learning	3 days	– Deep Learning	
	3. Big Data Architecture and Analytics Platforms	3 days	– Big Data and Data Analytics	
AIAT Academy	Intensive Training Python for Data Science	1 day	– Python	Yes
NSTDA Academy	Art of Data Science: ADS	3 days	– Big Data and Data Analytics	Yes
Techtalkthai training	Intro to deep learning	2 days	– Machine learning – Deep Learning	No
–	Smart speaker, Smart home, Chatbot or Smart vision	–	– Data modelling and management	–
ALTERYX, INC.	Alteryx Data + Analytics rEvolution Summit	–	– Data modelling and management	–

2.3 Indonesia

Syiah Kuala University delivers a course of 3 days on Big Data and Data Analytics using Java and Hadoop, giving a professional certificate at the end. Similarly, the Institut Teknologi Bandung provides a certificate for the successful attendance of a course on machine learning using Python as programming language. The table below summarize other professional courses offered by private companies in Indonesia.

Company	Course name	Duration	Subject area	Certification
Telkom Professional Certification Center (TelkomPCC)	Practical Data Science	3–5 days	– Data modelling and management – Data engineering – Database – Management of information systems;	Yes
Inixindo Jogja	Certified Data Science Specialist	2 days	– Data modelling and management – Data engineering – Management of information systems	Yes

Digital Talent Scholarship	topics on Artificial Intelligence	–	Machine learning	–
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2.4 Sri Lanka

In Sri Lanka, no university is providing a professional course on data science or artificial intelligence. Some of the courses offered by the private sector are listed below. They all use basic of Python and/or R as standard programming language.

Company	Course name	Duration	Subject area	Certification
NIBM : National Institute of Business Management (NIBM)	- Advanced Certificate Course in Data Analytics - Data Analytics with R for Working Professionals - Analytics for Business Managers	4 months one day 2 days	– Data modelling and management – Machine learning – Natural language processing – Statistics	Yes
Institute of Applied Statistics, Sri Lanka	- Statistical Methods for Data Mining - Introduction to R - Statistical Methods for Big Data Analysis	4 days 2 days 4 days	–	–
NobleProg	- A Practical Introduction to Data Science Training - Data Science Programme Training	35 hours 245 hours	–	–
IASSL	Statistical course for data mining	4 days	–	–
University of Moratuwa	- Phyton Essentials - Big data & Analytics	80 hours 70 hours	–	–

2.5 Conclusion

In Thailand, Indonesia, and Sri Lanka professional trainings data science or artificial intelligence are provided mostly by private companies, all focusing on data modelling and processing and machine learning.

3. Companies Needs Assessment through South Asia

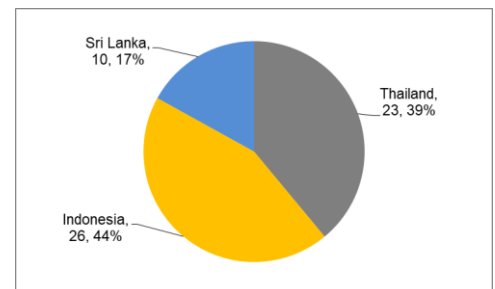
Good companies will meet needs; great companies will create markets.

--- Philip Kotler

3.1 Introduction

Across South Asia, talent shortages in data science and artificial intelligence—caused by gaps and mismatches between labour market needs and the available supply of educated and trained professionals—constrain economic growth.⁵ These shortages prevent companies from scaling up, meeting demand in new locations, and launching new products and services. The talent shortage will have a direct impact on their competitiveness and productivity. In this chapter we explore the current needs that companies have for data science and artificial intelligence experts.

We sent a questionnaire to several companies with varying number of employees. We received a response from 59 companies from Thailand (23), Indonesia (26), and Sri Lanka (10). This survey has three main objectives: 1) To evaluate the companies' current status and future needs for personnel in data science and AI related positions; 2) To receive feedback from companies on how an internship programme could best operate during the MSc programme; 3) To receive feedback from companies on how a short duration professional course could be delivered so that it addresses the companies' most immediate training needs by upskilling its existing personnel in data science and artificial intelligence. Next, we present the results per country.

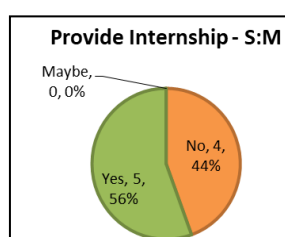
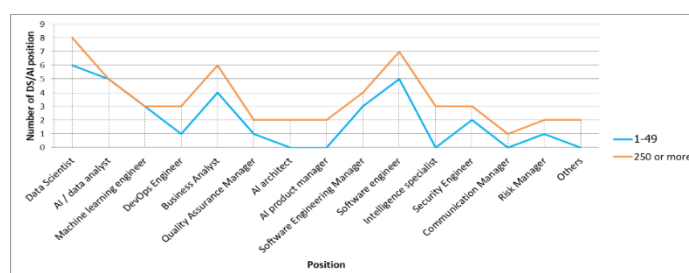


3.2 Thailand

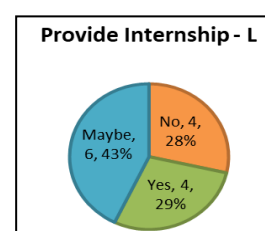
In Thailand we received a response from 23 of the companies we contacted. They include 9 small size company with less than 49 employers, and 14 larger companies with more than 250 employers. Unfortunately, we received no response from mid-size companies with a number of employers between 50 and 249 employers. Some of the companies are from the private sector (fintech, banking, ICT, and automotive related companies) but few are also from the public sector (healthcare and government). The companies and their answers to our questionnaire can be found in Appendix A, here we report a summary.

⁵ Skinner, Saunders and Beresford (2004), Towards a shared understanding of skill shortages: differing perceptions of training and development needs.

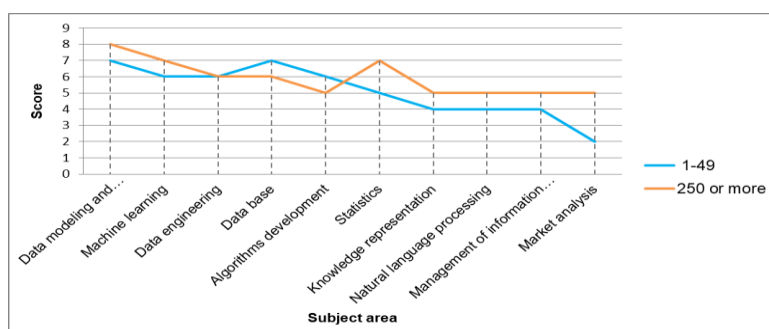
The diagram to the right summarizes the current available positions in data science and artificial intelligence. Overall, the highest demand for job positions in these fields are data scientist, software engineer, and business analyst, respectively. The demands of job positions follow a similar trend for small size as well as large size companies. For both the highest demand is for data scientist, AI/data analyst, software engineer, and business analyst.



About half of small-size companies provide internship opportunities for 1–3 students with a duration of 3 months or less (diagram on the left). Large-size companies can offer more places to students for internships, but only 29% answered positively, although 43% answered that maybe it can



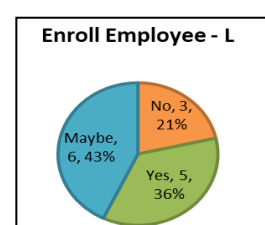
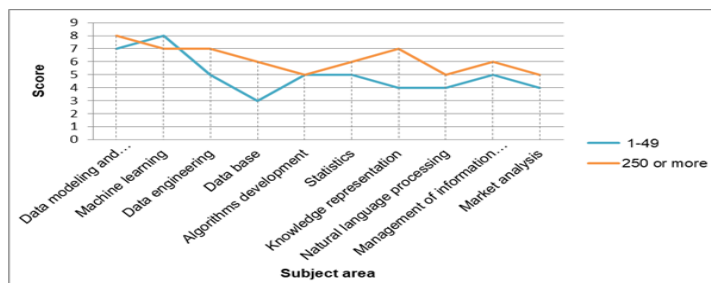
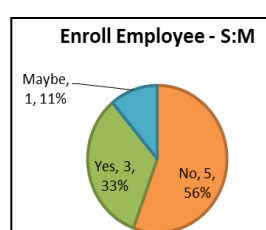
be an option (diagram on the right). Before starting the internship, companies require from students to have a strong background in programming (Python, R, SQL, Anaconda, Tensorflow, Genetic Algorithm,



and NoSQL), to be fast learners, to have basic skills to complete the end-to-end workflow (public cloud computing platform, SAP, Microsoft Office 365, Power BI, Microservice (Docker for Deployment project)), and to have knowledge on several subject areas as illustrated by the figure on

the left. The priority lies on data modelling and management, databases, machine learning, data engineering, and algorithms development, and statistics.

Only one third of the small size companies provide training courses, typically for 1–3 employees with

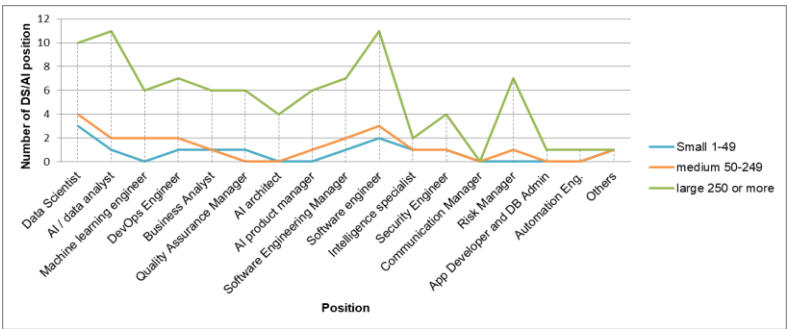


durations varying from 1 week to 3 months (diagram on the left for small companies, and on the right for large ones). Regarding the training needs, most companies had demand for the professional development courses for 1–6 employees with the duration of 1–2 weeks to 1 month. Companies think

most of the courses are too focused on statistical theory and algorithm developments, and that training courses should also teach the data analyst to demonstrate their model. During training, the companies assume knowledge of programming languages like Python, R, Scala, PHP, noSQL, DB, DB Monet. The demanded subject areas during training courses are described in the figure above on the right. The most important subject areas are considered to be data modelling and management, machine learning, data engineering, and knowledge representation.

3.3 Indonesia

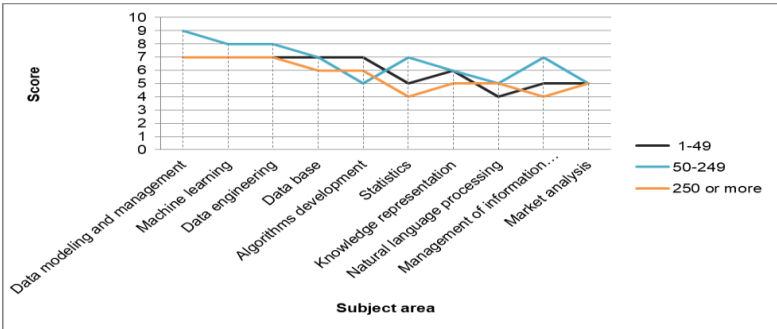
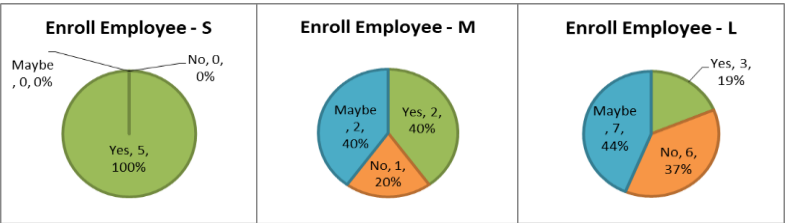
In Indonesia we received responses from 26 of the companies we contacted. They include 5 small size company with less than 50 employers, 5 mid-size companies with a number of employers between 50 and 250, and 16 larger companies with more than 250 employers. As for the case in Thailand, some of the companies are from the private sector (ICT, software and hardware vendors, aquaculture and agriculture related companies) but few are also from the public one (e.g. healthcare). The companies and their answers to our questionnaire can be found in Appendix B.



Overall, the highest demand for data science and artificial intelligent job positions are data scientist, software engineer, and artificial intelligence/data analyst, respectively. Considering only small-size companies (1–49 employees) and medium-size companies (50–250 employees), the highest demand for

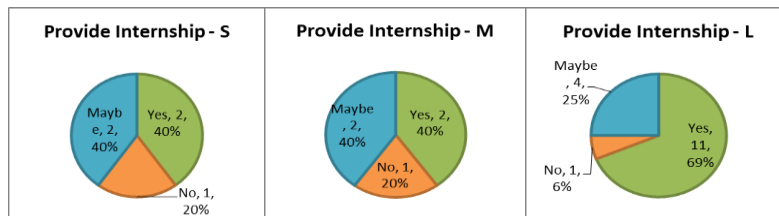
data science and artificial intelligent job positions is for data scientist and software engineer, respectively. Large-size companies (more than 250 employees), additionally, are also looking for artificial intelligence/data analysts.

The demand for training courses for employee per size of the company is summarized in the diagrams on the right. Small-size companies had demand for training 1–3 employees in short training courses (1 week to 1



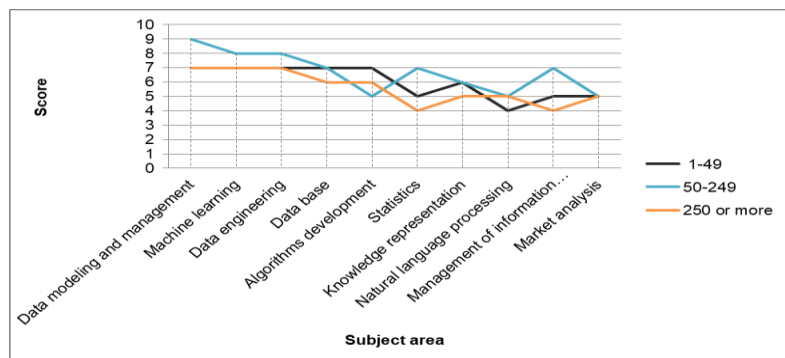
month). Most medium-size companies have needs to train different sizes of group of employees (1–3, 4–6, and 7–10 employees) for a period varying from 3 days to 2 weeks. Circa 37% of large-size companies do not have training needs, while the remaining could positively consider

enrolling about 1–3 employees for a training course of 1–week to 1–month. The most desirable topics among all the analysed companies corresponds to data modelling and management, machine learning and data engineering. The table on the left shows the average score given by the companies to topic areas for the training courses. Courses on statistics, natural language processing, and management of information systems are considered, on the average, least interesting for employees.



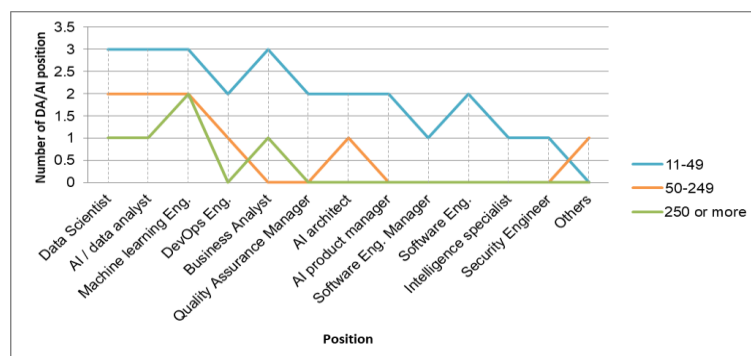
Most companies, independently from their size, might be able to provide 1 to 3 internship placements for a period of 3 months or less. Larger companies are however more in favour towards offering internships (94% consider that possibility). All

companies would require students to have knowledge on data modelling, machine learning and data engineering. In addition, small size companies require knowledge on data bases and algorithms. Natural language processing is felt in general as not really necessary. Interestingly, also statistics is one of the knowledge areas that is not really required from students by large companies. The diagram on the right summarize the average score given by the companies on the required knowledge of a student for an internship.



Knowledge is also required of programming languages like Python, Tensorflow, R, SQL, Java or any web-based programming Language, and of statistical and data visualization tools like Hadoop, D3.js, Microsoft Power BI, SAP, or similar.

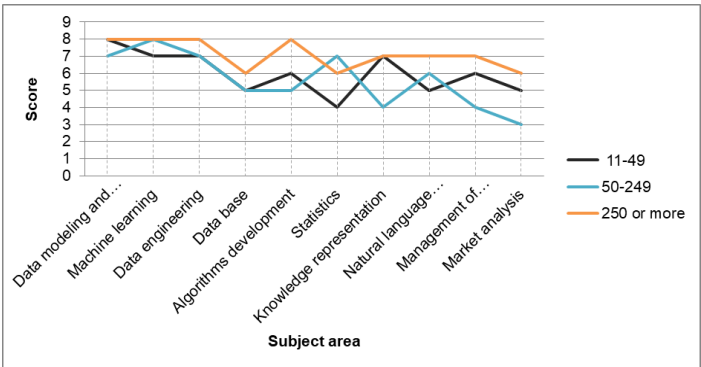
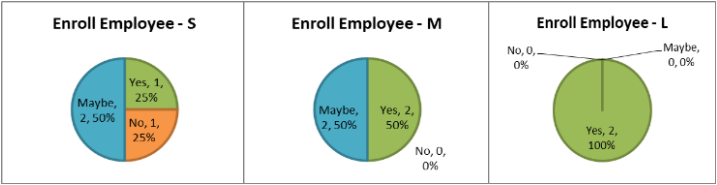
3.4 Sri Lanka



In Sri Lanka we received a response from 10 companies, 4 small-size, 4 mid-size, and 2 large ones. They are all private and all in positioned in an ICT elated area. Overall, the highest demands for data science and artificial intelligence job positions are machine learning engineer, data scientist, and artificial intelligence/data analyst, respectively. Small-size and large size companies

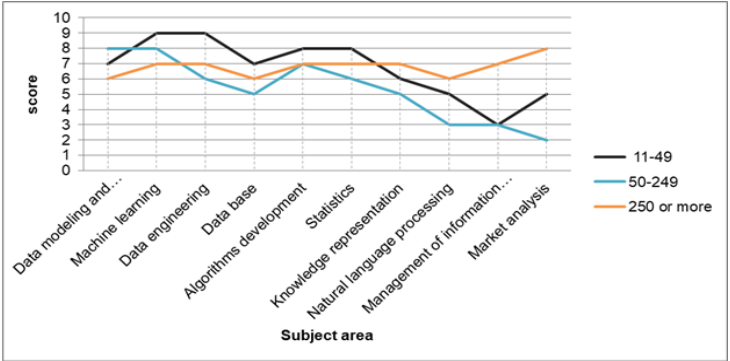
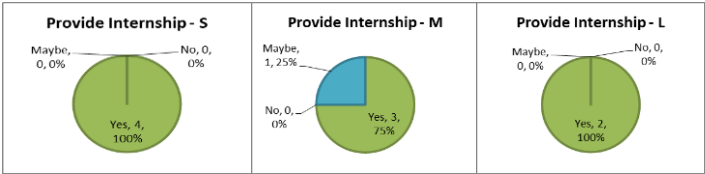
additionally are in needs of business analysts. The companies and their answers to our questionnaire can be found in Appendix C.

Most companies may consider enrolling some employees to training courses lasting between one to four weeks. All medium-size companies tend to support training courses for 1–3 employees per year with a duration ranging from a few days to a month. Large companies are interested in short training courses of at most 3 days. The most important subject areas for the courses are Data Modelling and Management, Machine Learning, and Data Engineering. Large companies find Algorithms also very important. The least important subject areas are Databases, Statistics and Market Analysis, probably because the employees already have knowledge on these subjects and do not need extra training. The table below summarize the average scores given by the companies (1 to 10) to different subject areas that could be considered for a professional training of their employees.



All small and large-size companies could offer 1–3 internship placements for students with the duration of 3–6 months. Mid-size companies could do the same but for more students: 1 to 10. Students would be required to have knowledge of programming language such as Python, TensorFlow, R, SQL, and to be able to use Matlab, Hadoop, and Git. There

are large differences between what is considered important as knowledge of the students before an internship, depending on the size of the company. Large companies prefer their interns to have knowledge of Market Analysis, whereas small and medium size companies prefer students to have knowledge of Machine Learning, Algorithms, and consider Market Analysis as the least important subject. Other topics that are considered important are Data Modelling and Management and Data Engineering. The table on the left summarize the findings.



3.5 Conclusion

In Thailand, Indonesia, and Sri Lanka companies are willing to provide internships, especially to students with knowledge in data modelling and in machine learning. Strangely enough, natural language processing is not considered relevant, while applications using chatbot are very much in use by all companies.

Appendix A Needs Assessment Survey: Thailand

Current available positions in data science and artificial intelligence

Company Profile			Positions present in the company related to data science and AI															
Number of employees	Company name	Sector	Data Scientist	AI / data analyst	Machine Learning Eng.	DevOps Eng.	Business Analyst	Quality assurance	AI architect	AI product manager	Software Eng. Manager	Software Eng.	Intelligence specialist	Security Engineer	Communication Manager	Risk Manager	Others	Total positions
1-10	Quantium Technology	Fintech										X						1
11-49	SmartContract Thailand	IT, Professional Service	X	X	X		X	X			X	X						7
	Intelligist Co.,Ltd.	-	X	X			X											3
	SOFTSION Co., Ltd.	-	X			X	X				X	X		X		X		7
	Q. Point Software Services Limited	Enterprise Software Development	X	X														2
	Thanadol & Kojchaboon Co., Ltd.	Healthcare		X			X							X				3
	BridgeAsia	Healthcare	X									X						2
	Deepscope	FinTech, WealthTech			X													1
	Energy Response	Commercial and industrial	X	X	X						X	X						5
	Microsoft Thailand Limited	Commercial Software Engineering	X		X	X			X	X	X	X						7

Company Profile			Positions present in the company related to data science and AI															
Number of employees	Company name	Sector	Data Scientist	AI / data analyst	Machine Learning Eng.	DevOps Eng.	Business Analyst	Quality assurance	AI architect	AI product manager	Software Eng. Manager	Software Eng.	Intelligence specialist	Security Engineer	Communication Manager	Risk Manager	Others	Total positions
≥2 50	Nissan Motors Asia Pacific	Automotive					X	X			X			X	X	X		6
	Essilor Manufacturing (Thailand) Co.,Ltd.	Ophthalmic optics company	X	X		X	X				X	X						6
	Datapro computer system	-	X															1
	TEAM Consulting Engineering and Management PLC	Engineering Consultancy	X									X	X					3
	IBM	IT	X	X	X	X	X	X	X	X	X	X	X	X		X		13
	True Digital Group	Telecommunications	X	X			X						X					4
	Office of Agricultural Economics	Government, Agricultural	X	X	X													3
	Insurance Company	Insurance company		X			X											2
	Bank of Thailand	Central Bank	X				X					X		X				4
	Seagate	-										X						1
	PTTEP	-										X						1
	Innovation technology Co.	-															X	1
	CAT Telecom	ICT															X	1
Total Companies			14	10	6	4	10	3	2	2	7	12	3	5	1	3	2	84

Employee training courses and student internships

Number of employees	Company name	Number of DS&AI employees				Enrol employees in short training courses					Providing internships to students completing a course in DS&AI?				
		1-3	4-10	11-25	>25	Yes	No	Maybe	How many	Duration	Yes	No	Maybe	How many	Duration
1-10	Quantum Technology	X				X			1-3	1 week	X			1-3	3 months
11-49	SmartContract Thailand	X					X					X			
	Intelligist Co.,Ltd.		X			X			>10	3 months	X			1-3	3 months
	SOFTSION Co., Ltd.	X				X			1-3	<3 months	X			1-3	>3 months
	Q. Point Software Services Limited	X					X				X			1-3	3 months
	Thanadol & Kojchaboon Co., Ltd.	X					X					X			
	BridgeAsia		X				X					X			
	Deepscope		X				X		1-3	2 weeks		X			
	Energy Response		X					X	1-3	1 week	X			1-3	2 months
>=250	Microsoft Thailand Limited				X	X			1-3	1 month	X			4-6	3 months
	Nissan Motors Asia Pacific				X			X	>10	3 days			X	>10	3 months
	Essilor Manufacturing (Thailand) Co.,Ltd.		X			X			4-6	3 months			X	4-6	6 months
	Datapro computer system		X					X			X			1-3	3 months
	TEAM Consulting Engineering and Management PLC	X						X	1-3	1 week			X	1-3	3 months

	IBM				X		X					X			
	True Digital Group			X			X					X			
	Office of Agricultural Economics							X	4-6	1 month	X			1-3	3 months
	Insurance Company			X				X	1-3	1 week		X			
	Bank of Thailand				X	X			4-6	2 weeks			X	1-3	1 month
	Seagate	X				X			1-3	2 weeks	X			1-3	Other
	PTTEP			X			X		>10	Others		X		1-3	Other
	Innovation technology Co.	X				X			4-6	1 month			X		3 months
	CAT Telecom				X			X	4-6	1 month			X	1-3	2 months

Required knowledge for internships (score 1 - 10)

Number of employees	Company name	Data modelling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
1-10	Quantum Technology	7	8	5	10	9	3	4	2	6	1
11-49	SmartContract Thailand	-	-	-	-	-	-	-	-	-	-
	Intelligist Co.,Ltd.	10	7	9	8	6	5	4	3	2	1
	SOFTSION Co., Ltd.	6	3	4	10	8	7	2	9	5	1
	Q. Point Software Services Limited	10	6	9	7	3	8	5	1	4	2
	Thanadol & Kojchaboon Co., Ltd.	-	-	-	-	-	-	-	-	-	-
	BridgeAsia	-	-	-	-	-	-	-	-	-	-

>=250	Deepscope	9	8	7	7	8	6	7	4	2	3
	Energy Response	2	3	1	2	2	2	3	2	2	2
	Average: Small-size company (rounded)	7	6	6	7	6	5	4	4	4	2
	Microsoft Thailand Limited	8	10	5	4	3	9	7	6	2	1
	Nissan Motors Asia Pacific	9	8	2	7	1	6	3	4	5	10
	Essilor Manufacturing (Thailand) Co.,Ltd.	8	10	7	5	4	9	2	6	3	1
	Datapro computer system	10	7	6	5	8	9	3	4	1	2
	TEAM Consulting Engineering and Management PLC	9	4	7	3	1	2	8	10	5	6
	IBM	–	–	–	–	–	–	–	–	–	–
	True Digital Group	–	–	–	–	–	–	–	–	–	–
	Office of Agricultural Economics	9	6	7	8	5	10	4	2	3	1
	Insurance Company	–	–	–	–	–	–	–	–	–	–
	Bank of Thailand	8	7	3	6	10	5	4	2	9	1
	Seagate	8	10	10	10	10	5	8	1	1	1
	PTTEP	8	8	8	1	6	8	8	9	8	8
	Innovation technology Co., Ltd.	6	7	10	10	6	8	5	5	10	10
	CAT Telecom	3	3	5	8	3	8	8	3	3	9
	Average: Large-size company (rounded)	8	7	6	6	5	7	5	5	5	5

Small-size companies (based on average score)

Top 5 (6–8 scores)	Average (4–5 scores)	Least interested (2 scores)
1. Data modelling and management	1. Statistics	1. Market analysis
2. Data base	2. Knowledge representation	
3. Machine learning	3. Natural language processing	
4. Data engineering	4. Management of information systems	

5. Algorithms development		
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Large-size companies (based on average score)

Top 5 (6–8 scores)	Average (5 scores)
1. Data modelling and management	1. Algorithms development
2. Statistics	2. Knowledge representation
3. Machine learning	3. Natural language processing
4. Data engineering	4. Management of information systems
5. Data base	5. Market analysis

Demanded subject areas for professional development (score 1 – 10)

Number of employees	Company name	Data modelling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
1–10	Quantium Technology	7	10	6	1	8	4	3	5	9	2
11–49	SmartContract Thailand	–	–	–	–	–	–	–	–	–	–
	Intelligist Co.,Ltd.	10	9	8	7	6	5	4	3	2	1
	SOFTSION Co., Ltd.	6	8	3	2	1	10	4	5	7	9
	Q. Point Software Services Limited	–	–	–	–	–	–	–	–	–	–
	Thanadol & Kojchaboon Co., Ltd.	–	–	–	–	–	–	–	–	–	–
	BridgeAsia	–	–	–	–	–	–	–	–	–	–
	Deepscope	9	9	4	1	8	2	6	7	5	6
	Energy Response	3	2	2	2	3	2	2	2	2	2

>=250	Average: Small-size 1-49 (rounded)	7	8	5	3	5	5	4	4	5	4
	Microsoft Thailand Limited	8	10	5	4	3	9	6	7	2	1
	Nissan Motors Asia Pacific	9	7	4	8	3	1	5	6	2	10
	Essilor Manufacturing (Thailand) Co.,Ltd.	10	8	7	6	3	1	4	5	9	2
	Datapro computer system	-	-	-	-	-	-	-	-	-	-
	TEAM Consulting Engineering and Management PLC	10	6	8	5	4	1	9	7	3	2
	IBM	-	-	-	-	-	-	-	-	-	-
	True Digital Group	-	-	-	-	-	-	-	-	-	-
	Office of Agricultural Economics	9	7	10	3	4	5	8	2	6	1
	Insurance Company	9	3	4	5	2	7	8	1	10	6
	Bank of Thailand	10	9	5	3	4	6	8	7	2	1
	Seagate	10	10	10	10	10	10	10	10	10	10
	PTTEP	8	8	8	1	8	8	8	5	8	8
	Innovation technology Co., Ltd.	1	4	4	9	5	8	5	5	8	6
	CAT Telecom	3	3	8	9	9	9	3	3	8	10
	Average: Large-size (rounded)	8	7	7	6	5	6	7	5	6	5

Small-size companies (based on average score)

Top 2 (7-8 scores)	Average (5 scores)	Least interested (3-4 scores)
1. Machine learning	1. Data engineering	1. Knowledge representation
2. Data modelling and management	2. Algorithms development	2. Natural language processing
	3. Statistics	3. Market analysis
	4. Management of information systems	4. Data base

Large-size companies (based on average score)

Top 4 (7–8 scores)	Average (6 scores)	Least interested (5 scores)
1. Data modelling and management 2. Machine learning 3. Data engineering 4. Knowledge representation	1. Data base 2. Statistics 3. Management of information systems	1. Algorithms development 2. Natural language processing 3. Market analysis

Appendix B Needs Assessment Survey: Indonesia

Current available positions in data science and artificial intelligence

Company Profile			Positions present in the company related to data science and AI																
Number of employees	Company name	Sector	Data Scientist	AI / data analyst	Machine Learning Eng.	DevOps Eng.	Business Analyst	Quality Assurance Manager	AI architect	AI product manager	Software Eng. Manager	Software Eng.	Intelligence specialist	Security Engineer	Risk Manager	App Developer and DB Admin	Automation Eng.	Others	Total positions
1–10	FR Softnet (Pvt) Ltd	Information Tech.	X	X									X						3
11–49	PT. Lunata Technologies	–										X							1
	SMKS Islamic Technology Marinah Al-Hidayah Medan	–	X				X	X											3
	UPT TIK (Teknologi Informasi dan Komunikasi) – Universitas Syiah Kuala	ICT				X						X		X					3
	Sangkuriang	IT, custom software development	X								X							1	3
50–249	BALAI VETERINER MEDAN KEMENTERIAN PERTANIAN	–	X									X							2
	Oracle Indonesia	Software & Hardware Vendor	X	X									X						3
	PT Prosa Solusi Cerdas	–			X														1
	GDP Labs	Information Tech.	X		X	X				X	X	X		X					7
	eFishery	Aquaculture	X	X		X	X				X	X			X			X	8

Company Profile			Positions present in the company related to data science and AI																
Number of employees	Company name	Sector	Data Scientist	AI / data analyst	Machine learning Eng.	DevOps Eng.	Business Analyst	Quality Assurance Manager	AI architect	AI product manager	Software Eng. Manager	Software Eng.	Intelligence specialist	Security Engineer	Risk Manager	App Developer and DB Admin	Automation Eng.	Others	Total positions
>= 250	PT Perkebunan Nusantara IV	Agriculture Palm Oil					1									X			2
	PT Dua Empat Tujuh	ICT	X		X	X	X	X	X	X		X		X					9
	PT Aplikanusa Lintasarta	Telecommunication		X		X	X	X				X		X	X				7
	BPJS Ketenagakerjaan	–		X								X			X				3
	PT Solusi Bangun Andalas	Cement Industry		X	X		X	X	X	X			X		X				8
	PT. Bank sumut	–		X	X					X	X								4
	Tokopedia (Mobile engineer)	IT	X			X					X	X			X				5
	SMEC Group (CTO)	Eye Hospital	X			X		X			X	X		X	X				7
	SMEC Group (IT–HRD)	Eye Hospital	X			X		X			X	X		X	X				7
	PT Bank Mandiri (Persero) Tbk.	–		X		X	X	X	X	X	X	X	X		X		X		11
	PT. TELKOM INDONESIA	–	X	X			X												3
	Tokopedia (Software engineer)	Technology	X	X	X							X							4
	Bukalapak	E–commerce	X	X	X					X	X								5
	GDP Labs	–	X	X	X	X					X		X					X	7
	Airy	–	X	X								X	X						4
	PT Airy Nest Indonesia	Hospitality; Information Tech.	X	X								X	X						4
	Total Companies		17	14	8	10	8	7	4	7	10	16	4	6	8	1	1	3	124

Employee training courses and student internships

Number of employees	Company name	Number of DS&AI employees				Enrol employees in short duration courses					Providing internships to students completing a course in DS&AI?				
		1-3	4-10	11-25	>25	Yes	No	Maybe	How many?	Duration	Yes	No	Maybe	How many?	Duration
1-10	FR Softnet (Pvt) Ltd	X				X			1-3	1 month	X			1-3	Other
11-49	PT. Lunata Technologies	X				X							X	1-3	1 month
	SMKS Islamic Technology Marinah Al-Hidayah Medan	X				X			1-3	1 week	X			1-3	3 months
	UPT TIK – Universitas Syiah Kuala	X				X						X			
	Sangkuriang	X				X			1-3	1 week			X	1-3	2 months
50-249	Balai Veterinier Medan Kementerian Pertanian	X				X			1-3	3 days			X	1-3	2 weeks
	Oracle Indonesia		X				X					X			
	PT Prosa Solusi Cerdas				X	X			4-6	1 week	X			1-3	3 months
	GDP Labs			X				X	7-10	Other	X			4-6	3 months
	eFishery		X					X	1-3	2 weeks			X	1-3	3 months
>=250	PT Perkebunan Nusantara IV						X		4-6	1 month			X	1-3	3 months
	PT Dua Empat Tujuh			X				X	1-3	1 week	X			1-3	1 month
	PT Aplikanusa Lintasarta		X				X		1-3	2 weeks	X			1-3	3 months
	BPJS Ketenagakerjaan		X					X					X	1-3	3 months
	PT Solusi Bangun Andalas		X				X		1-3	1 week			X	1-3	1 month
	PT. Bank sumut						X				X			1-3	3 months

Number of employees	Company name	Number of DS&AI employees				Enrol employees in short duration courses					Providing internships to students completing a course in DS&AI?				
		1-3	4-10	11-25	>25	Yes	No	Maybe	How many?	Duration	Yes	No	Maybe	How many?	Duration
	Tokopedia (Mobile eng.)				X			X	>10	1 month			X	>10	3 months
	SMEC Group (CTO)	X					X		4-6	1 month	X			1-3	1 month
	SMEC Group (IT-HRD)	X					X					X			
	PT Bank Mandiri (Persero) Tbk.				X	X			7-10	1 month	X			1-3	2 months
	PT. Telkom Indonesia				X			X	>10	1 week	X			>10	Depends
	Tokopedia (Soft. eng.)				X	X			1-3	1 week	X			>10	3 months
	Bukalapak				X			X	1-3	Other	X			1-3	3 months
	GDP Labs			X				X	>10	1 week	X			>10	2 months
	Airy		X					X	4-6	3 days	X			1-3	Other
	PT Airy Nest Indonesia		X			X			1-3	1 month	X			1-3	3 months

Required knowledge for internships (score 1 - 10)

Number of employees	Company name	Data modelling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
1-10	FR Softnet (Pvt) Ltd	3	4	5	3	4	5	5	4	3	7
11-49	PT. Lunata Technologies	10	6	5	7	9	4	8	3	2	1

Number of employees	Company name	Data modelling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
	SMKS Islamic Technology Marinah Al-Hidayah Medan	8	10	9	6	7	2	4	1	5	3
	UPT TIK – Universitas Syiah Kuala	–	–	–	–	–	–	–	–	–	–
	Sangkuriang	8	7	8	10	8	9	8	9	10	7
	Average: Small-size company : 1–49 (rounded)	7	7	7	7	7	5	6	4	5	5
50–249	Balai Veterinier Medan Kementerian Pertanian	6	4	7	9	2	8	5	3	10	1
	Oracle Indonesia	–	–	–	–	–	–	–	–	–	–
	PT Prosa Solusi Cerdas	10	9	8	6	5	4	3	7	2	1
	GDP Labs	10	10	10	5	5	8	10	5	5	8
	eFishery	8	7	8	8	6	8	6	4	9	9
	Average: Medium-size company: (rounded)	9	8	8	7	5	7	6	5	7	5
>=250	PT Perkebunan Nusantara IV	6	5	3	10	8	1	7	4	9	2
	PT Dua Empat Tujuh	9	10	6	5	4	1	7	8	3	2
	PT Aplikanusa Lintasarta	8	10	4	1	9	5	2	7	3	6
	BPJS Ketenagakerjaan	8	7	9	10	4	1	5	6	3	2
	PT Solusi Bangun Andalas	3	7	9	4	2	5	6	1	8	10
	PT. Bank sumut	8	10	6	4	3	1	9	7	2	5
	Tokopedia (Mobile engineer)	6	5	9	10	8	4	2	1	3	7
	SMEC Group (CTO)	7	5	10	9	8	6	3	4	2	1
	SMEC Group (IT-HRD)	–	–	–	–	–	–	–	–	–	–

Number of employees	Company name	Data modelling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
	PT Bank Mandiri (Persero) Tbk.	4	1	10	8	9	2	5	3	6	7
	PT. Telkom Indonesia	8	1	9	5	3	4	2	7	6	10
	Tokopedia (Software engineer)	8	9	6	5	10	4	1	7	2	3
	Bukalapak	8	9	10	4	7	6	2	5	1	3
	GDP Labs	3	10	4	2	8	9	7	6	1	5
	Airy	7	8	6	6	5	8	6	6	5	7
	PT Airy Nest Indonesia	7	8	9	10	5	6	4	3	1	2
	Average: Large size company (rounded)	7	7	7	6	6	4	5	5	4	5

Small-size companies: 1–49 (based on average score)

Top 5 (7 scores)	Average (5–6 scores)	Least interested (4 scores)
1. Data modelling and management 2. Machine learning 3. Data engineering 4. Data base 5. Algorithms development	1. Knowledge representation 2. Statistics 3. Management of information systems 4. Market analysis	1. Natural language processing

Medium-size companies: 50–249 (based on average score)

Top 3 (8–9 scores)	Average (6–7 scores)	Least interested (5 scores)
1. Data modelling and management 2. Machine learning 3. Data engineering	1. Data base 2. Statistics 3. Management of information systems 4. Knowledge representation	1. Algorithms development 2. Natural language processing 3. Market analysis

Large-size companies (based on average score)

Top 3 (7 scores)	Average (5–6 scores)	Least interested (4 scores)
1. Data modelling and management 2. Machine learning 3. Data engineering	1. Data base 2. Algorithms development 3. Knowledge representation 4. Natural language processing 5. Market analysis	1. Statistics 2. Management of information systems

Demanded subject areas for professional development (score 1 – 10)

Number of employees	Company name	Data modelling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
1–10	FR Softnet (Pvt) Ltd	4	5	4	5	4	5	7	6	4	6
11–49	PT. Lunata Technologies	–	–	–	–	–	–	–	–	–	–

Number of employees	Company name	Data modelling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
	SMKS Islamic Technology Marinah Al-Hidayah Medan	8	7	9	10	2	3	5	4	6	1
	UPT TIK – Universitas Syiah Kuala	–	–	–	–	–	–	–	–	–	–
	Sangkuriang	10	8	9	10	8	10	8	8	9	8
	Average: Small-size company (rounded)	7	7	7	8	5	6	7	6	6	5
50–249	Balai Veterinier Medan Kementerian Pertanian	8	5	7	9	2	6	3	4	10	1
	Oracle Indonesia	–	–	–	–	–	–	–	–	–	–
	PT Prosa Solusi Cerdas	10	9	8	7	6	5	4	3	2	1
	GDP Labs	9	7	9	4	9	4	4	4	9	9
	eFishery	9	8	8	8	6	10	2	5	6	6
	Average: Medium-size company (rounded)	9	7	8	7	6	6	3	4	7	4
>=250	PT Perkebunan Nusantara IV	6	5	3	9	7	1	8	4	10	2
	PT Dua Empat Tujuh	10	9	6	4	5	1	7	8	3	2
	PT Aplikanusa Lintasarta	8	10	4	6	7	1	3	9	5	2
	BPJS Ketenagakerjaan	–	–	–	–	–	–	–	–	–	–
	PT Solusi Bangun Andalas	4	8	10	6	2	3	7	1	5	9
	PT. Bank sumut	–	–	–	–	–	–	–	–	–	–
	Tokopedia (Mobile engineer)	10	9	7	6	5	2	8	1	4	3
	SMEC Group (CTO)	10	5	8	9	7	6	3	4	2	1
	SMEC Group (IT-HRD)	–	–	–	–	–	–	–	–	–	–
	PT Bank Mandiri (Persero) Tbk.	5	3	10	9	8	1	7	4	6	2

Number of employees	Company name	Data modelling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
	PT. Telkom Indonesia	8	1	7	5	4	3	2	6	9	10
	Tokopedia (Software engineer)	8	9	6	5	10	4	1	7	2	3
	Bukalapak	9	7	10	1	4	3	5	8	2	6
	GDP Labs	4	8	3	2	7	1	5	9	10	6
	Airy	10	10	10	8	8	8	10	8	10	10
	PT Airy Nest Indonesia	7	9	10	6	5	4	3	2	8	1
	Average: Large-size company (rounded)	8	7	7	6	6	3	5	5	6	4

Small-size companies: 1–49 (based on average score)

Top 5 (7–8 scores)	Average (6 scores)	Least interested (5 scores)
1. Data base 2. Data modelling and management 3. Machine learning 4. Data engineering 5. Knowledge representation	1. Statistics 2. Natural language processing 3. Management of information systems	1. Algorithms development 2. Market analysis

Medium-size companies (based on average score)

Top 2 (8–9 scores)	Average (6–7 scores)	Least interested (3–4 scores)
1. Data modelling and management 2. Data engineering	1. Machine learning 2. Data base	1. Natural language processing 2. Market analysis

	3. Management of information systems 4. Algorithms development 5. Statistics	3. Knowledge representation
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Large-size companies (based on average score)

Top 3 (7–8 scores)	Average (5–6 scores)	Least interested (3–4 scores)
1. Data modelling and management 2. Machine learning 3. Data engineering	1. Data base 2. Algorithms development 3. Management of information systems 4. Knowledge representation 5. Natural language processing	1. Market analysis 2. Statistics

Appendix C Needs Assessment Survey: Sri Lanka

Current available positions in data science and artificial intelligence

Company Profile			Positions present in the company related to data science and AI													
Number of employees	Company name	Sector	Data Scientist	AI / data analyst	Machine learning	DevOps Eng.	Business Analyst	Quality Assurance	AI architect	AI product	Software Eng.	Software Eng.	Intelligence	Security Engineer	Others	Total positions
11–49	Trabeya Pvt Ltd	ICT	X	X	X	X	X	X								6
	Linear Squared Private Limited	AI/Data Science	X	X	X		X		X	X		X				7
	Paraquum Technologies (Pvt) Ltd	Service Integration		X	X	X	X	X	X	X	X	X	X	X		11
	Axiata Digital Labs (Pvt) Ltd	–	X													1
50–249	VizuaMatix	–	X													1
	n*able pvt ltd	Electronics Design Services and Network Product Development		X	X											2
	Hsenid Mobile Solutions	IT/Telco	X	X	X	X			X							5
	SimCentric Technologies	Mobile Application													X	1
>=250	DIALOG AXIATA PLC	IT			X											1
	V S Information Systems (Pvt) Ltd.	ICT	X	X	X		X									4
	Total		6	6	7	3	4	2	3	2	1	2	1	1	1	39

Employee training courses and student internships

Number of employees	Company name	Number of DS&AI employees				Enroll employees in short duration courses					Providing internships to students completing a course in DS&AI?				
		1-3	4-10	11-25	>25	Yes	No	Maybe	How many?	Duration	Yes	No	Maybe	How many?	Duration
11-49	Trabeya Pvt Ltd			X				X	1-3	1 week	X			1-3	6 months
	Linear Squared Private Limited		X					X	1-3	1 month	X			1-3	3 months
	Paraqum Technologies (Pvt) Ltd	X				X			1-3	1 month	X			1-3	Other
	Axiata Digital Labs (Pvt) Ltd			X			X		1-3	Other	X			7-10	3 months
50-249	VizuaMatix		X			X			1-3	1 month	X			4-6	6 months
	n*able pvt ltd		X					X	1-3	1 month	X			1-3	3 months
	Hsenid Mobile Solutions	X						X	> 10	Other	X			1-3	Other
	SimCentric Technologies	X				X			1-3	3 days			X	7-10	Other
>=250	DIALOG AXIATA PLC			X		X			1-3	Other	X			1-3	Other
	V S Information Systems (Pvt) Ltd.		X			X			1-3	3 days	X			1-3	Other

Required knowledge for internships (score 1 – 10)

Number of employees	Company name	Data modeling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis
11–49	Trabeya Pvt Ltd	4	10	9	5	7	8	6	3	2	1
	Linear Squared Private Limited	7	9	8	7	9	9	3	6	3	6
	Paraqum Technologies (Pvt) Ltd	8	8	8	7	8	8	8	1	1	8
	Axiata Digital Labs (Pvt) Ltd	8	8	10	8	9	7	8	8	5	5
	Average: Small-size company(rounded)	7	9	9	7	8	8	6	5	3	5
50–249	VizuaMatix	10	8	6	5	7	9	3	1	4	2
	n*able pvt ltd	10	8	9	5	3	7	6	4	2	1
	Hsenid Mobile Solutions	9	9	9	8	8	8	8	6	5	5
	SimCentric Technologies	1	7	1	1	10	1	1	1	1	1
	Average: Medium-size company (rounded)	8	8	6	5	7	6	5	3	3	2
≥250	DIALOG AXIATA PLC	8	8	8	7	8	8	8	6	8	8
	V S Information Systems (Pvt) Ltd.	4	6	6	5	5	6	6	5	5	7
	Average: Large-size company (rounded)	6	7	7	6	7	7	7	6	7	8

Small-size companies (based on average score)

Top 4 (8–9 scores)	Average (6–7 scores)	Least interested (3–5 scores)
1. Machine learning 2. Data engineering	1. Data modeling and management 2. Data base	1. Natural language processing 2. Market analysis

3. Algorithms development 4. Statistics	3. Knowledge representation	3. Management of information systems
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Medium-size companies (based on average score)

Top 3 (7-8 scores)	Average (5-6 scores)	Least interested (2-3 scores)
1. Data modelling and management 2. Machine learning 3. Algorithms development	1. Data engineering 2. Statistics 3. Data base 4. Knowledge representation	1. Natural language processing 2. Management of information systems 3. Market analysis

Large-size companies (based on average score)

Top 1 (8 scores)	Average (7 scores)	Least interested (6 scores)
1. Market analysis	1. Machine learning 2. Data engineering 3. Algorithms development 4. Statistics 5. Knowledge representation 6. Management of information systems	1. Data modeling and management 2. Data base 3. Natural language processing

Demanded subject areas for professional development (score 1 – 10)

Number of employees	Company name	Data modeling and management	Machine learning	Data engineering	Data base	Algorithms development	Statistics	Knowledge representation	Natural language processing	Management of information systems	Market analysis	Small-size companies (based on average score)
11–49	Trabeya Pvt Ltd	9	6	5	10	3	4	8	7	2	1	
	Linear Squared Private Limited	4	4	7	4	4	4	7	4	4	4	
	Paraqum Technologies (Pvt) Ltd	9	9	9	1	9	1	6	1	9	8	
	Axiata Digital Labs (Pvt) Ltd	9	9	6	4	6	8	7	8	7	7	
	Average: Small-size (rounded)	8	7	7	5	6	4	7	5	6	5	
50–249	VizuaMatix	10	6	8	5	7	9	3	1	4	2	
	n*able pvt ltd	7	8	9	4	3	10	5	6	2	1	
	Hsenid Mobile Solutions	9	9	9	9	8	6	7	8	9	6	
	SimCentric Technologies	1	10	1	1	1	1	1	10	1	1	
	Average: Medium-Size (rounded)	7	8	7	5	5	7	4	6	4	3	
>=250	DIALOG AXIATA PLC	8	8	8	7	8	8	6	8	8	8	
	V S Information Systems (Pvt) Ltd.	7	7	7	4	7	4	8	6	5	4	
	Average: Large-size (rounded)	8	8	8	6	8	6	7	7	7	6	
Top 4 (7–8 scores)		Average (6 scores)				Least interested (4–5 scores)						
1. Data modelling and management 2. Machine learning 3. Data engineering 4. Knowledge representation		1. Algorithms development 2. Management of information systems				1. Data base 2. Natural language processing 3. Market analysis 4. Statistics						

Medium-size companies (based on average score)

Top 4 (7–8 scores)	Average (5–6 scores)	Least interested (3–4 scores)
1. Machine learning 2. Data modelling and management 3. Data engineering 4. Statistics	1. Natural language processing 2. Data base 3. Algorithms development	1. Knowledge representation 2. Management of information systems 3. Market analysis

Large-size companies (based on average score)

Top 4 (8 scores)	Average (7 scores)	Least interested (6 scores)
1. Data modelling and management 2. Machine learning 3. Data engineering 4. Algorithms development	1. Knowledge representation 2. Natural language processing 3. Management of information systems	1. Data base 3. Statistics 4. Market analysis

