

VOCATIONAL EDUCATION AND TRAINING (VET) PLAN FOR REFRIGERATION AND AIR CONDITIONING SECTOR



**TERTIARY AND VOCATIONAL EDUCATION
COMMISSION**
Ministry of Education

In Collaboration with National Ozone Unit
Ministry of Environment



Executive Summary

Led by scientific discovery during the 1970s, the depletion of the ozone layer has been linked to the presence of halogen-source gases in the stratosphere, known as Ozone Depleting Substances (ODS). International action has been effective in protecting the ozone layer by universal ratification to several Multilateral Environmental Agreements (MEAs). Many countries around the world have already made structural changes in their economies to accommodate initiatives to reduce emissions of ODS and their substitutes. To survive in the future global market, it is imperative that Sri Lanka also grasps the concepts of introducing necessary changes to direct sectors such as Refrigerant and Air Conditioning (RAC) into a more sustainable path.

The Ministry of Environment's National Ozone Unit (NOU) and the Tertiary and Vocational Education Commission (TVEC) have recognized the importance of conducting a study on the projected market demand for Refrigerant and Air Conditioning (RAC) services and identifying the training requirements under the "Enabling Activities" project for phasing down hydrofluorocarbons (HFCs) in Sri Lanka.

To achieve this task, an island-wide survey of key stakeholders of the RAC sector was undertaken, covering employers, employees, educational and training providers and trainees/students in the RAC sector. The main objective is to identify key industrial sectors to focus on preparation of the Vocational and Educational Training (VET) plan for RAC sector in Sri Lanka. Accordingly, this report examines characteristics of the current RAC market, driving factors and future demands, skill needs and training provision, to understand and evaluate the future demand for training for each occupation categories in the RAC sector.

The Gap Analysis of the study led to the identification of several core gaps relevant to vocational education training in the RAC sector. Major gaps include absence of a proper mechanism for quality assurance and accreditation, limitations in focus on imparting employability/practical skills and lack of relevance, resources limitation, lack of industry and worker awareness on emerging trends and opportunities in RAC sector, lack of external collaborations, gender inequity in job opportunities in the RAC sector, and finally, the absence of a formally defined qualifications for instructors.

The analysis of challenges and trends in the country's RAC sector revealed the requirement for different levels of development in the VET system. To meet the future demand for RAC related skills and training, the strategy and action plans are proposed to meet the following goals and objectives:

- Enhance the relevance and quality of RAC- related VET
- Raising awareness on emerging career opportunities in RAC sector
- Offer more diversified and flexible training opportunities in RAC
- Improve the stakeholder collaboration in RAC sector

The proposed VET plan requires a strong collaboration of many Government and private sector stakeholders to achieve the objectives specified in the training plan. The proposed VET plan has highlighted improvement of inter-institutional collaboration among relevant higher education and vocational training institutes as well as other relevant private sector stakeholders in effective delivery of RAC related trainings in the future. Such collaborations will help overcome the limitations in resources, training facilities and training opportunities for students in RAC vocational training programs. Recommendations and strategies are also provided to encourage the recruitment and retaining of students on RAC vocational training programs. The necessity to equip current RAC trainers with the knowledge and skills that are essential to effectively teach students about the principles, techniques, and best practices in the field of refrigeration and air conditioning.

As the apex body in the tertiary and vocational education training sector in the country, Tertiary and Vocational Education Commission needs to take the leadership in this regard. Monitoring and review mechanism to ensure the timely implementation of the VET plan is also provided.

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List of Abbreviations

AC	Air Conditioning
BMS	Building Management System
BOI	Board of Investment
CEA	Central Environment Authority
CFC	Chlorofluorocarbon
CGTTI	Ceylon German Technical Training Institutes
CPD	Continuing Professional Development
CTC	Carbon Tetrachloride
DTET	Department of Technical Education and Training
EPL	Environmental Protection License
FDG	Focus Group Discussion
GBCSL	Green Building Council of Sri Lanka
GHG	Greenhouse Gas
GOSL	Government of Sri Lanka
GT	Green Technology
GWP	Global Warming Potential
HC	Hydrocarbon
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HPMP	Hydrochlorofluorocarbon Phase-out Management Plan
KA	Kigali Amendment
KII	Key Informant Interview
IS	Institutional Strengthening
MAC	Mobile Air Conditioning
MEA	Multilateral Environmental Agreement
MLF	Multilateral Fund
MMDE	Ministry of Mahaweli Development & Environment
MP	Montreal Protocol
NAITA	National Apprentice and Industrial Training Authority
NDC	Nationally Determined Contribution
NEA	National Environmental Act
NGO	Non-Government Authority

NVQ	National Vocational Qualification
NYSC	National Youth Services Council
ODS	Ozone Depleting Substances
PCB	Printed Circuit Board
RAC	Refrigeration and Air Conditioning
RMP	Refrigerant Management Plan
SLQF	Sri Lanka Qualifications Framework
SME	Small and Medium Enterprises
TVEC	Tertiary and Vocational Education Commission
TVET	Technical and Vocational Education and Training
UGC	University Grants Commission
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VET	Vocational Educational and Training
VRF	Variable Refrigerant Flow
VRV	Variable Refrigerant Volume
VTa	Vocational Training Authority
VTC	Vocational Training Center

Chapter 1

INTRODUCTION

1.1 Background and Rationale

Sri Lanka is transitioning from factor - driven to efficiency-driven development hence, efficient technical and vocational education and training (TVET) is vital to move up the value chain. Such education and training are crucial for economies that want to move beyond simple production processes and products. The TVET sector in Sri Lanka comprises public, private, and nongovernment providers. The public TVET sector is the dominant, with the Tertiary and Vocational Education Commission (TVEC) serving as the sector's apex body. A growth in the private and nongovernment organization (NGO) training providers have been observed over the past 2 decades. NGOs include voluntary organizations that offer craft training targeting unemployed youth, school dropouts, and semiskilled or unskilled workers. TVET sector operates through a nationwide training service network with an annual enrollment of more than 150,000 students¹. TVEC, the apex policy-making body for the Technical and Vocational Education and Training (TVET) sector of Sri Lanka, is entrusted with planning, coordination, and developing TVET at all levels in keeping abreast with the human resource needs of the economy.

The rise in residential and commercial construction projects, along with the high growth of the tourism and hospitality industry in the post-war period, is creating demand for Heating, ventilation, and air conditioning (HVAC) products in Sri Lanka. As a signatory to the Montreal Protocol (MP) on substances that deplete the Ozone Layer, the Government of Sri Lanka (GOSL) is committed to complying with its phase-out plans specified for Hydrochlorofluorocarbons (HCFCs) and phase-down plans for Hydrofluorocarbons (HFCs). Accordingly, Chlorofluorocarbons (CFCs) has already been phased-out, and the HCFC phasing-out plan is progressing in Sri Lanka. HFCs are widely used as alternatives to CFCs and HCFCs although many HFCs are characterized by a high global warming potential (GWP). As per the Kigali Amendment (KA) to the Montreal Protocol in 2016, the HFC phase-down plan in Sri Lanka (being A5-Group 1) will start in 2024. However, the use of HFC refrigerants prevails in the Refrigeration and Air Conditioning (RAC) Sector in Sri Lanka even when the global use of HFCs for most developing countries is expected to be reduced by around 80% by

¹Asian Development Bank (ADB). (2015). Sector Assessment - Education. Asian Development Bank. <https://www.adb.org/sites/default/files/linked-documents/6-SRI-Sector-Assessment-Education.pdf>

2045². Being a tropical country, Sri Lanka incurs significant energy and infrastructure expenditure related to RAC sector. Hence, it is imperative to switch to using HFC-alternatives refrigerants that have a low GWP.

In this context, the Ministry of Environment has received financial assistance from the Multilateral Fund (MLF) to assess the future market demand in the RAC service sector and identify training needs under the project “Enabling Activities” for the HFC phase-down in Sri Lanka. To achieve this task, the National Ozone Unit (NOU) of the Ministry of Environment expects to map and identify human resources and skill requirements of growing industry sectors, including the RAC sector and prepare Vocational Education and Training (VET) Plans to be implemented through the training providers with the coordination of the Tertiary and Vocational Education Commission (TVEC).

Under this program, NOU expects to develop a VET Plan for the Refrigeration and Air Conditioning sector, an important industry sector of the national economy that provides significant employment.

1.2 Scope of the Study

The VET plan has focused on understanding the current industry, human resources, and training profiles of the RAC sector, conduct a comprehensive situation analysis and gap analysis of the RAC sector, and predict the future growth, occupation opportunities and training needs to equip the human resources to meet the future demand and challenges.

1.3 Objectives

The VET plan aims to achieve the following objectives to facilitate and develop future strategies for the RAC sector.

- To identify the characteristics of the current RAC market
- To identify factors driving the RAC market and its growth
- To assess the training needs in the RAC sector
- To understand the current development trends of the RAC sector
- To determine the future demands in the RAC sector
- To understand the geographical distribution of the industry-Province/ District
- To envisage the technological changes of the RAC sector in the next 5 years
- To understand the Government policies and other external factors impacting on the industry

² The Kigali Amendment to the Montreal Protocol: HFC Phase-down, Ozone Action fact sheet. Ministry of Environment. (2020). Country Assessment Report - MOE.

- To determine the present status of training provisions in the RAC sector (pre-employment training/ skill upgrading/apprenticeship/company based/ on the job)
- To understand and evaluate the future demand for training for each occupation category in the RAC sector (current and future training profiles)
- To determine the requirement of human resources for each occupation
- To conduct a Gap Analysis between demand for and supply of skills in the and future RAC sector

1.4 Research Design

Both primary and secondary data were used in gathering necessary data to perform a situation analysis and gap analysis of the RAC sector.

1.4.1 Literature Review

- As the first step, a thorough literature review was undertaken to cover the full scope of the assignment. The objective was to gain a broader perspective of the background and the depth of coverage needed in the study.
- Substantial amount of information that could be utilized to design subsequent phases of study were already available in various publications and databases of the NOU, TVEC, Department of Census and Statistics, and Central Bank of Sri Lanka. In addition, useful information was available with the Ceylon Chamber of Commerce, Sri Lanka Customs and other Government Agencies and industrial surveys/research conducted by various universities in the country.
- In addition to that the findings of the recent studies on the RAC sector in different countries were referred to analyses of the emerging trends.

1.4.2 Gathering of Primary Data

An island-wide sample-based survey of RAC sector stakeholders was conducted. The survey design for this study included both exploratory and descriptive methods.

Exploratory methods included key informant/Focus Group Interviews, while descriptive research methods predominantly included personal interview surveys based on structured questionnaires. The technique involves randomly intercepting a respondent and administering the questionnaire via a face-to-face interview. This design offers numerous advantages; personal interviews have high flexibility in data collection, allow high diversity of questions, and permit good control over the data collection environment. In addition, adequate control/supervision of the field force can be maintained during the implementation. The design further ensures speedy data collection and higher response rates. In the

context of this study, a personal interview survey design was specially selected since there were time constraints on data collection, and there was a need for speedy collection of primary data.

1.4.3 Preparation of Survey Questionnaire

Key stakeholders relevant to the scope of the assignment were identified. They included both the Government (officials from NOU, TVEC, Sri Lanka Customs, officials from the administrative divisions) and private sector institutions/firms (large, medium, and small-scale formal and informal RAC workshops, RAC contractors, and importers) related to industrial and service industries as well as education and training providers/institutes (experts from local universities and training institutions registered under TVEC).

Regulatory bodies

Training providers

Service sector (large, medium, small, formal, informal)

Following a qualitative research approach, several Focus Group Discussions (FGDs) and interviews of key personnel were conducted to obtain their views and perceptions on issues to be addressed by the quantitative survey. The study team did this to design and plan the subsequent steps of the study and develop comprehensive survey instruments considering the sector-specific issues related to refrigeration and air conditioning.

Three Focus Group Discussions representing different sectors of RAC were held. Due to the prevailed pandemic situation during the data collection stage, all Key Informant Interviews and Focus Group Discussions were held online using Zoom platform (Annexure 1). The comments received from diverse stakeholders during validation meetings were further considered in VET plan development.

1.4.4 Preparation of survey questionnaires design

The study team comprised competent personnel/experts specialized in questionnaire survey development for the primary survey.

The questionnaires were designed to address all the research objectives. It predominantly included structured questions. Structured questions provided a set of alternative responses, and were in the form of either multiple choice, dichotomous, or scale. They were mainly used to minimize interviewer bias (potential biases due to the way the questions are asked and recording responses).

Some items were measured in an interval scale to facilitate subsequent statistical analysis. A five-point Likert scale anchored by 1 = strongly agree to 7 = strongly disagree, 1 = very dissatisfied to 7 = very

satisfied, and 1= very low to 7= very high was employed to measure the respondent's level of agreement with different statements. During the questionnaire design process, effort was made to make the questionnaire more user-friendly for both the interviewer and the respondent and increase the response rate. Each questionnaire was pre-tested using a group of individuals/industries proportionate to the sample size (Employer = 30, Employee = 30, Training Institutes = 10) to check the validity and adequacy of items in questionnaires, and necessary adjustments have been made prior to administering the questionnaire in the field. Table 1.1 indicates which questionnaires have been prepared for which stakeholders.

Table 1.1: Questionnaires and targeted stake holder groups

Questionnaire	Targeting stakeholder group	Annex number	No of Respondents
1	Employers	I	365
2	Employees	II	303
3	Trainers	III	38
4	Training institutes	III	41

1.5 The Questionnaire Survey

Four separate questionnaires were developed to collect information from key stakeholder groups in RAC sectors. These included,

- Employers in the RAC sector industries
- Employees in the RAC sector industries
- Educational and training providers
- Trainees/ Students

The questionnaire survey on **employers** in the RAC sector industries specifically focused on acquiring information about the following:

- General information about the establishment
- Specific products and services provided
- Information about the current employees
- Servicing practiced in RAC workshops
- Knowledge of good RAC servicing practices
- Type of employee training and training facilities related to RAC
- Perceptions on good RAC servicing practices
- Perceptions on future expansions in the RAC sector

The questionnaire survey on **employees** in the RAC sector was focused on gathering information related to the following:

- Nature of academic and training qualifications related to RAC
- Past and current occupation status
- Knowledge and experience levels in RAC servicing practices
- Future professional or academic career prospects
- Employee demand for future training
- Perceptions on future expansions in the RAC sector
- Perceptions on good RAC servicing practices

The questionnaire survey on **training providers** in RAC sector was focused on gathering information related to the following aspects:

- The nature of the establishment
- Current education/training courses
- Course content/curriculum
- Information on curriculum revision inline to the trend of RAC sector
- Information on internship and apprenticeship
- Views on the training facilities available within the premises
- Information on alumni
- Implementations planned for RAC related courses in future

1.6 Sample Frame and Sampling Strategy

1.6.1 Sampling Methodology for the Survey of Employers (Service Providers) in the RAC sector

The sampling frame of this survey was restricted to state and private employers engaged in the RAC sector during the last 3 years. According to the Country Assessment Report for the Ratification and Implementation of the Kigali Amendment of the Montreal Protocol on the Substances that Deplete the Ozone Layer prepared by the Air Resource Management and NOU, (MOE, 2020), the number of formal and informal servicing workshops in each province summed has been estimated as 3043. The number of RAC servicing workshops in each province is indicated in Table 1.2.

This information was used to determine the total sample size for the RAC employers' survey with a 95% confidence level and 5% margin of error. (See equation 1 and 2 below)

$$n_0 = \frac{z^2 pq}{MOE^2} \dots\dots\dots \text{Equation 1}$$

n_0 : The minimum sample size required for a given confidence level, margin of error, and population proportion.

z : The z-score, which is a statistical value that represents the number of standard deviations a given proportion is from the mean.

p : The proportion of the population that has a certain characteristic of interest.

q : The complement of p , i.e., $1-p$.

MOE: The margin of error

$$n = \frac{n_0}{1 + \left(\frac{n_0 - 1}{N}\right)} \dots\dots\dots \text{Equation 2}$$

n_0 – sample size calculated from eq. 1

N – The size of the population

Though the calculated sample size was 341, the survey reached 10% more employers expecting for non-respondents. However, in the final accounts the sample size was 366. Following a stratified random sampling method based on the geographical location of firms, the sample was proportionally allocated among provinces and interviews were conducted to cover all the provinces, as shown in Table 1.2 Within a stratum (province), samples were selected based on convenience.

Table 1.2: Sample selection based on formal and informal RAC servicing workshops in Sri Lanka

No.	Province	Number of RAC servicing workshop	Number of interviews
1	Central	340	41
2	Eastern	65	08
3	Sabaragamuwa	111	14
4	Southern	460	43
5	North Central	145	17
6	Northern	22	04
7	North-Western	180	24
8	Western	1640	206
9	Uva	80	09
	Total	3043	366

Source: Country Assessment Report – MOE (2020)

1.6.2 Sampling Methodology for the Survey of Employees in the RAC sector

Employees belonging to different skill/experience levels (supervisor, master technician, and technician) from each RAC sector company were selected for the survey. A sample size of 303 individuals who have completed a VET course in the RAC sector and are currently employed in the RAC industry was selected as per the Terms of Reference (ToR) for the study. Following a stratified systematic sampling method based on the geographical location of RAC firms (MOE 2020), the sample of 303 interviews were proportionally allocated among provinces. Randomly selected respondents from both formal and informal RAC sectors were interviewed. The number of respondents selected from each geographical region is indicated in Table 1.3.

Table 1.3: Number of RAC employee’s interviews per province

	Province	Number of interviews
1	Central	40
2	Eastern	05
3	Sabaragamuwa	08
4	Southern	35
5	North Central	17
6	Northern	04
7	North-Western	17
8	Western	168
9	Uva	09
	Total	303

Source: Country Assessment Report – MOE (2020)

1.6.3 Sampling Methodology for the Survey of Training Providers (Skill Developers) in the RAC sector

The sampling frame of this survey was restricted to government, private or NGO-owned educational and vocational training institutions that offer vocational training courses in refrigeration and air conditioning. The number of institutions offering certificates, diplomas or degrees in RAC in the country summed up to 85 (TVEC, 2021), and they are indicated in Table 1.4. Stratified random Sampling method was used to determine the sample size of 38, at 90% confidence level and 10% precision. The number of respondent training centers selected from each category is also indicated.

Table 1.4: Number of institutions offering the Certificate/ Diploma or Degree in RAC

Ownership	Institute	Number of Centers	Number of interviews per institute
Government	Department of Technical Education & Training (DTET) Technical Colleges and Colleges of Technology	22	10
	National Apprentice and Industrial Training Authority (NAITA)	02	01
	National Youth Services Council of Sri Lanka (NYSC)	04	02
	Public- Other	09	04
	Vocational Training Authority (VTA)	31	14
NGO	Private Institutes	04	02
Private	Private Institutes	13	05
Total		85	38

Source: TVEC (2021)

1.6.4 Sampling Methodology for the Survey of Trainers in the RAC sector

One training instructor from each institute in section 1.4.3 was selected for the survey. Accordingly, 38 instructors were interviewed as indicated in Table 1.4.

1.7 VET Plan Preparation

The VET plan preparation included the following key activities.

- Carrying out a questionnaire survey among employers, employees, training institutes and trainees/students in RAC sector to analyze the human resource profile and current job qualification levels.
- Describing and analyzing the economic environment of the RAC sector.
- Identifying the current training and educational levels through analysis of RAC sector training providers.
- Forecasting the demand and supply of the RAC sector jobs for the next five years.
- Preparing a training plan to meet training needs in the RAC sector.

1.8 Data Analysis

The responses were coded for each question in the questionnaires to meet the requirements of the statistical analysis, and data was manually entered into Excel spreadsheets. Prior to proceeding to analysis, data clearing was performed through consistency checks and treating for missing responses. Statistical analysis included a mix of qualitative and quantitative methods. Validation meetings were held with key stakeholder participation. Comments received during the validation meetings were further addressed to finalize the VET plan.

1.9 Limitations and Exclusions

The present study may have limitations, as the current economic downturn may impact RAC sector market growth and vocational training landscape. Thus, the market projections and forecasting were based on pre-pandemic data, current developments, and expert views/opinions.

1.10 Structure of the VET Plan

The structure of the present study consists of an executive summary and six chapters. The first chapter introduces the VET plan and the overall design of the study. The sample selection is elaborated in the first chapter.

The second chapter contains an overview of the RAC (Refrigeration and Air Conditioning) Sector in Sri Lanka. It portrays a comprehensive description about the industry composition, the current establishments and classifications, the types of refrigerants and the applicable state and international policies in the RAC Sector. The chapter concludes with the key highlights.

The third chapter explains the human resources profile and the skill demand in the RAC sector. This chapter provides insights of the employment categorization, the current employability and the future preferences of the RAC Sector Employees, as well as the emergence of the new occupations to RAC sector.

The fourth chapter describes the current training profile in the RAC sector. It illustrates the RAC training providers, the courses offered under RAC, the type of training provided for students, about the current curriculum revisions, the training facilities in Sri Lanka, educational qualifications of the trainers and the difficulties faced by the trainers while conducting RAC courses and the suggestions to improve.

The fifth chapter describes the gap between the current VET landscape and the skill demand. It considers both local and foreign RAC skill demand and highlights the gaps to enable developing strategies for VET plan preparation.

The sixth chapter consists of the training plan. It has given attention to the gap analysis and the RAC sector's training strategies. The sixth chapter is the last chapter which provides mechanisms for the coordinators, describes the monitoring and review status, and provides recommendations for the overall development of the current scenarios considered under the VET Plan. The appendices of the report contain the support documents and details described in the context of the report.

Chapter 2

AN OVERVIEW OF THE RAC SERVICE SECTOR

2.1 Introduction

This chapter provides an overview of the RAC service sector in Sri Lanka. It presents the composition, scale, and market trends in the RAC sector based on primary and secondary data sources. The chapter further describes technological innovations and anticipated changes in the sector during the next five years due to changing national and global policies with special reference to environmental concerns.

2.2 Industry Profile and Dynamics

RAC industry in Sri Lanka can be broadly categorized as RAC manufacturing and assembling, and RAC maintenance and service. The process of manufacturing and assembling RAC (Refrigeration and Air Conditioning) equipment involves the necessity of importing refrigerants, as these substances are not produced domestically. The importation and management of refrigerants are integral activities within the realm of RAC manufacturing. However, it is important to note that refrigerant importation is also crucial for RAC maintenance and servicing purposes. Under RAC product categories several types of refrigerators (industrial, commercial, domestic, and transport refrigeration applications) and diverse types of Air Conditioners (residential, commercial/ industrial and mobile) can be identified. RAC maintenance services are available across all the RAC product categories (Figure 2.1).

Types of refrigeration system

- Industrial
- Commercial
- Domestic
- Transport refrigeration applications

Types of Air Conditioner system

1. Human comfort
 - Residential – Single and multi-split / VRF,
2. Industry
 - Commercial – package System with ducted air systems, chillers
 - Industrial – (Servers and computer rooms, medical applications, incubators)
 - Mobile air conditioning

The rise in residential and commercial construction projects, along with the high growth of the tourism and hospitality industry in the post-war Sri Lankan economy, creates demand for heating,

ventilation, and air conditioning (HVAC) products in Sri Lanka. With per capita income increasing in the country (before pandemic and economic recession), the demand for Air Conditioner Market grew by 2.1% in 2017- 2020 and is expected to grow at a compound annual growth rate of 7.7% during 2021- 2027³ . Recent reports suggest that domestic refrigerator and freezer imports to Sri Lanka has gradually decreased from 2015 to 2018 due to the increased market share of two local refrigerator and freezer manufacturers⁴.

³ 6Wresearch. (2021). Sri Lanka Air Conditioner (AC) Market (2019-2025)- Report, Outlook & Trends- 6Wresearch. <https://www.6wresearch.com/industry-report/sri-lanka-air-conditioner-market-2019-2025>

⁴ Ministry of Environment. (2020). Country Assessment Report – Ministry of Environment, Battaramulla, Sri Lanka.

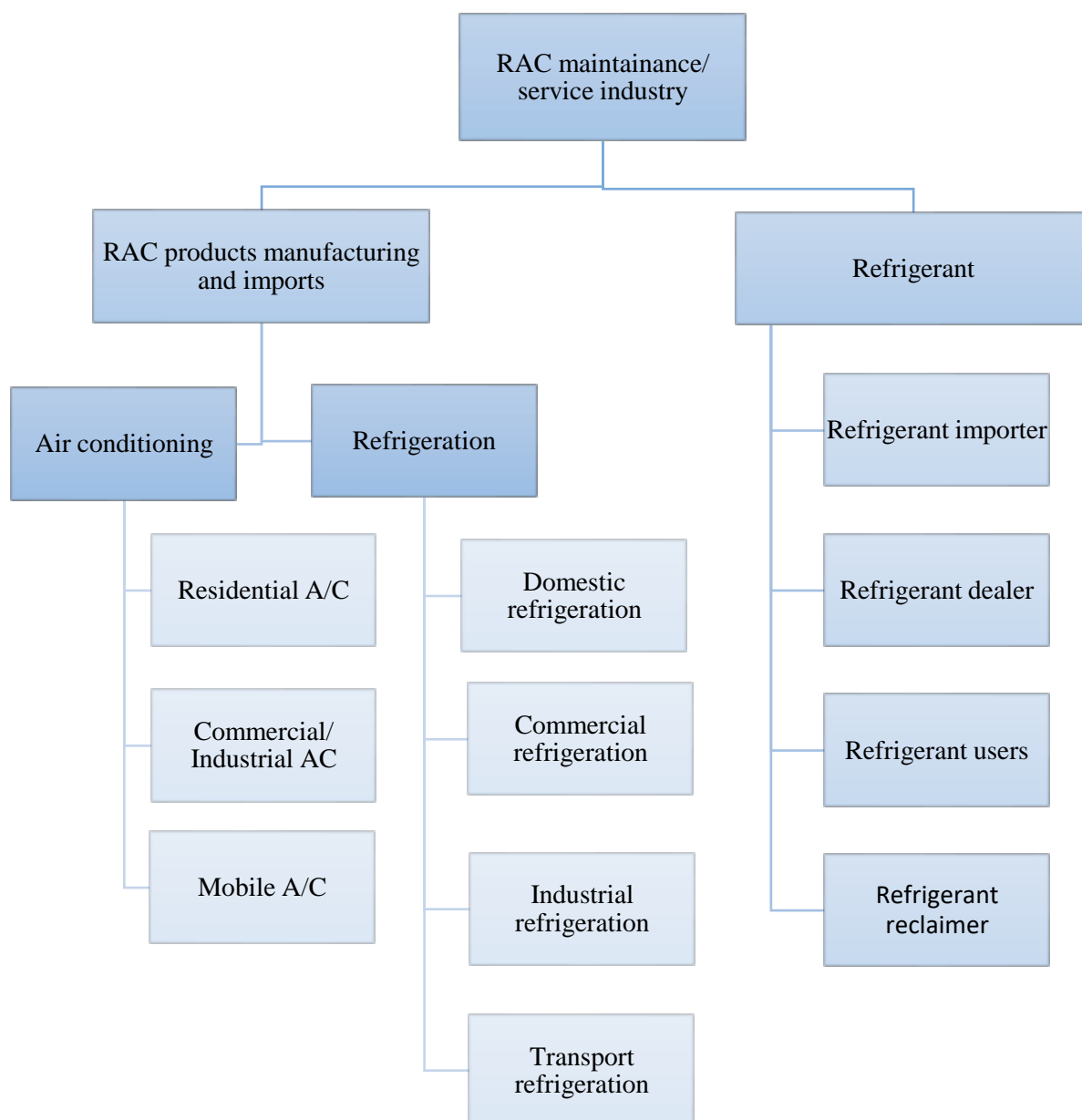


Figure 2.1: Composition of the RAC sector of Sri Lanka

All product categories use an array of refrigerants. A refrigerant is the working fluid used for heat transfer in refrigeration and air conditioning systems. Refrigerants can be classified under different categories as shown in Table 2.1⁵.

⁵ Wijewardane, A. (2020). Phasing-down the HFC Refrigerants in Sri Lanka: from Montreal Protocol to Kigali Amendment. SLEN - IESL, 1–5. <https://iesl.lk/SLEN/55/img/Refrigerants-SLEN%20article-Dr%20MA%20Wijewardane.pdf>

Table 2.1: Classification of refrigerants

Synthetic refrigerants	Natural refrigerants
CFCs Chlorofluorocarbon (CFC – 11, CFC – 12)	Inorganic (R-717 (NH ₃), R -744 (CO ₂), R – 718 (H ₂ O))
HCFCs Hydrochlorofluorocarbon (HCFC – 22, HCFC -123)	
HFCs Hydrofluorocarbon (HFC – 23, HFC – 134a, HFC -32, R – 404A, R – 410a)	HCs Hydrocarbons (HC – 290, HC- 600a, HC -1270)
HFOs Hydrofluoroolefins (HFO-1234yf, HFO – 1234ze, HFO -1233zd)	

Source: Ministry of Environment, (2020)

RAC servicing sector plays a vital role in refrigerant handling in Sri Lanka. About 90% of the imported refrigerants are used for RAC equipment servicing purposes⁶. Table 2.2 summarizes the main RAC equipment types used in different industry sectors.

Table 2.2: RAC equipment used by industrial sectors.

Industry	Usage of RAC equipment
Food processing industry	freezing and storage application
Fishing industry	refrigeration equipment is still used in large fishing boats – fishing trawlers, refrigerated trucks
Seafood processing and exporting	blast freezing, plate freezing and storage facilities, cold storage
Poultry farms	Blast freezing, refrigerated trucks
Milk processing industry	Chilling tanks, transportation tucks
Meat Processing and Storage	Blast freezing, Storage and transportation
Ice cream manufacturing	Ice cream hardening machine, transportation

⁶ <https://www.undp.org/sites/g/files/zskgke326/files/publications/Sri%20Lanka%20HFC%20Inventory.pdf>

Other Industrial Applications	Industrial refrigeration equipment and chillers are used to produce flake ice and chilled water for plastic-molding, rubber, textile, printing industries, storing pharmaceutical and agricultural products
Hotels, Hospitals, Resorts, and Commercial & Housing Complexes	Chillers and central Air-Conditioning equipment
Food transport	Reefer containers

2.3 RAC Servicing Sector Composition

It is estimated that there are approximately 3,043 formal and informal RAC servicing workshops throughout the country⁴. Besides the RAC workshops, businesses with large RAC facilities such as central air conditioning (AC) systems generally have in-house RAC crews and are equipped with standard tools to perform repairs and maintenance of the RAC systems.

2.3.1 Size of establishments and geographical distribution

According to Ministry of Environment⁴, the highest number of RAC servicing workshops in Sri Lanka is in the Western Province. The island-wide geographical distribution of the 3043 formal and informal workshops in 2020 is shown in Table 2.3. In addition, the workshops are classified by size according to the number of trained technicians employed. Trained technicians are those who have followed the NVQ course in RAC equipment. Accordingly, different scales of businesses can be identified as,

- Small-scale (<2 trained technicians)
- Medium scale (3-5 trained technicians)
- Large-scale (5 or more trained technicians)

Table 2.3: Servicing workshop distribution by size and province in Sri Lanka, 2020

Province	Total	Breakdown by size		
		Small size	Medium size	Large size
Western	1640	164 (19.5%)	984 (60.9%)	492 (84.4%)
Southern	460	120 (14.2%)	296 (18.3%)	44 (7.5%)
Central	340	258 (30.6%)	64 (4.0%)	18 (3.1%)
Sabaragamuwa	111	48 (5.7%)	58 (3.6%)	5 (0.9%)
Uva	80	56 (6.6%)	22 (1.4%)	2 (0.3%)

Eastern	65	26 (3.1%)	39 (2.4%)	0 (0.0%)
Northern	22	18 (2.1%)	4 (0.2%)	0 (0.0%)
North Central	145	85 (10.1%)	54 (3.3%)	6 (1.0%)
North-Western	180	68 (8.1%)	96 (5.9%)	16 (2.7%)
Total	3,043	843	1617	583

Source: MOE (2020)

As shown in Table 2.3, the majority of the small-size workshops are concentrated in the Central Province (30.6%), and Approximately 61% of the medium-scale RCA workshops and 84.4% of the large-size RCA workshops are located in the Western Province.

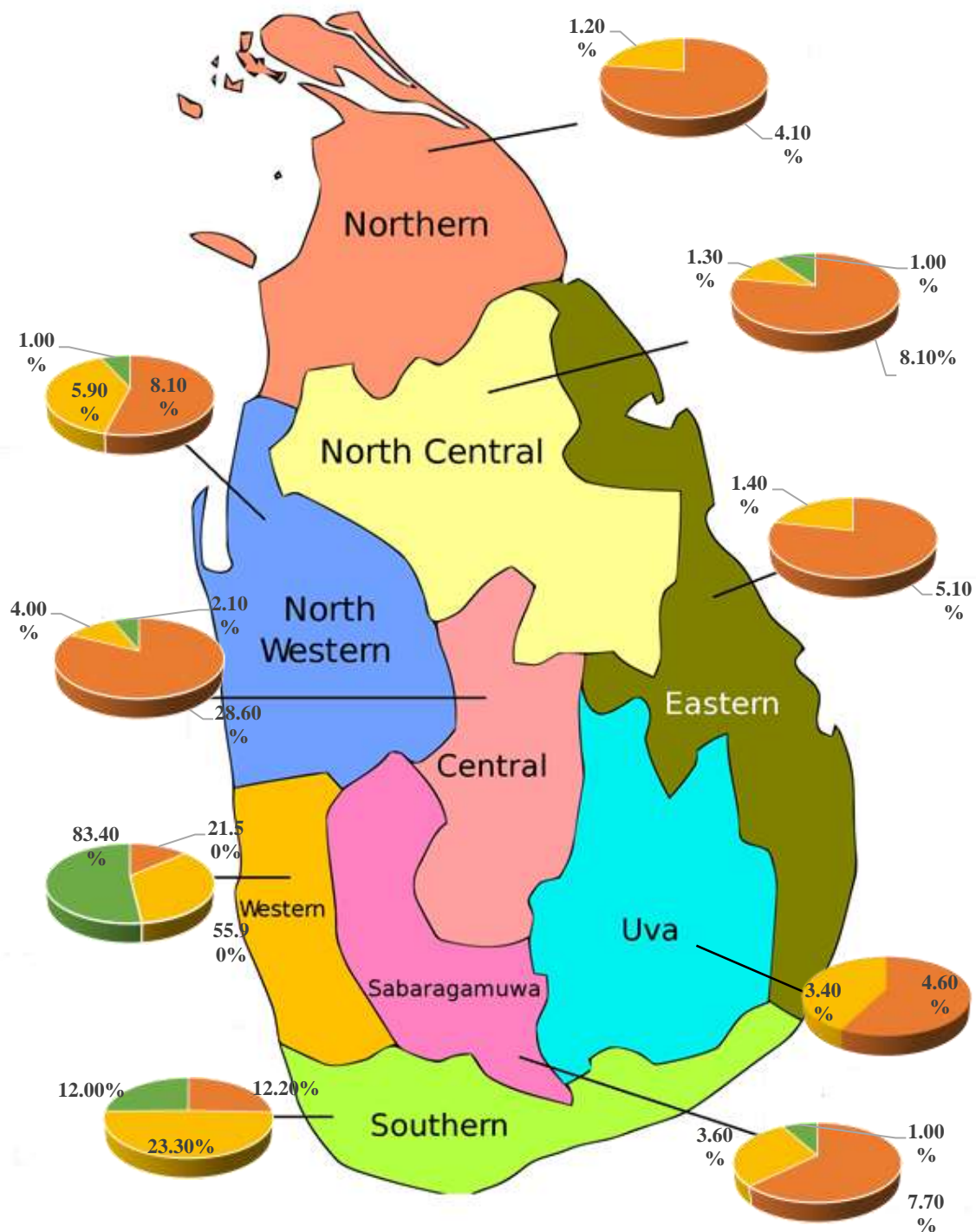


Figure 2.2: Distribution of the RAC workshops in the sample by Province (N=366)

(Green: Large scale workshops, Yellow: Medium-scale workshops, Orange: Small scale workshops)

Compared with the national figures on the number of small, medium and large size RAC workshops in each province, the present survey has captured a representative proportion of the industrial establishments of each province. The distribution of the RAC workshops in the sample (N=366) is represented in Figure 2.2.

2.3.2 Formal and Informal Establishments

RAC servicing workshops and centers can also be categorized as formal and informal workshops/establishments.

- I. **Formal workshops:** Those registered with the Provincial Council and have a license issued by the Provincial Council to operate. Moreover, these workshops usually have the required resources (equipment/tools/devices) and skilled manpower (engineers, supervisors, skilled technicians) to perform installation, repair, and servicing.
- II. **Informal workshops:** Those that are neither registered with nor licensed by the local government and may be operating with one or no formally trained skilled technicians (e.g., the owner and an unskilled helper), to perform the repair and service work for domestic and commercial ACs and refrigerators.

The sample selected for this study represented a good mix of formal and informal establishments. About 73% of responding firms were formal establishments. Although the informal sector dominates the Sri Lankan market, the informal sector firms were more likely to decline participating in the survey. Nonetheless, 26% of the sample represents informal establishments. Two respondents did not want to disclose their workshops' legal/registration details.

Table 2.4: Distribution of formal and informal sector establishments in the sample (N=366)

Province	Formal	Informal	Not mentioned	Total
Western	150	54	2	206
Southern	30	13	0	43
Central	33	8	0	41
Eastern	6	2	0	8
Northern	4	0	0	4
Uva	4	5	0	9
Sabaragamuwa	9	5	0	14
North Central	16	1	0	17
Northwestern	16	8	0	24
	268	96	2	366

The term "BOI companies" refers to companies that have received approval from the Board of Investment of Sri Lanka (BOI) for their Foreign Direct Investments (FDI) or Local Investments⁷. These companies have undergone the necessary criteria set by the BOI to establish their business operations in Sri Lanka. Various terms are used interchangeably to describe such companies, including BOI Company, BOI Companies in Sri Lanka, BOI registered company, BOI approved company, and BOI approved projects. Despite slight variations in terminology, they all indicate that the company has successfully met the requirements to operate in Sri Lanka. In the sample, 19.23% were BOI (Board of Investment) firms, whereas 80.77% were non-BOI firms. About 7.42% of the BOI firms in the sample were located within BOI zones, while 11.81% of the BOI firms were located outside the BOI zone (Table 2.5).

Table 2.5: BOI and non-BOI composition of the RAC service providers

	BOI		Non-BOI	Total
	Inside the BOI	Outside the BOI		
Percentage (%)	7.42 %	11.81%	80.77%	100%

Out of the total sample of 366 workshops, a significant majority of 84.23% exclusively offered installation, servicing, and repair services for RAC equipment. However, a smaller portion comprising 15.77% not only provided these services but also engaged in the sale of RAC equipment.

2.3.3. Servicing categories

Figure 2.3 shows a classification of the main activities performed by the servicing workshops of RAC equipment captured in the sample. In the maintenance and servicing of refrigerators and ACs, the most frequent service activity performed by the respondent servicing workshops is the maintenance and servicing of residential/small refrigerators and ACs accounts for residential refrigerators and ACs.

The RAC service data were analyzed based on the type of activity. The major activity (41.37%) was the repair and service of AC systems followed by repairing refrigerators, deep freezers, display units, bottle coolers, water coolers (38.39%) and the installation of ACs (32.44%). Other service activities are further listed in Table 2.6. Other service activities included wholesale and retail trade of refrigerators and ACs, Operation and maintenance of Centralized ACs, repairing of the electrical system in ACs and refrigerators, replacing components in high-and low-pressure system, Refrigerant handling, recovery and recycling, and RAC contracting services.

⁷ About Us New – Investment Opportunities – Board of Investment of Sri Lanka (investsrilanka.com) , How to set up a BOI company in Sri Lanka | simple books

Figures 2.4 and 2.5 further provide the distribution of RAC service facilities by their location/province. Accordingly, it is evident that the highest proportion of all types of RAC service centers are located in the Western Province.

Table 2.6: RAC business activities (N = 366 with multiple responses possible)

RAC Service Activities	Percentage (%)
Installation of ACs	58.47
Repairing refrigerator, deep freezers, display units, bottle coolers and water coolers	66.12
Repair and service of AC systems	74.32
Wholesale & retail trade of refrigerators and ACs	19.13
Operation and maintenance of Centralized ACs (chillers)	24.32
Repairing of the electrical system in ACs and refrigerators (power supply)	40.44
Replacing components in high-and low-pressure system	34.97
Refrigerant handling, recovery, and recycling	27.60
RAC contracting services	26.23
Other service activities (Wholesale or retail Spare parts dealing, refrigeration equipment manufacturing)	26.78

Service workshops are also commonly used in commercial and industrial settings. For instance, refrigeration systems are widely utilized in supermarkets, including island freezers, display cases, bottle coolers, and cold rooms to keep food and beverages fresh and chilled. Bulk ice manufacturing plants and ice cube machines and beer chilling machines are also commonly found in the food and beverage industry. Small ice cube machines are also commonly found in food and beverages industry. While beverage cooling machines are commonly used in bars and restaurants to keep drinks cold. Additionally, centralized air conditioning systems play a crucial role in large commercial buildings by controlling moisture levels, maintaining indoor air quality, and preventing mold growth. Also, some equipment, such as dehumidifiers are used with industrial purposes.

RAC systems are not limited to these sectors alone. RAC systems have become a vital component in the agriculture sector. Milk coolers (farm tanks) incubators, meat processing plants are widely used in agriculture and food processing industry. The temperature and humidity control features of these systems are critical in the preservation and maintenance of the quality of various agricultural products. For instance, farm tanks are widely used in the dairy industry to maintain the chilled state of milk and

other dairy products before they are transported for processing. Similarly, meat producers and sausage makers rely heavily on RAC systems to maintain the ideal temperature and humidity levels necessary for the curing and storage of meat products. Seeds incubators and post-harvesting facilities use refrigeration units to preserve the quality and longevity of seeds, fruits, and vegetables. Florist boxes are also designed with cooling and humidity control features to extend the lifespan of flowers and plants during transport and storage. In short, RAC systems play an important role in the agriculture sector, ensuring the quality and safety of food and other perishable products throughout the supply chain.

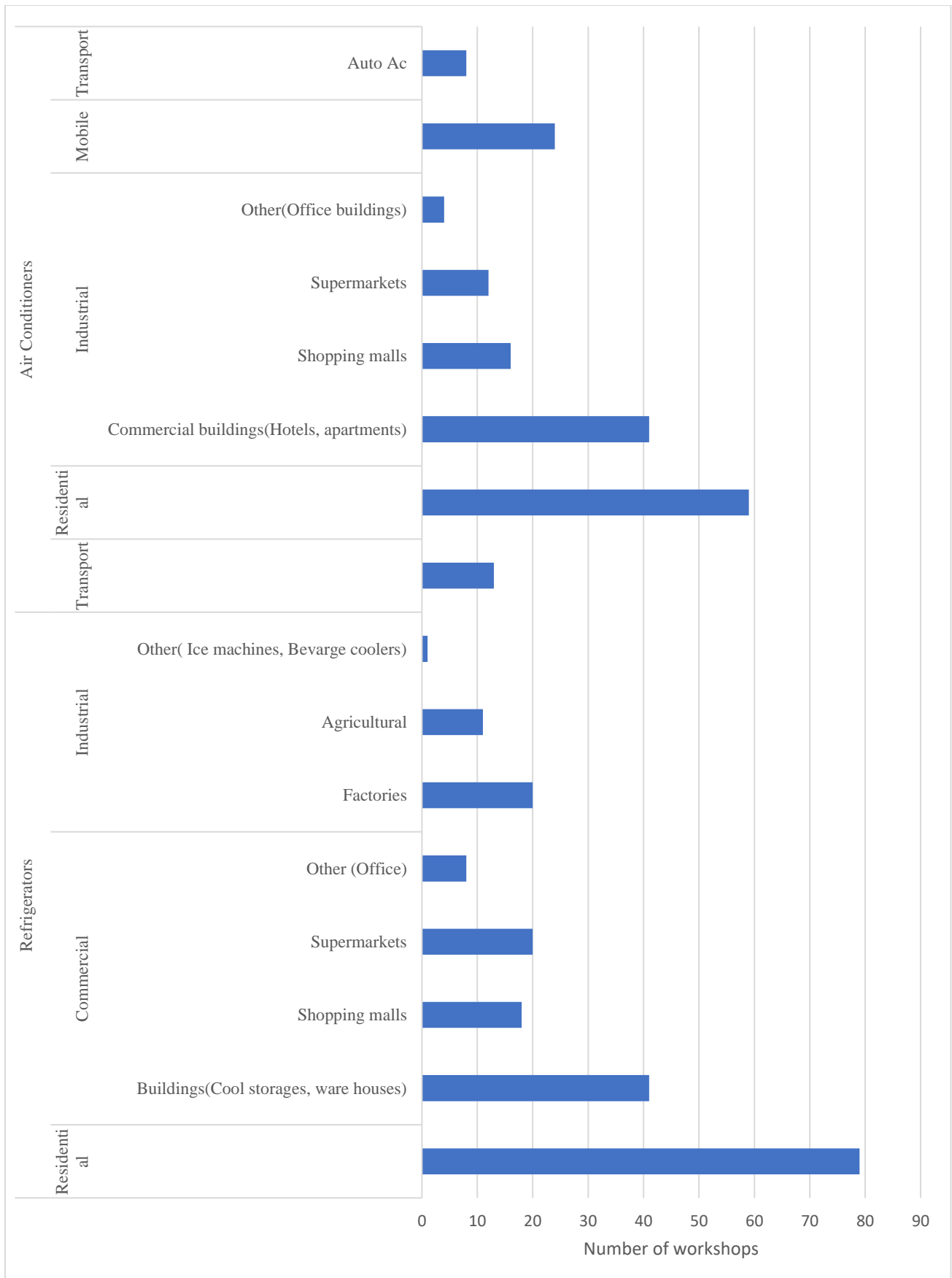


Figure 2.3: Percentage of RAC Workshops for maintenance and servicing of RAC by service types

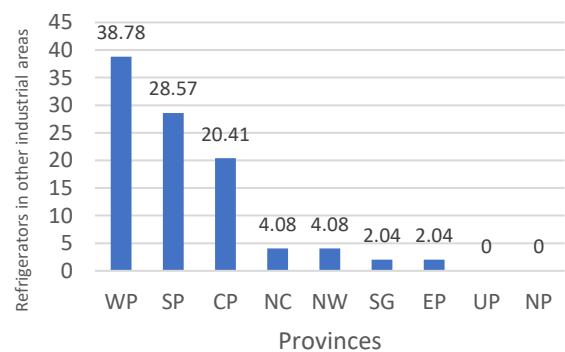
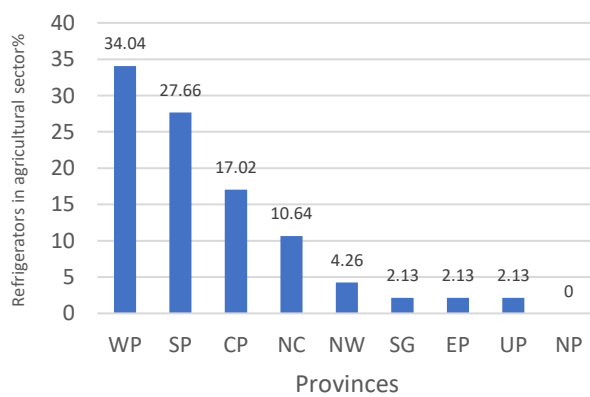
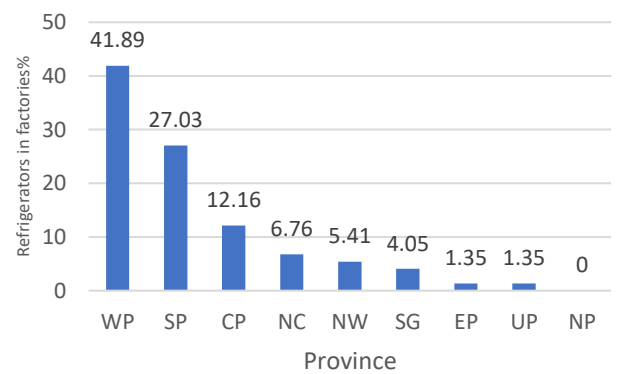
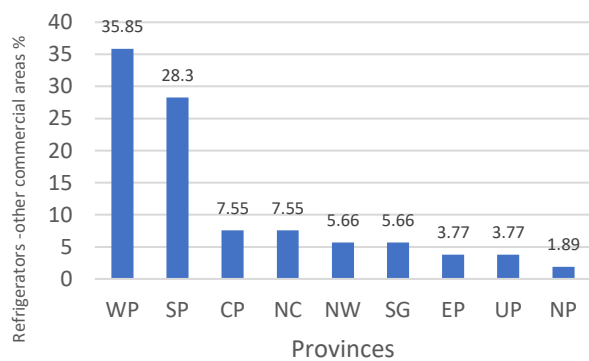
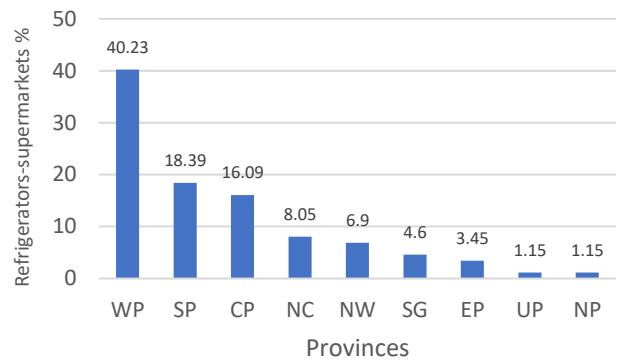
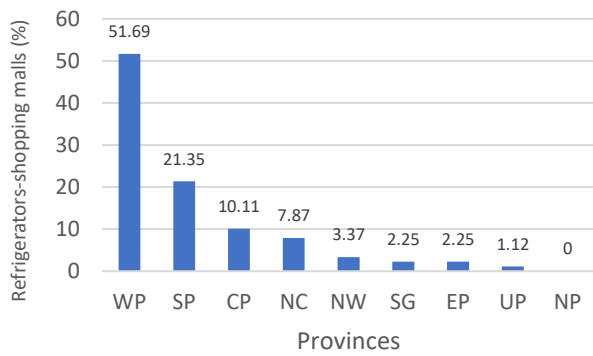
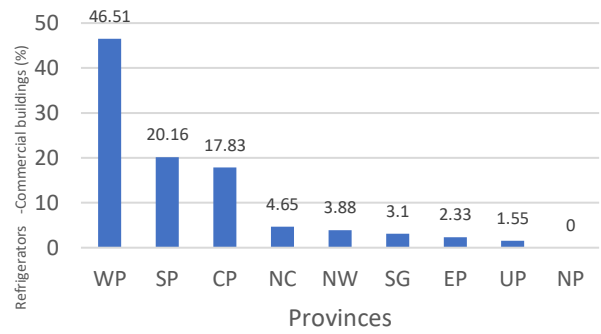
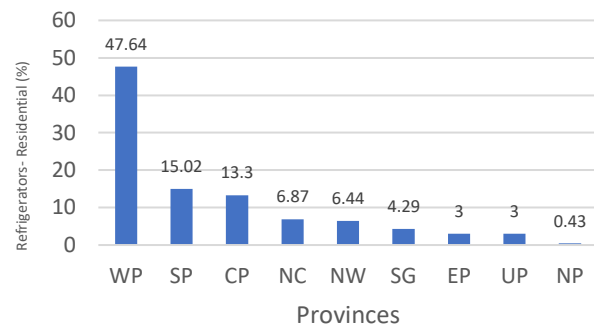


Figure 2.4 : Ref-service workshops by service types and province

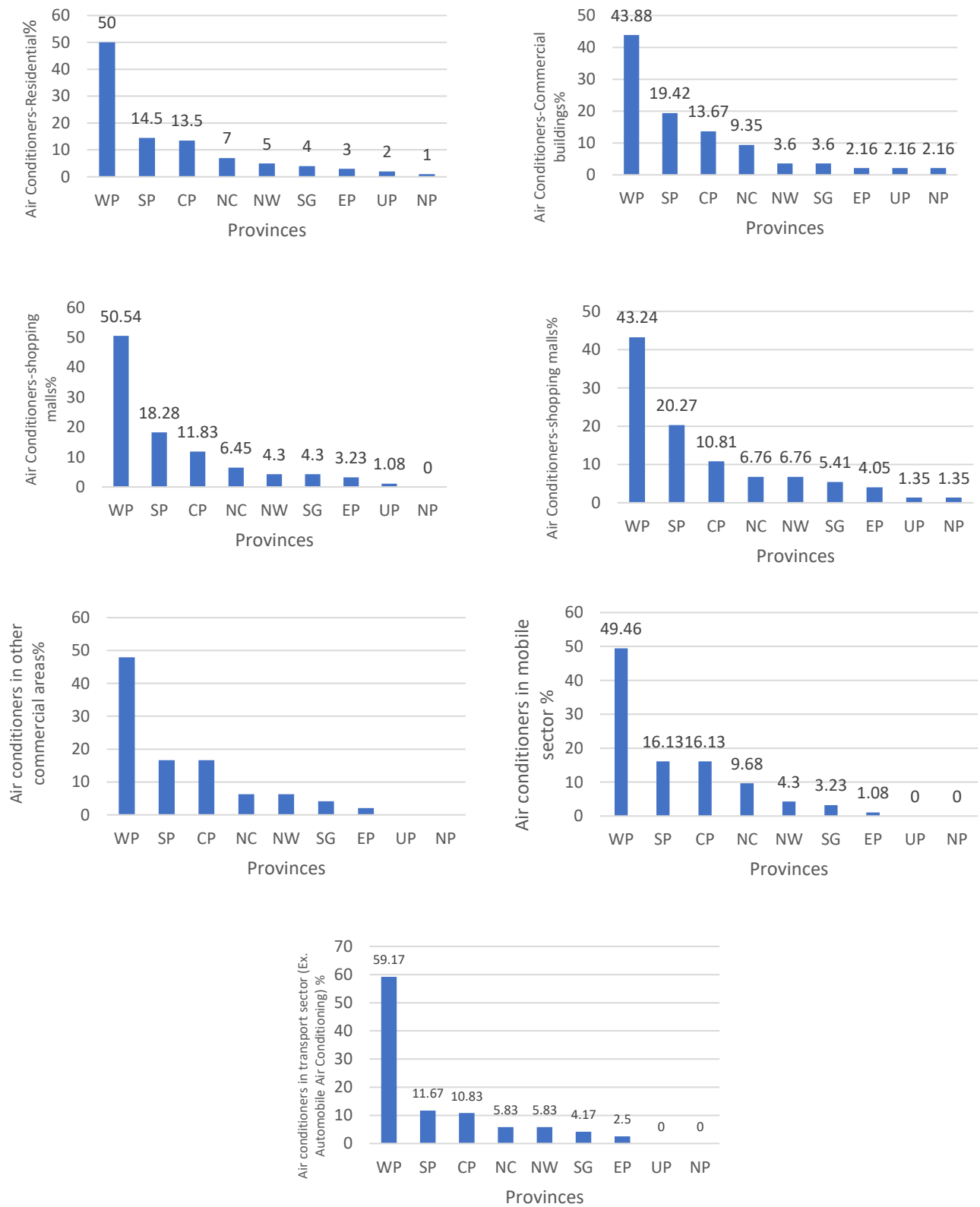


Figure 2.5: Air Conditioner service workshops by service types and province

2.4 Servicing practices in RAC workshops

2.4.3 Recovery, recycling and reusing of refrigerants.

Despite the mandatory requirement for the workshops to have recovery machines, about 60% of the servicing workshops did not recover, reuse or recycle refrigerants at their own facilities. Those practicing the recovery, reuse or recycle of refrigerants have only recently started doing so since the beginning of 2019.

The majority of the technicians are unaware of the importance of refrigerant recovery and do not have experience in recovering and handling leak new refrigerants. However, the National Survey on HFC use in Sri Lanka⁶ (2015) shows that many awareness programs have been conducted over the past years to promote refrigerant recovery technology among the technicians. This highlights the need for systematic training and awareness for the technicians and major stakeholders in the RAC sector.

The NOU encourages the RAC workshops to purchase their own recovery machinery by themselves while supporting them with a soft loan scheme from local banks. In addition, new regulations have been introduced under the National Environment Protection Act to prohibit the release of refrigerants into the atmosphere. In line with this, Ministry of Mahaweli Development & Environment (MMDE) launched a pilot project in 2015 to establish refrigerant reclamation centers around the country. Under this project, nine refrigerant reclamation centers have been established, covering all nine provinces in the country (Table 2.7)

Table 2.7: List of reclamation centers for recovered HCFC-22

Reclamation center	Location/District	Province
Ceylon German Technical Training Institute	Moratuwa	Western
College of Technology	Galle	Southern
CEB	Kolonnawa	Western
Technical College	Badulla	Uva
Technical College	Batticaloa	Eastern
Technical College	Polonnaruwa	North-Central
Vocational Training Authority	Vauniya	Nothern
North-West (Wayamba) Technical College	Kurunagala	North-Western
Technical College	Gampaha	Western

2.4.1 Types of services provided.

The RAC (refrigeration, air conditioning) sector provides a diverse range of services. These include after-sales service which are provided by sales/installation company for an agreed time period (warranty period), and servicing/maintenance/repair service provided by RAC workshops that do not sell or distribute appliances/systems. Typically, in the case of large RAC installation companies and service establishments, the technicians are formally trained in servicing refrigeration and air conditioning equipment.

2.4.2 Refrigerant handling and types of refrigerants handled.

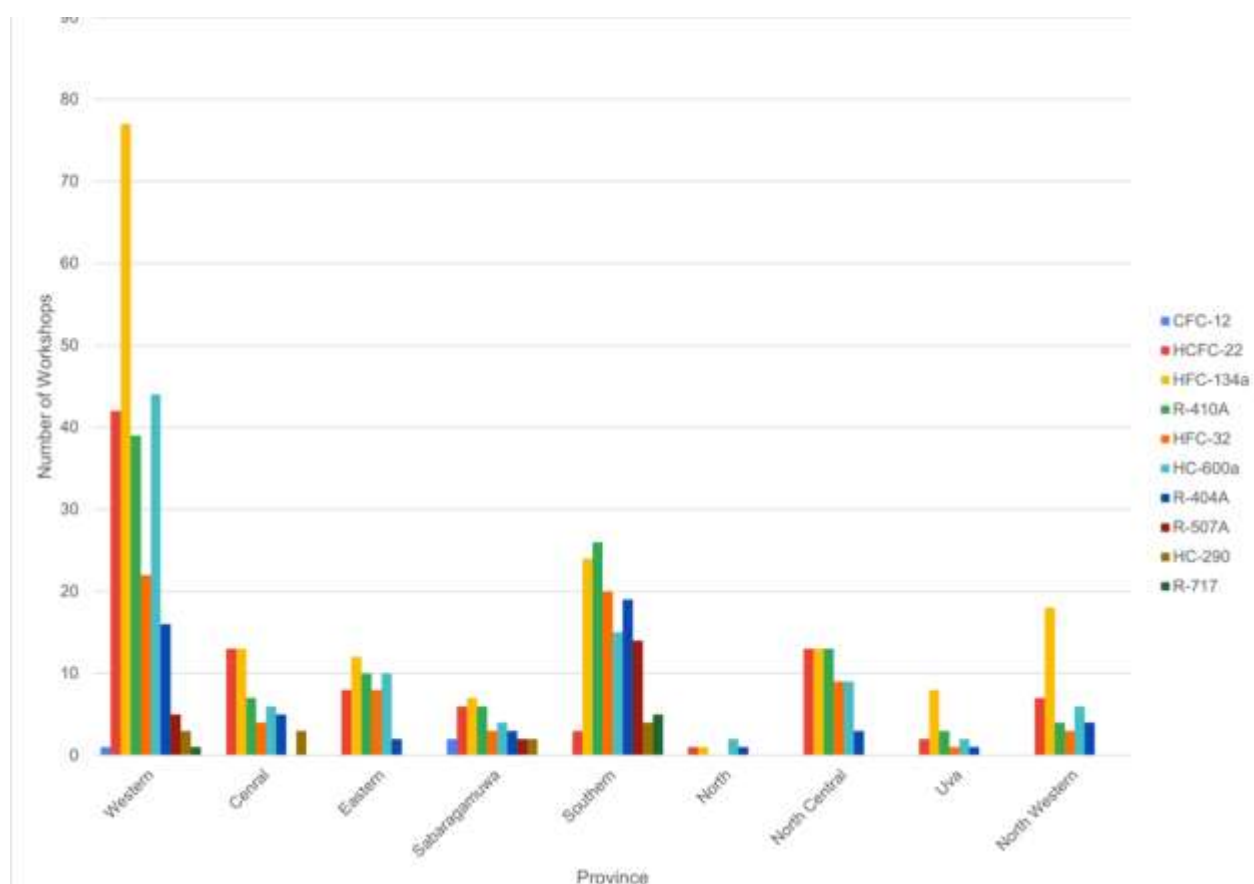


Figure 2.6: Number of RAC service firms handling different refrigerants in year 2020.

Based on the sample observed, HFC-134a is the most common type of refrigerant handled in all the provinces other than the Southern Province. In North-Western, Uva and Western province the usage of HFC-134a by the RAC service centers is proportionally substantially higher than in the other provinces, as compared to other types of refrigerants. (Figure 2.6) Next prominent types of refrigerants

used by the sample respondents are R-410A, HC-600a, HCFC-22 and HFC-32. Least common types of refrigerants used by the respondents were R-507A, R-404A, and R-717.

2.4.4 High priority training areas in RAC workshops

In the survey of RAC sector firms, the respondents were asked to report the training needs of their RAC technicians/ employees over the past five years. During the period of 2016 to 2020, the demand for training in maintenance Services of Refrigerators and/or air-conditioning (routine maintenance) experienced a steady rise. Similarly, the RAC sector firms have prioritized training needs for mobile needs for Mobile AC servicing, good RAC and MAC service practices, and refrigerant handling, recovery, and recycling. There was a decline in training for Installation and Servicing of Chillers and Commercial Building AC Installation & Servicing from 2019 onwards (figure 2.7 and Annexure II)

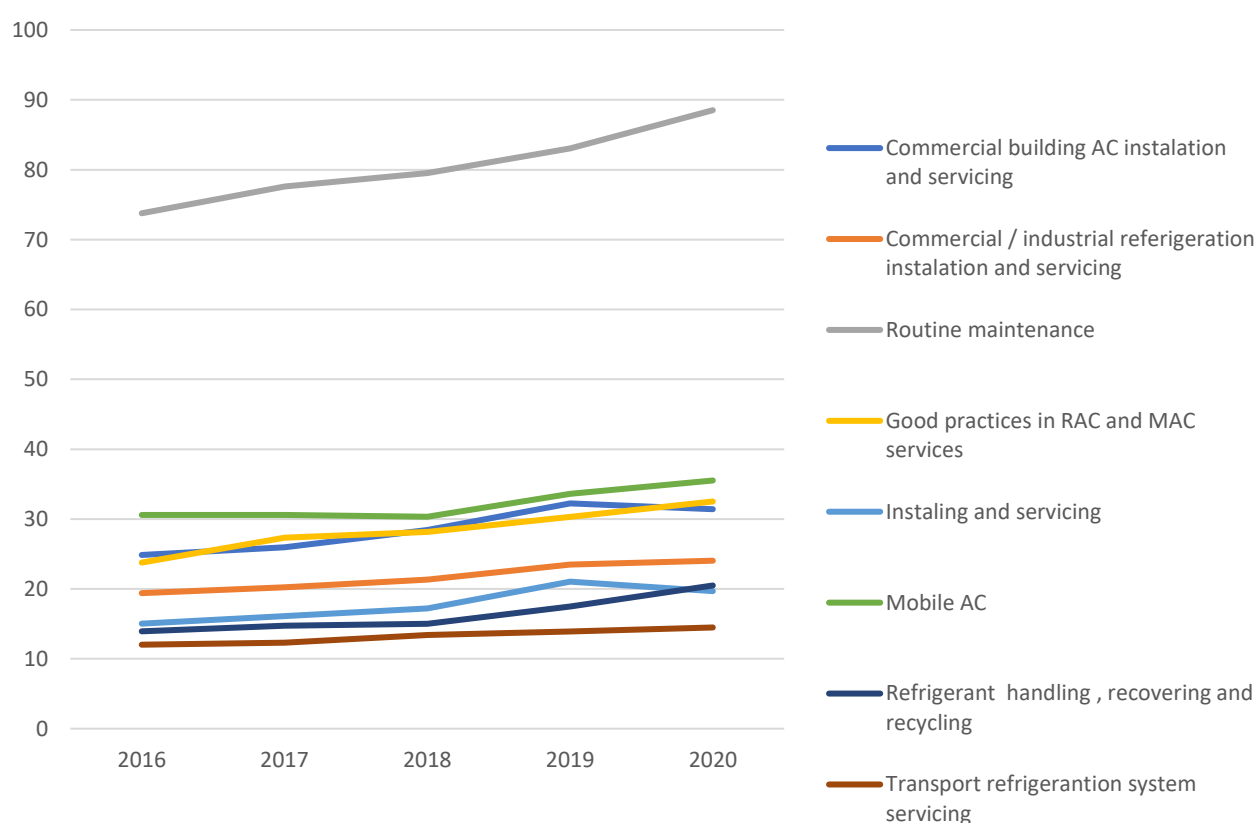


Figure 2.7: Priority Trends by Category and Year

Refrigerators	Air Conditioners
Find Refrigerator Faults - check compressor pressure, test refrigerant leak in the equipment, check capillary tube, check evaporator flow, check condenser flow.	Assemble and disassemble of ACs - removal and installation of grill, removal and installation of evaporator fans, removal of condenser/compressor with refrigerant.
Repair Refrigerators- clean condenser, replace condenser, replace evaporator, pinch copper pipe, leak test, replace defrost, replace condensers and thermostat, perform vacuum.	Repair of ACs- cleaning of main components, check of low/high-pressure cut-out, check of oil pressure cut-out, oil change/charge, refrigerant charging, leak testing, perform vacuum and holding.
Good service Practices	
Handling of alternatives refrigerants to HCFCs and their Characteristics	
Handling HCFC and HFC Refrigerants	
Refrigerant Recovery, Recycling	
Selection and Safe Use of Cleaning Solvents	
Proper handling tools and Equipment for Servicing and Repair	
Do's and Don'ts in Refrigeration and Air- Conditioning Servicing	
Handling Hydrocarbon (HC) Refrigerants and Safety Issues	
Servicing HCFC and HFC-based Air Conditioners	
Servicing HC-Based Air Conditioners	
Installation Procedures for Window and Split Air Conditioners	

Figure 2.8: Good Practices of RAC Sector

2.4.5 Perceptions of the service sector management towards Good Servicing Practices

2.4.5.1 Good RAC Practices and National Competency Standards and Curricula of RAC occupations

RAC technicians must adhere to good service practices (GSP) to prevent refrigerant leakage and environmental damage. This section reviews National Competency Standards (NCS) for RAC occupations to assess GSP and related issues. Curricula are mainly used in training courses.

For RAC vocations, there are six National Competency Standards (NCS) and curricula; five are for NVQ 1–4 NCS and one is for NVQ levels 5 and 6 under the NVQ Framework.⁸

- a. NCS for Refrigeration and Air Conditioning Technician NVQ 1 - 4 (Version 3, 2019)
- b. NCS for Refrigeration and Air Conditioning Serviceman NVQ 1 - 4 (Version 1, 2014)
- c. NCS for Automobile Air Conditioning Technician NVQ 1 - 4 (Version 3, 2019)
- d. NCS for Automobile Refrigeration and Air Conditioning Technician NVQ 1 - 4 (version1, 2019)
- e. Reefer Container Technician NVQ 1 - 4 (Version 1, 2018)
- f. NCS for Refrigeration and Air Conditioning Technology NVQ Level 5 and 6 (Version 1,2009)

In this case, a competency element is a sub-job function, and a competency unit can be thought of as a job function of an occupation. There are one or more performance criteria for each competency element, which represent the standards of performance anticipated of technicians working in a particular occupation. When a technician is evaluated against a competency (competency unit), they are required to complete competency parts of the competency units, and their performance is assessed using the performance criteria specific to those elements. It is visible when a person demonstrates a specific competency element. However, in order to do tasks related to competencies, that person needs some knowledge and abilities that might not be apparent. underlying knowledge and underlying skills are terms used to describe this.

Table 2.8: Number of Competency Units, Competency Elements and Performance Criteria of the NCS for RAC Technicians

Unit No	Competency unit title	Number of elements	Performance criteria
U1	Install Split Type Air Conditioners	3	19
U2	Service and Repair Split type Air Conditioners	4	19
U3	Install Packaged type Air Conditioning Systems	6	54
U4	Operate and maintain Central Air Conditioning systems	8	50
U5	Repair Domestic and Light Commercial Refrigerators and Deep Freezers	3	25
U6	Install, maintain, and repair industrial refrigeration systems	4	26
U7	Perform refrigerant recovery	3	12

⁸ Recognition of prior learning of RAC technicians situational and need assessment report. National Ozone Unit, Ministry of Environment(2022)

U8	Prepare estimates on installation and/or maintenance of Refrigeration and Air Conditioning systems	3	23
U9	Service and maintain Refrigerated Truck Refrigeration Units	4	29
U10	Install Central Air Conditioning Systems	6	45
U11	Practice occupational health and safety measures	3	15
U12	Carryout workplace communication	4	9
U13	Apply workplace literacy and numeracy	2	4
U14	Work in teams	2	5
	Total competency elements and performance criteria	55	335

Source: National Competency Standards for RAC Technician-D29S002.3 (www.tvec.gov.lk, 24.11.2021)

2.4.5.2 Coverage of Good Service Practices in NCS and Curricula

RAC service sector places a strong emphasis on adhering to sound servicing practices when addressing system maintenance and repairs. This approach aims to prevent refrigerant leaks during equipment operation and maintenance. The implementation of regular scheduled cleaning and preventative maintenance serves to ensure optimal energy efficiency and temperature regulation, while also mitigating potential system malfunctions or failures. It is imperative to conduct routine servicing of all system components according to manufacturer recommendations. This typically involves comprehensive system inspections, duct cleaning, filter replacements, and monitoring refrigerant levels.

When undertaking repairs on RAC systems, technicians must diligently adhere to prevailing regulations governing the conservation, recovery, and recycling of refrigerants. These regulations encompass proper handling and disposal protocols for fluids and pressurized gases. The use of suitable safety equipment is essential due to the hazardous nature of refrigerants, which can cause skin damage, frostbite, and blindness upon contact. Additionally, working in confined spaces raises the risk of inhalation hazards associated with refrigerants. Certain refrigerants are highly flammable and require heightened precautions. Observing good practices is therefore critical to mitigate occupational hazards and ensure safety, particularly as refrigerant leakage can occur during the transfer process, both when emptying and filling refrigerant systems.

When confronted with the need to empty or fill a system, service technicians have several options at their disposal:

- **Recovery:** Involves removing refrigerant and storing it in an external container without extensive testing or further processing.
- **Recycling:** Entails reducing contaminants in used refrigerant through processes such as oil separation, removal of non-condensable substances, and utilization of core filter driers to minimize moisture, acidity, and particulate matter.
- **Reclaim:** Encompasses processing used refrigerant to meet new product specifications, potentially involving distillation. Chemical analyses are performed to verify compliance with product specifications.

Furthermore, technicians should possess expertise in the following servicing operations:

- a) Leak detection, purging, evacuation/cleaning, and flushing
- b) Repairing
- c) Flushing and choke testing
- d) Leak testing, evacuation, and vacuum holding
- e) Charging refrigerants
- f) Sealing process tubes
- g) Verifying proper system operation

These tasks necessitate proficiency in identifying and utilizing specialized service-specific tubing tools and techniques such as sizing, unrolling, cutting, bending, flaring, swaging, piercing, pinching, and welding. Additionally, technicians must be skilled in the appropriate use of servicing instruments, including manifold gauges, charging scales, and thermometers.

The NOU introduced the Good Practices in RAC and MAC Services to the RAC training curriculum in 2017 together with UNEP. Accordingly Good Servicing Practices of the RAC has been identified as a key component in training (Figure 2.8 and table 2.9).

NCSs designed for roles in Refrigeration and Air Conditioning (RAC) fields consist of sets of skills related to refrigerant management. These skills encompass areas such as refrigerant recovery/recycling, which involves understanding various refrigerant types, their properties, applications, lubricants, charging procedures, pressure testing, gas leak detection, recharging processes, and the appropriate selection and application of lubricants based on manufacturer guidelines.

Within the National Vocational Qualification Framework (NVQF), a total of six NCSs have been formulated specifically for RAC occupations. These are divided into five NCSs categorized at NVQ

levels 1 to 4, and one NCS at NVQ Levels 5 and 6. All of these NCSs encompass teachings on refrigerant recovery, recycling, and reclamation techniques. However, it's noteworthy that only the Auto AC technician NCS covers knowledge related to Green Technology within this context.

The assessment of candidates centers around their proficiency in accordance with the NCS competencies, performance criteria, and the foundational knowledge that underpins these skills. Recognizing the need for enhanced effectiveness, there is room for improvement in the implementation of these NCSs and the assessment process.

Table 2.9: key elements good practices in RAC servicing and their level of coverage in NCS

Critical Aspects in competency units in NCS for RAC Technicians	Units where they are included
Adhere to safety procedures and practices.	
Carry out systematic fault diagnosis on Refrigeration and Air conditioning units	8
Correct selection and use of tools, testing & measuring instruments and material	2, 1, 3, 10, 6, 9, 4, 11
Ensure adherence to safe working procedures & practices	1,5,3, 9, 10,7
Ensure compliance with relevant environment protection regulations	7
Ensure full recovery of the refrigerant recovered from the system	7
Ensure prevention of excessive heat entering air-conditioned space	1
Ensure proper functions of safety devices as flame arrestors, pressure regulators	2
Ensure safety of self, others, and property	8
Ensure satisfactory performance and functioning of the unit/s, without any leak of refrigerant and other defects	4,1, 5, 9,3, 10, 2,6
Exhibit knowledge of current market prices of spares, material etc.	8
Identify potential hazards	11
Prepare reasonable and competitive estimates	8
Adhere to safety procedures	11

The perceptions of RAC sector firms on good RAC practices were also assessed during the employer survey. Table 2.10 indicates the key questions and the percentages of the employer's responses. Around 76% of the respondents requested the supplier's energy-efficient and sustainable products that contain eco-friendly refrigerants. Around 66% of the respondents have stated their response as “Yes” to the customer requests for eco-friendly, energy efficient and sustainable products, which is seen as one of the greatest developments in the RAC industry. The majority of respondents (above 80%) identify the importance of having a good RAC servicing practices as it adds value for the company. More than 80% of respondents identified the importance of recovery, reuse and recycling

of refrigerants. However, close to half of the respondents are not interested in energy star certification and promote the natural refrigerants as alternatives to the harmful ozone layer depleting substances and not willing to incur additional costs to promote the good RAC servicing practices (Table 2.10).

Table 2.10: Current trend in RAC good servicing practices.

Key questions related to the RAC Good Servicing Practices	Yes (%)	No (%)
Has your workshop/ company ever requested the energy-efficient and sustainable products which contain environmental friendly refrigerants, from a supplier?	76	24
Have your customers ever requested the products which contain environmental friendly refrigerants), energy efficient and sustainable?	66	34
Are good RAC servicing practices a priority for your company/ workshop?	75	25
Do you believe good RAC servicing practices add value to your company/ workshop?	81	19
Do you believe that recovery, reuse and recycling of refrigerants are important for your company?	81	19
Is your company/ workshop willing to incur additional costs to promote the good RAC servicing practices?	54	46

The survey consisted of several items to gain insights to employer perceptions towards Good Servicing Practices. Approximately 92% wish to implement good RAC servicing practices in their company operations, and nearly 81% respondents like to continue the existing practices (Table 2.11). When asked about their future adoption and expansion of new good RAC servicing practices (i.e., Good RAC practices that are not currently implemented at the respondents' workshops), more than 65% of the firms stated they are willing to do additional initiatives other than the current practice. Results further revealed that around 68% are willing to deliver services that incorporate GSP; however, only 57% wish to establish a good RAC servicing practices department in their workshop.

Table 2.11: Employer perceptions on expanding the RAC good servicing practices.

Key questions related to the RAC Good Servicing Practices	Yes (%)	No (%)
Do you wish to implement good RAC servicing practices in your company?	92	8
Would you like to continue the existing practices?	81	19

Do you have any plans to initiate new good RAC servicing practices other than the current practices?	65	35
Do you wish to provide good RAC servicing jobs in your company?	68	32
Do you wish to establish a good RAC servicing practices department?	57	4

The current level of adoption of GSP in the RAC sector varies across different company scales. In larger sector companies, GSP is implemented effectively, reflecting a commitment to industry standards. However, there is room for improvement in small- and large-scale workshops, where the adoption of GSP could be enhanced. To elevate industry-wide standards, collaborative efforts are needed. Both the NO and the TVEC should take proactive measures to initiate improvements and upgrades in the application of GSP. This would ensure a more consistent and high-quality implementation of practices throughout the RAC sector.

Furthermore, an interesting trend has emerged where workshops are increasingly creating their own recovery machines to efficiently retrieve gases. This innovation demonstrates the sector's commitment to sustainable practices and finding practical solutions for gas recovery. This development highlights the potential for workshops to not only adopt established GSP but also contribute to the advancement of industry practices.

2.4.6 Methods of handling refrigerants

Focus group discussions and key informant discussions suggested that there are various methods of handling refrigerants. One approach is the use of a pump-down system, commonly employed in split air conditioning units, where the refrigerant is stored within the unit itself. Another method involves recovery and recycling, where the refrigerant is collected and processed for reuse. In certain plants, cylinders are utilized for refrigerant storage, ensuring proper care is taken to prevent overheating and overpressure situations.

2.4.7 Methods of disposal of used refrigerants

Among the respondents who do not recover refrigerants at their own facilities, approximately 55% admitted to lacking appropriate disposal methods for used refrigerants. Around 25% of the respondents opt for temporarily storing the refrigerants in a container while they await a long-term solution (see Figure 2.9). Additionally, 20% of the respondents choose to hand over the refrigerants to another party, such as reclamation centers capable of reclaiming and recovering them.

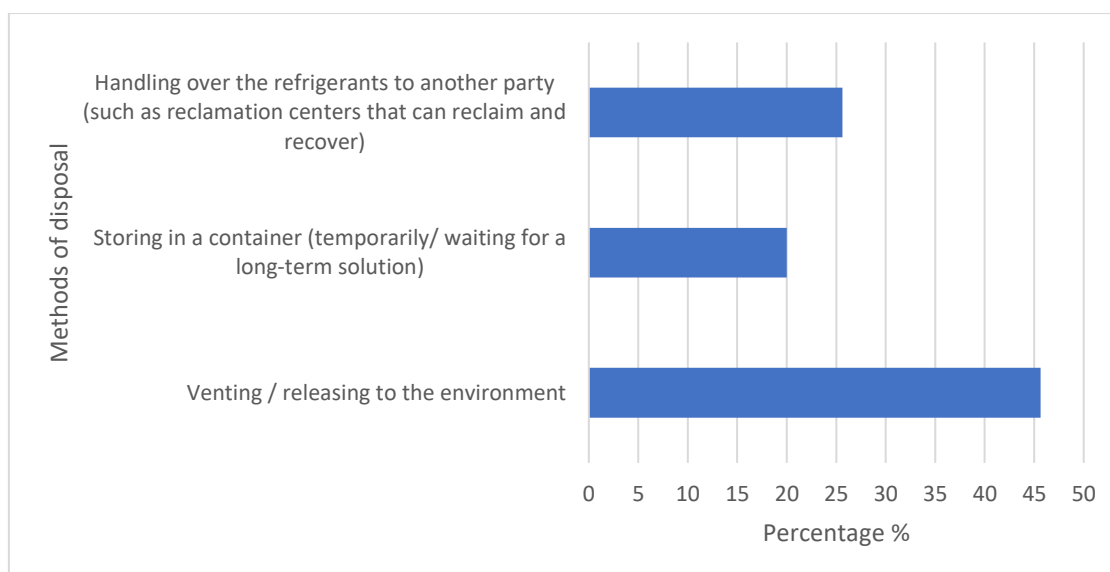


Figure 2.9: Refrigerant disposal methods adopted by the sampled RAC workshops.

Reclamation of used refrigerants is being practiced as a strategy to minimize the disposal of refrigerants to the environment. The amount of HCFC-22 refrigerant reclaimed for the last 5 years shows an increase from 2016 to 2020. A rise in recovery and reclaiming of refrigerants can be particularly observed from 2019 to 2020. This is a positive sign for both the industry and the environment regarding refrigerant recovery.

2.4.8. Changing regulatory landscape

Sri Lanka is party to the Montreal Protocol since 1987 and ratified the Kigali Amendment in 2018. According to the Protocol, Sri Lanka has prepared a schedule to phase out the production and consumption of ozone depleting substances. Sri Lanka has completely phased-out CFCs in 2008, two years ahead of the schedule. According to the HCFC phase-out schedule, which is in practice, Sri Lanka will phase-out HCFCs by 2030. The main strategies adopted by Sri Lanka to phase out HCFC are limiting the supply of HCFCs (imposed import bans on refrigerants), reducing the demand of HCFCs for manufacturing and servicing equipment, and limiting new demand for HCFC and reducing the emission of HCFC (imposed import bans on equipment operate on HCFCs). With the ratification of the Kigali amendment in September 2018, Sri Lanka is expected to phase-down HFC by 80% in 2045.

2.5 International and Government policies and other factors impacting on RAC sector.

The Sri Lankan government gazette the regulations discussed as follows to ensure that the RAC servicing sector provides high-quality service while adhering to good servicing practices and reducing the consumption and the emission of ODS and HFC.

- **The Environmental Protection License (EPL) under the provisions of the National Environmental Act (NEA) No: 47 of 1980 amended by Acts No. 56 of 1988 and No. 53 of 2000.**

It is mandatory to use refrigerant recovery machines from 1st January 2019 at all workshops engaged in the installation, service, maintenance, and repair of RAC equipment. This regulation applies when the Central Environment Authority (CEA) issues the EPL for the RAC workshops.

- **Gazette No. 2138/30 of 29.08.2019 and 218.2/10 of 30.06.2020 (Imports and Exports Control Regulation No. 01 of 1969) -Control of HFCs**

A licensing mechanism was introduced to control the imports of HFCs and HFC blends with effect from 29 August 2019. Therefore, RAC Servicing workshops that directly import HFCs and HFC blends should abide by this provision in the Extra Ordinary Gazette Notification No. 2138/30 of 29th August 2019.

- **The Gazette Notification No. 850/4 of 20.12.1994 and No. 1309/20 of 10.10.2003 -Prohibition on the use of CFCs, halons, Carbon tetrachloride (CTC) and MC**

It is prohibited to use CFCs (CFC-11, CFC-12, CFC-113, CFC-114, CFC-115) and halons (Halon-1211, 1301 and 2402) for servicing equipment and industrial plants with effect from 15 October 2003.

- **The Gazette Extraordinary No. 928/08 of 25.06.1996, No. 949/11 of 13.11.1996 and No. 1007/14 of 24.12.1997 - Introduction of import quota and licensing system**

Import license procedure was introduced to control the import of used and reconditioned refrigerators, air conditioners, heat pumps, CFCs, Halons and HCFCs, CTC, MC and MeBr. At present, in Sri Lanka, the import of HCFC is strictly controlled under the quota and licensing system.

- **Cabinet Paper No. 12/1126/527/010-I and the Gazette Notification No. 1821/4 of 29.07.2013 and No. 1821/40 of 01.08.2013 - Control of HCFCs**

Import of used HCFC-based equipment has been banned from 1st of January 2013. Importing used or reconditioned equipment with ODSs mentioned in the Montreal Protocol is prohibited.

In addition, several policies have been developed in Sri Lanka in order to fulfill commitments to international protocols and agreements. They have direct as well as indirect relevance to the RAC sector. Some of them are climate change and energy efficiency policies such as.

- National Climate Change Policy 2012
- Nationally Determined Contribution (NDC) 2016
- Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) 2012
- Sri Lanka Sustainable Energy Authority Act No. 35 of 2007
- The National Energy Policy and Strategies of Sri Lanka 2008
- Appliance Energy Labelling Programme
- SLS 1230:2003
- National Waste Management Policy 2018
- National Policies on Chemical Management 2018
- National Policy on Air Quality Management

2.6 Key Highlights

- The market demand for Air Conditioner and Refrigerators is likely to increase, however a short-term drop in the sector can be anticipated with the prevailing economic situation in the country.
- The rise in residential and commercial construction projects, along with the high growth of the tourism and hospitality industry in the post-war Sri Lankan economy, is creating demand for heating, ventilation, and air conditioning (HVAC) products in Sri Lanka.
- It is estimated that there are approximately 3,043 formal and informal RAC servicing workshops throughout the country⁴.
- The majority of the small-size workshops are concentrated in the Central Province (30.6%), and Approximately 61% of the medium-scale RAC workshops and 84.4% of the large-size RAC workshops are located in the Western Province.
- Sample-based study revealed that 84.23% of the RAC firms are exclusively operating as servicing workshops, while 15.77% of workshops are providing repair and maintenance services and also retailing RAC equipment.
- The major activity (41.37%) was the repair and service of AC systems followed by repairing refrigerators, deep freezers, display units, bottle coolers, water coolers (38.39%) and the installation of ACs (32.44%).
- Other service activities included wholesale and retail trade of refrigerators and ACs, Operation and maintenance of Centralized ACs, repairing of the electrical system in ACs and

refrigerators, replacing components in high-and low-pressure system, Refrigerant handling, recovery and recycling, and RAC contracting services.

- Changing regulatory landscape and new technologies are likely to affect and shape the demand for RAC services in the future.

Chapter 3

HUMAN RESOURCE PROFILE AND SKILL DEMAND IN THE RAC SECTOR

3.1 Introduction

This chapter describes the current profile of employees and trainees in the RAC sector. The chapter analyzes the demand and supply of human resources in industry. It analyzes the current human resources in the RAC sector based on primary and secondary data and forecasts the need for human resources in terms of numbers and types of qualifications to meet future skill requirements. The feedback from employers, employees currently in RAC firms and those who have completed RAC-related training were considered in the surveys. In addition, key comments raised in key informant interviews and focus group discussions were further considered in the current RAC sector human resource profile and future skill demands in both local and foreign markets.

3.2 RAC Service Sector Jobs and Employment

According to the Ministry of Environment ⁴ (2020), there are about 3043 RAC formal and informal service centers in the country. There are over 6500 individuals who have completed RAC sector training from state, private or NGO-managed vocational training institutes in the country. It is further estimated that about 2500 individuals who have not received formal training are further employed in the RAC sector. A sizeable proportion of trained RAC technicians leave for foreign employment. As such, the RAC sector makes a significant contribution to the national economy.

To better understand the current RAC service sector employment landscape, a survey of RAC sector employers and employees was undertaken. The major objective of this part of the study was to identify and describe the demographics, existing job categories, occupational levels, skill/training levels and salary scales in the RAC sector. Out of 352 service centers and workshops, the employee categories included managers, senior officers, clerk and assistant officers, service and sales officers, supervisors, master technicians, mid/junior technicians, and laborers. The 303 employees included in the sample were engaged in various refrigeration and air conditioning-related works described in subsequent sections of the Chapter.

3.3. RAC Service Sector employee Demographics

3.3.1. Age distribution

According to the sample-based surveys, relatively middle-aged employees dominate the RAC sector. As depicted in Figure 3.1, approximately 30% of the employees were in the age group of 25 to 35. 26% of the employees were in the age group of 24 years or below. Also, 28.50% of the employees were in the age group of 36 or above. Experienced employees (25 to 30) seem to be better equipped to fit into existing job portfolios in the RAC sector.

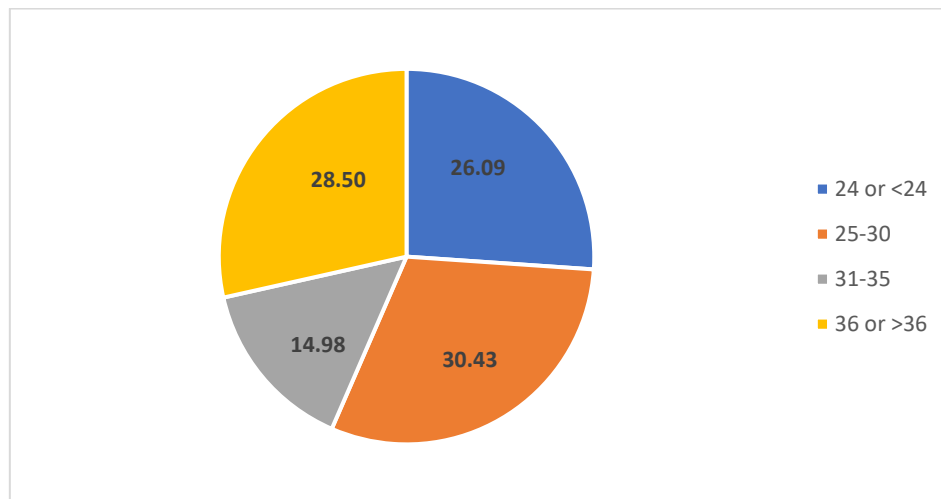


Figure 3.1. Age composition of the RAC sector technicians (N=303)

Figure 3.2 indicates the age distribution of RAC technicians/employees by province. It appears that job openings for new technicians (age group below 24) are more abundant in Western, Central, Eastern, North-western, and North-central provinces.

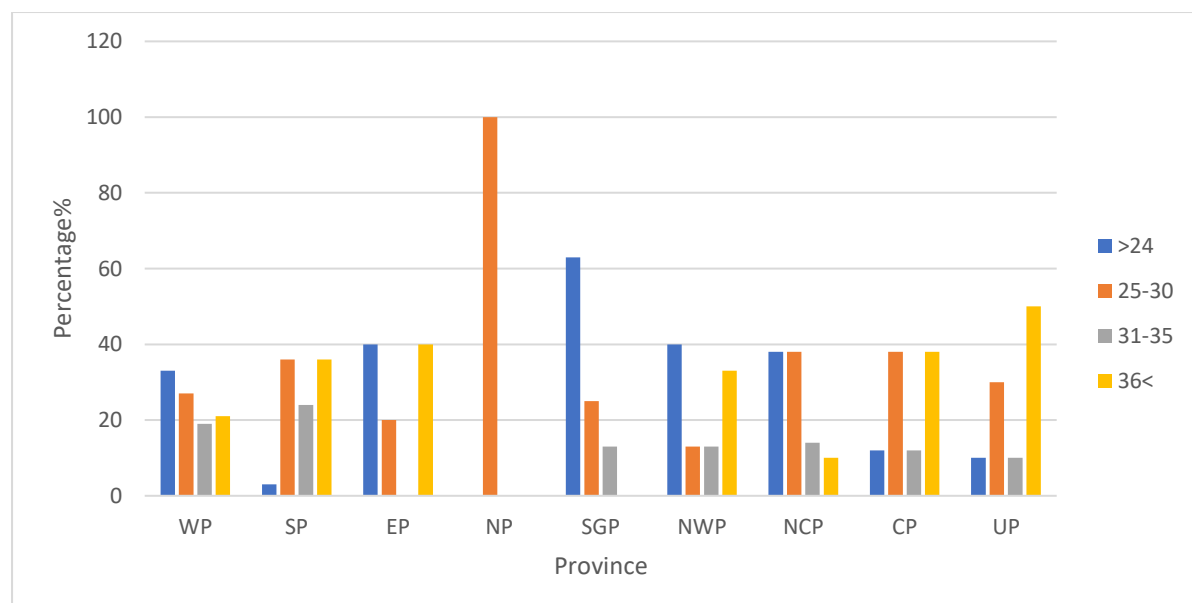


Figure 3.2: Age distribution of RAC technicians/employees by province

3.3.2. Gender composition

According to the results of an employee survey, males dominate by accounting for 97% of the current job positions in the RAC sector (Figure 3.3). Females occupied only 3% of the job positions in RAC where they were employed at administrative levels. The industry's clear preference for males over females may be attributed to the job profile, which typically demands extensive fieldwork/physically demanding work. Female employees were recorded from large-scale RAC workshops in Western and Central provinces only.

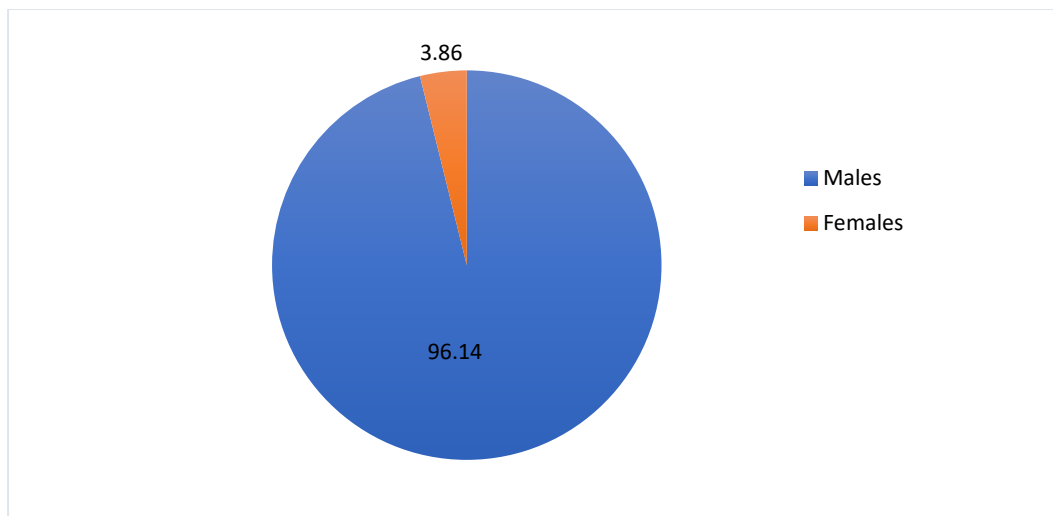


Figure 3.3: Gender composition of the RAC sector technicians (N=303)

As seen in the graph, the number of female students in the RAC sector is noticeably lower. During our focus group discussions, we identified several reasons for the low number of female students in RAC sector.

- The underrepresentation of females in the air-conditioning technician profession in the country can be attributed to a combination of social, cultural, and structural factors.
- Stereotypes and traditional gender roles often steer women away from technical fields, including air-conditioning.
- Limited awareness of the career opportunities, coupled with societal perceptions that associate technical work with masculinity, can discourage females from pursuing this profession.
- Additionally, a lack of female role models and mentors within the industry contributes to the perception that air-conditioning technician roles are not suitable for women.

- Inadequate access to appropriate education and training, along with workplace environments that may not be conducive to diversity and inclusivity, further hinder female participation.

promoting female participation and advancement in the air-conditioning sector in Sri Lanka requires a multifaceted approach that addresses both cultural and structural barriers. Fostering awareness and breaking down stereotypes about gender roles in technical fields is crucial. Educational initiatives should be developed to encourage young girls to pursue careers in air-conditioning and related fields. Mentorship and apprenticeship programs could provide female technicians with guidance, hands-on experience, and exposure to successful role models. Employers and industry associations should actively promote inclusivity and equal opportunities, ensuring that workplaces are safe, respectful, and free from gender discrimination. Flexible work arrangements, tailored training, and professional development opportunities should be provided to support career growth for female technicians.

Policy interventions, such as targeted incentives and diversity quotas, may also play a role in driving positive change.

Promising opportunities await female technicians in the RAC field. To further cultivate and enhance these opportunities, it is recommended that the TVEC engage in discussions with industry stakeholders. Collaboratively, they can identify areas for improvement and implement measures that support the growth and development of female participation in the RAC industry.

3.4. RAC Sector Jobs and Employees

3.4.1. Job categories

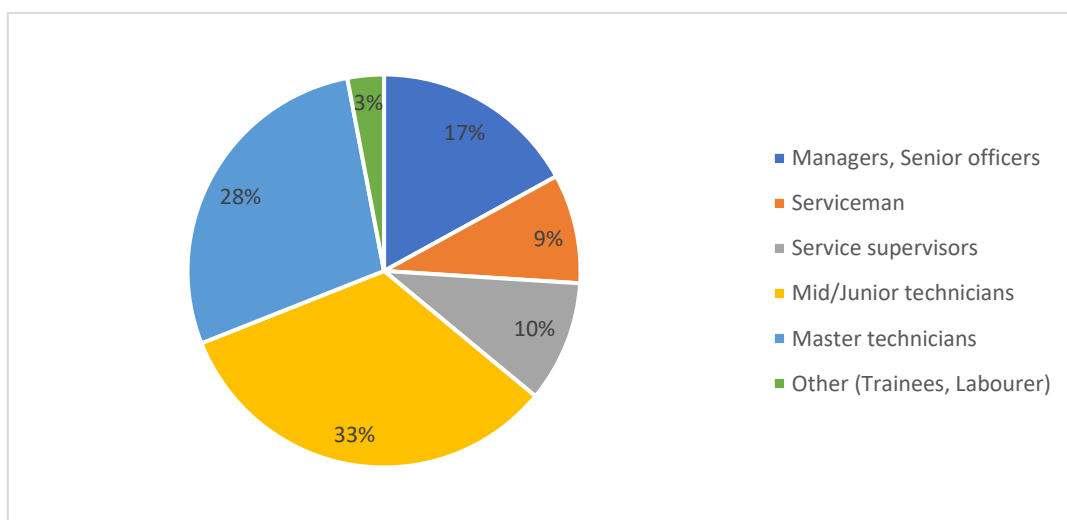


Figure 3.4: RAC employees by job category

Figure 3.4 summarizes the employment status of the studied sample in different job categories. It is evident that the highest percentage (33.2%) of employees are mid/junior level technicians, followed by the master technicians (28%). A significant percentage (16.8 %) is also employed in managerial and senior officer positions. High employment opportunities as mid or junior technicians are anticipated as most sector activities involve refrigeration and air conditioning services. Employment opportunities as service supervisors in the RAC sector accounted for only 10.2%.

Figure 3.5 provides the composition of the sample of RAC service sector employees surveyed. Accordingly, the majority of the respondents were involved in servicing commercial AC systems (45 %) followed by residential and commercial refrigerators. Commercial AC servicing includes servicing and maintenance of centralized AC systems/chillers in commercial buildings. Service and repair of residential refrigerators is the most commonly performed Ref service activity. Industry refrigerator system service includes cold-rooms in fish/meat/poultry industry and ice making for food preservation.

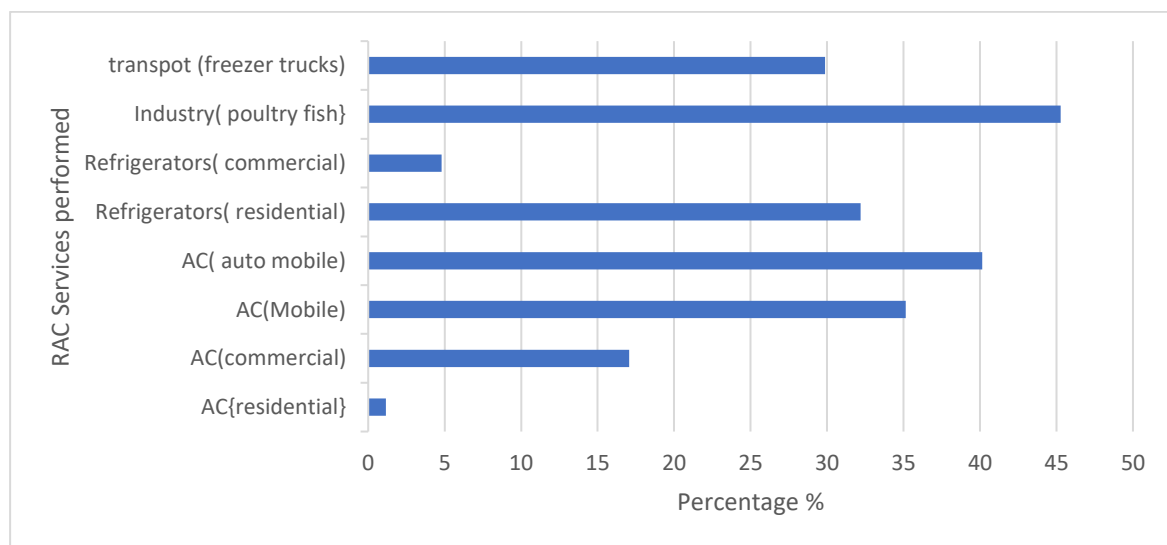


Figure 3.5: RAC employees by RAC services performed (multiple responses possible)

3.4.2. Qualifications and Experience

Out of the 303 RAC workshop employees surveyed, 80% have received formal qualification or training in RAC. The identified job titles through the survey demanded different levels of qualification and experience, and the salary ranges also showed a greater variability depending on the job hierarchy and job profile. Table 3.1 describes the profile of RAC jobs by level of employment/jobs. As top-level RAC jobs require a high level of competency and vocational training, most industries prefer trained employees from the leading RAC training/courses/diplomas offering institutions with at least 3 to 5 years of experience in the industry.

Table 3.1: Employee qualifications in each job category and salary scale

Occupational Category	Average Salary Range (LKR)	Average Qualifications
Technical Officer	90,000 – 120,000	Diploma/ higher diploma/ Degree 3–5 years of experience NVQ Level 4, level 5
Service Supervisor	40,000 – 70,000	Certificate/ Diploma NVQ Level 4
Master Technician	40,000 – 70,000	AL/Certificate/ Diploma NVQ Level 3 Level 4
Technician	30,000 – 70,000	O/L, A/L or Certificate

Table 3.1 suggests that those who are employed in the RAC sector draw a comparable salary as those in other sectors in similar industries/ companies. Most of the technical officers and service engineers are taking a higher salary compared to the technical level, which can be attributed to their educational qualifications rather than years of experience in the RAC sector. The master technician level has a higher starting salary scale than technicians.

The survey results indicate that most employees who work as technicians completed the national certificate courses before entering the RAC field. Thus, the preferred entry qualification of the technician level is a national certificate followed by the GEC O/L. The most frequently sited qualification attained by service supervisors is NVQ level 4. Some service supervisors have qualifications up to the national diploma level (NVQ 6) and graduate level. However, the highest qualification attained by the technicians is national diploma level (NVQ Level 6). About 6% of employees in the upper management have completed both the undergraduate and post-graduate levels in the management field. Figure 3.6 depicts the

educational qualifications of the employees (N=303) interviewed during the questionnaire survey.

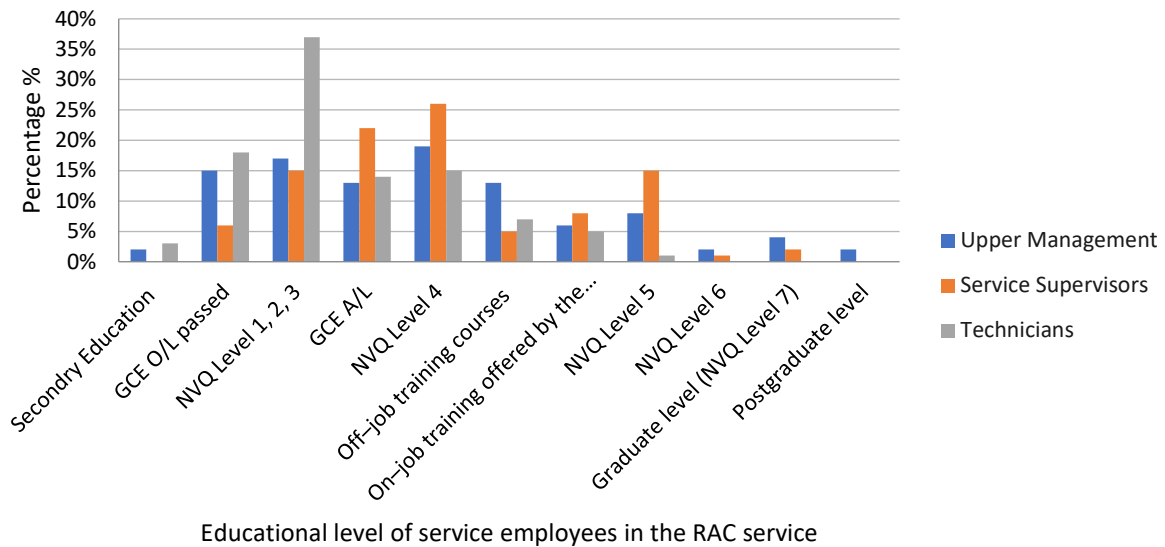


Figure 3.6: RAC employees training by job category (N=303)

3.4.3. Qualifications of RAC service sector employees by firm size

According to the survey of RAC service sector employees, it was revealed that managers/owners of small to medium RAC workshops mostly had NVQ L1-3 or GCE OL qualifications. Large RAC workshops on the other hand employed NVQ4 or above personal in top management positions (Figure 3.7). It appears that large-scale firms prefer superior qualifications for positions in upper management. Service supervisors of small RAC workshops mostly had GCE OL qualifications with on-the-job training. In contrast, medium to large scale RAC workshops demanded GCE A/L and NVQ4 or above qualifications for Service supervisor positions (Figure 3.8). RAC technician positions in small scale workshops were dominated by those with NVQ L1-3 qualified personal. Medium to large scale firms employed individuals with at least NVQ L1-3 or above qualified persons as technicians (Figure 3.9).

In general, large-scale firms employed professionally qualified individuals for all RAC service jobs compared to small and medium scale firms. Small scale firms employed less qualified persons in RAC servicing jobs, however they receive on-the-job training.

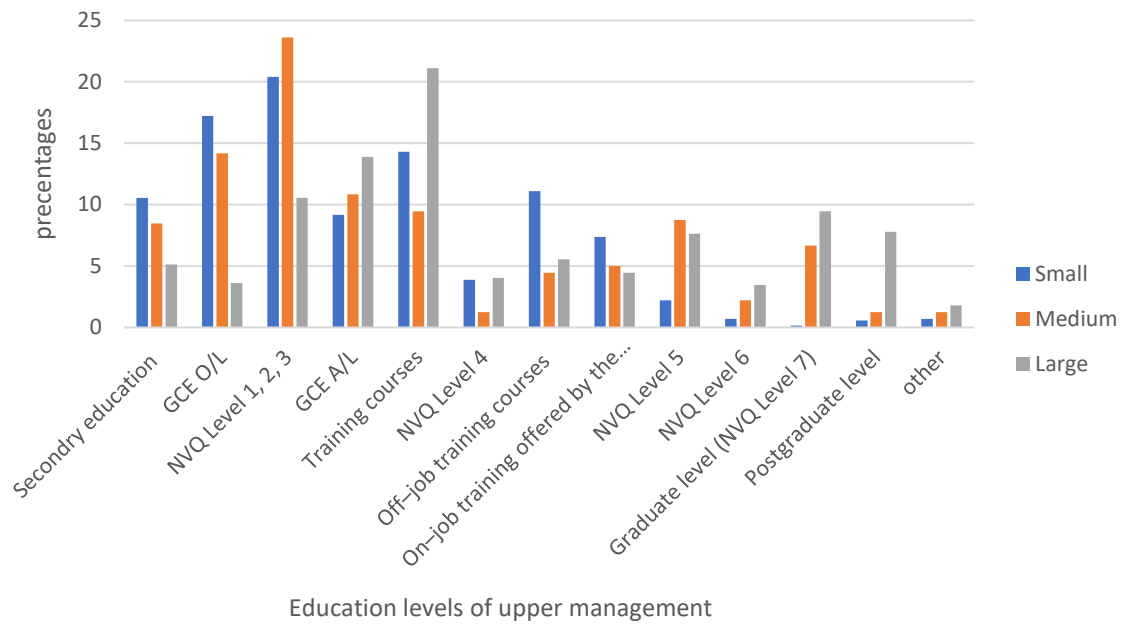


Figure 3.7: Qualifications of RAC employees in Upper Management Level across firm size

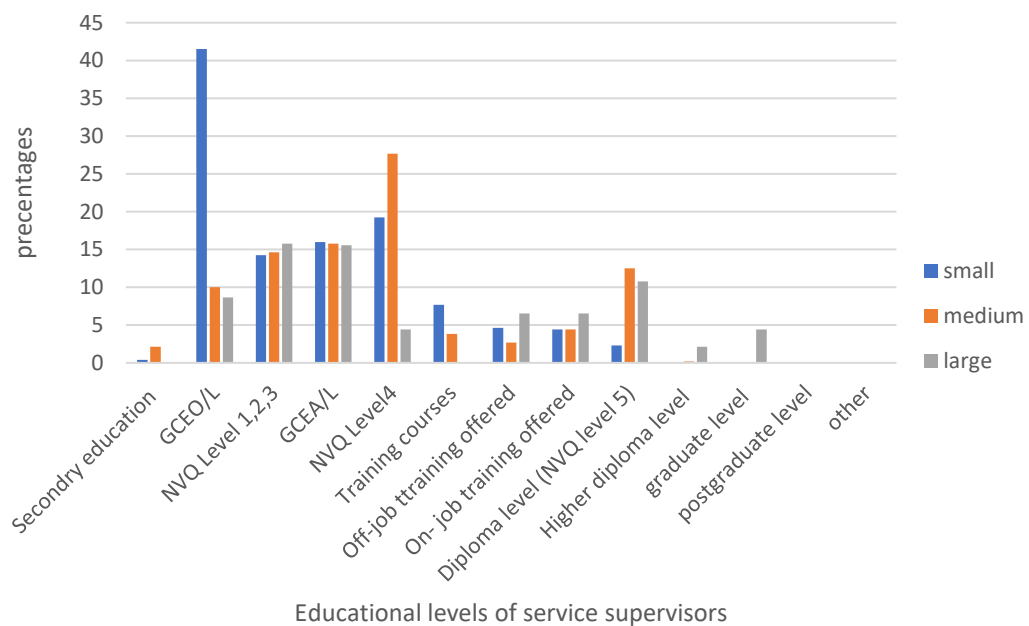


Figure 3.8: Qualifications of RAC employees in Service supervisor Level across firm size

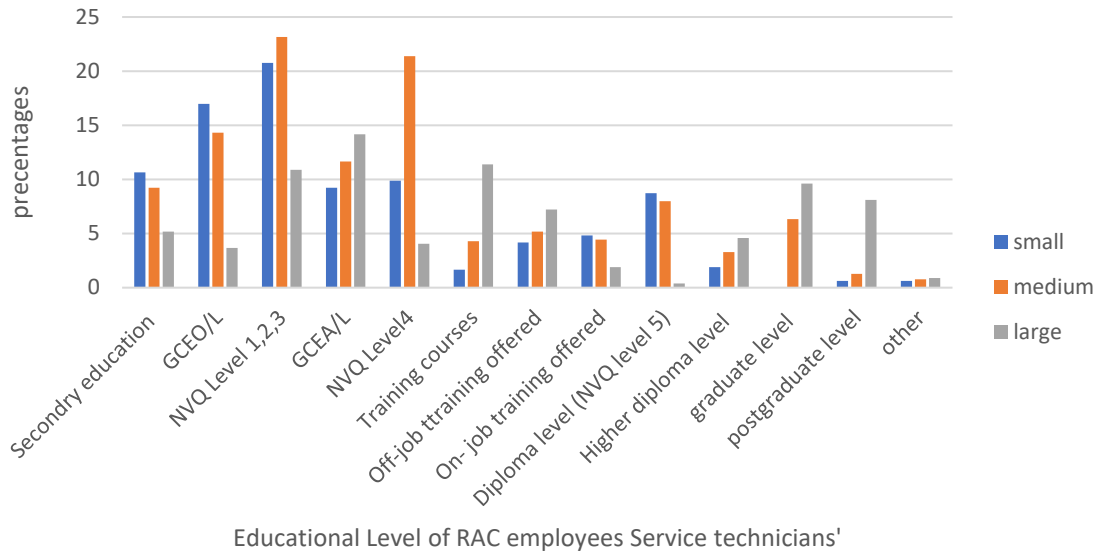


Figure 3.9: RAC employees Service technicians' Educational Level across Firm Size (N=303)

3.4.4. Employment of RAC service sector professionals by formal and informal workshops

Both formal and informal RAC service workshops were included in the sample. Qualifications of different RAC service sector job professions were compared by the formality of the business to understand the qualification requirements. The qualifications of employees in all job categories varied substantially irrespective of the firm type. In general, service supervisor and technician jobs in formal RAC workshops employed better qualified individuals. The preferred minimum level of qualification for service supervisor and technician positions in formal RAC workshops appears to be NVQ L1-3 (Figure 3.10, 3.11, 3.12).

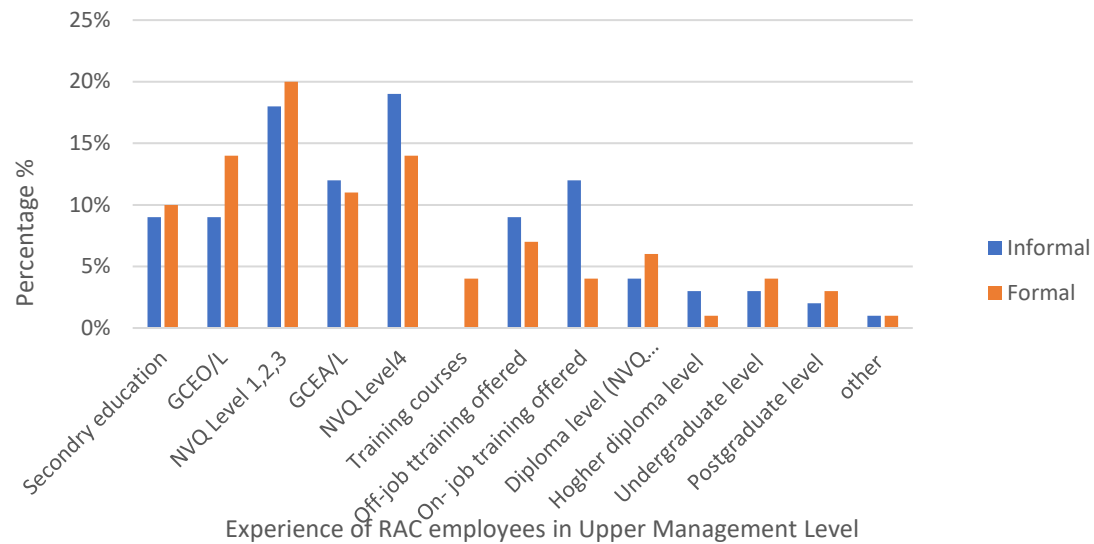


Figure 3.11: Experience of RAC employees in Upper Management Level in formal and informal workshops

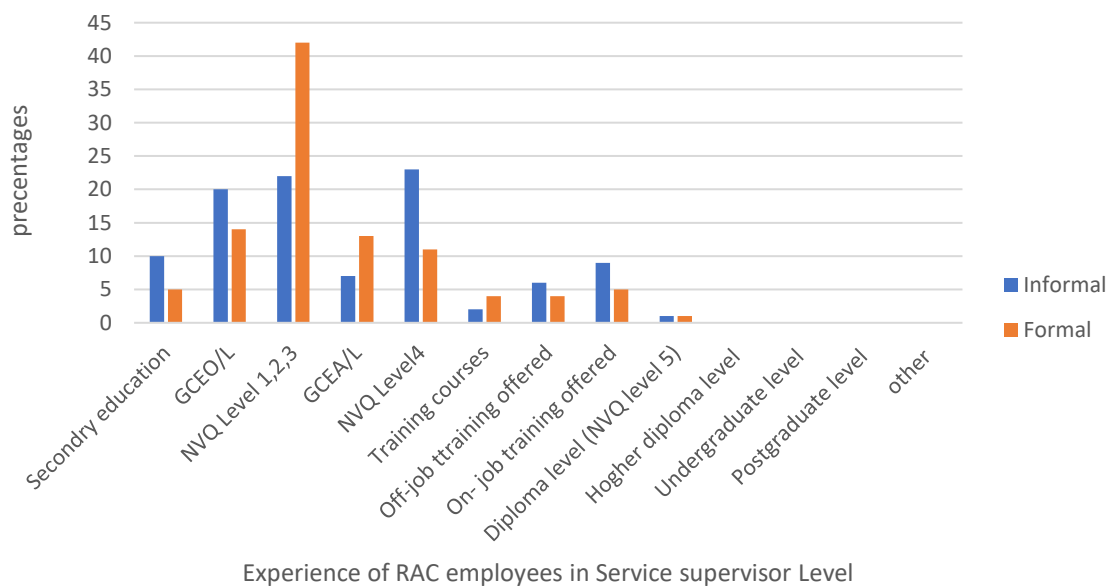


Figure 3.10: Experience of RAC employees in Service supervisor Level in formal and informal workshops

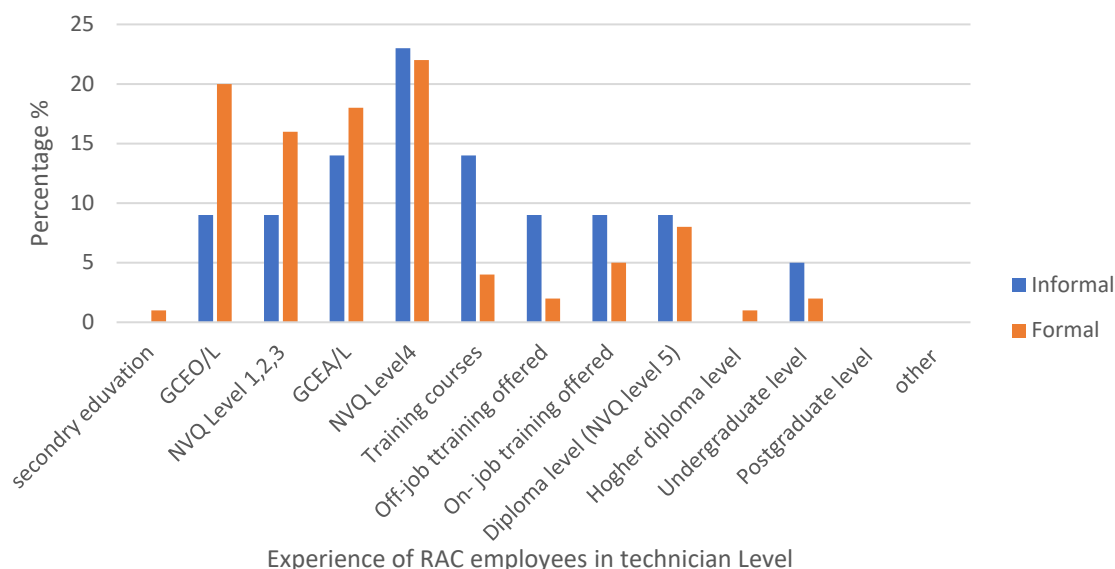


Figure 3.12: Experience of RAC employees in technician Level in formal and informal workshops

In Figure 3.13, it is evident that workers' experience within the formal and informal RAC firms is more pronounced across all three job categories: management, supervision, and technician positions. A higher proportion of 'management/ownership' positions and technician positions in the formal RAC sector are dominated by employees who have less than 10 years of experience. This suggests that employment in the formal RAC sector is dynamic with more job opportunities opening for those with better qualifications. At the same time, high proportion of less experienced but professionally qualified individuals in the formal RAC sector may suggest the leaving of jobs in the local market by RAC professionals after gaining few years of experience, and possibly seeking foreign employment where lucrative salaries are available.

Informal RAC sector in contrast appears to be more stagnant in terms of experienced workers and as many firms are independent small business owner companies, the level of experience appears to be high across all job categories considered. In essence, the informal sector is characterized by more experienced but comparatively less formally qualified employees.

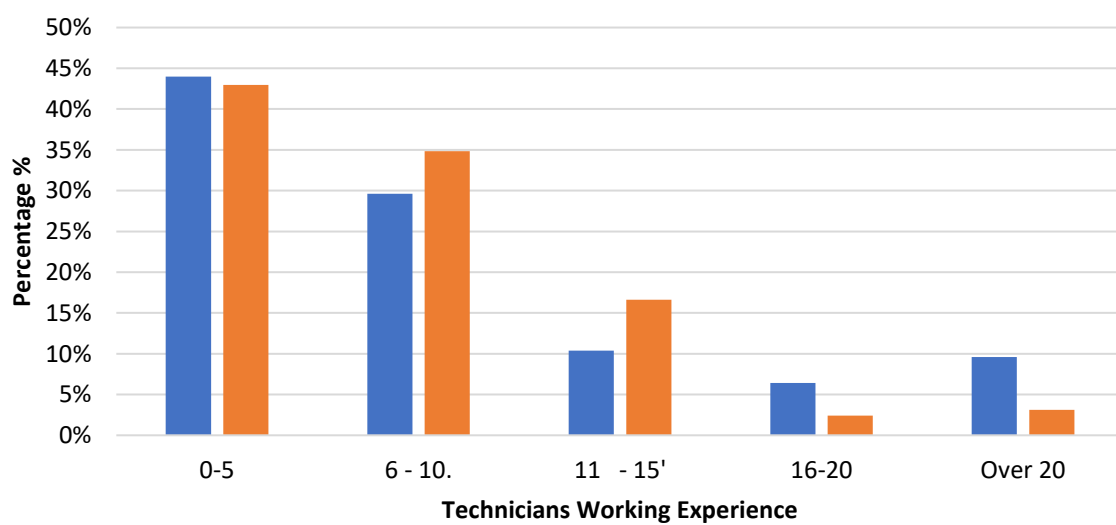
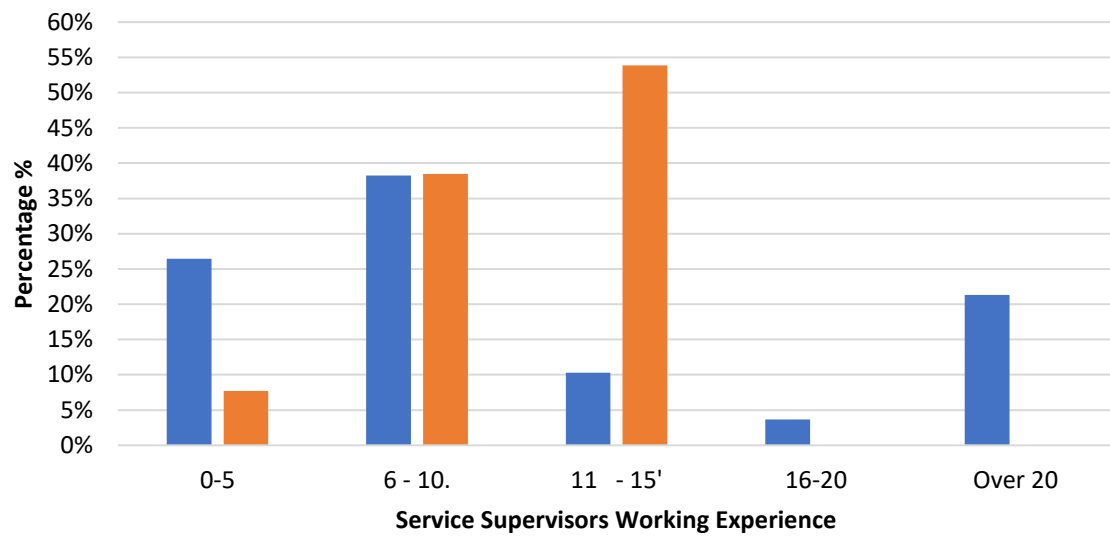
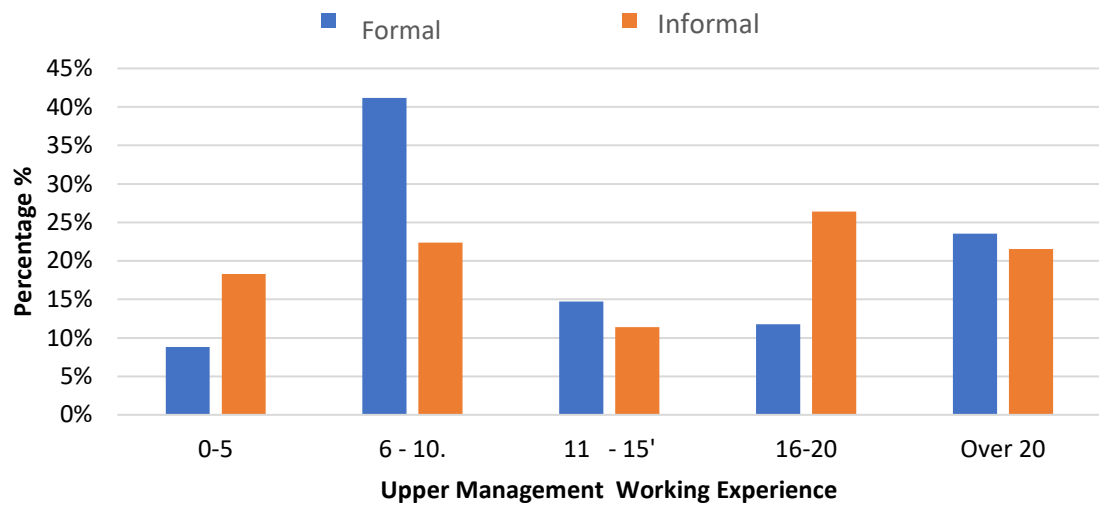


Figure 3.13: Years of Experience in the profession across different job layers

3.5 Continuous Professional Development of RAC sector employees (Knowledge and skill upgrading programs)

Despite the fact that the majority of RAC service sector employees have received formal training, 56% of the respondents stated that they would like to receive further training in RAC. Gaining experience, gaining practical knowledge and gaining confidence in their respective professions were the main reasons for them to opt for further training.

According to the survey, more than 57% of the employees in different categories in the RAC workshops have not obtained any qualifications other than the initial levels (such as national certificate, national diplomas in RAC, and other vocational training experience obtained before the start of the workshop). Between 15 to 40% of them have participated in Continuous Professional Development training programs (awareness workshops) conducted by the private sector, or the government under Montreal Protocol related programs such as the Good Servicing Practices Programs conducted by the NOU.



Figure 3.14: RAC service employees' perceptions on CPD training

3.6. Demand for RAC sector skilled persons in international markets

It is worthwhile to note that the annual departures of RAC workers to foreign international markets have shown a decline from 880 to 192 from 2015 to 2021 (Tables 3.2 and 3.3). Technician - RAC job category shows the highest numbers of foreign departures each year until 2018. However, after 2018, the job categories of junior and senior A/C technicians (AC/Ref Technicians/Mechanics/Forman/ Assistant Technicians) showed a surge in numbers. Looking at the overall job categories, it is clear that all technician categories have higher demand out of all job categories. Due to the abnormal situation that occurred during the 2019-2021 period because of the COVID-19 pandemic, foreign recruitments and departures were significantly

affected. Thus, the predictions of RAC sector worker demand in foreign labor markets were not undertaken in this study.

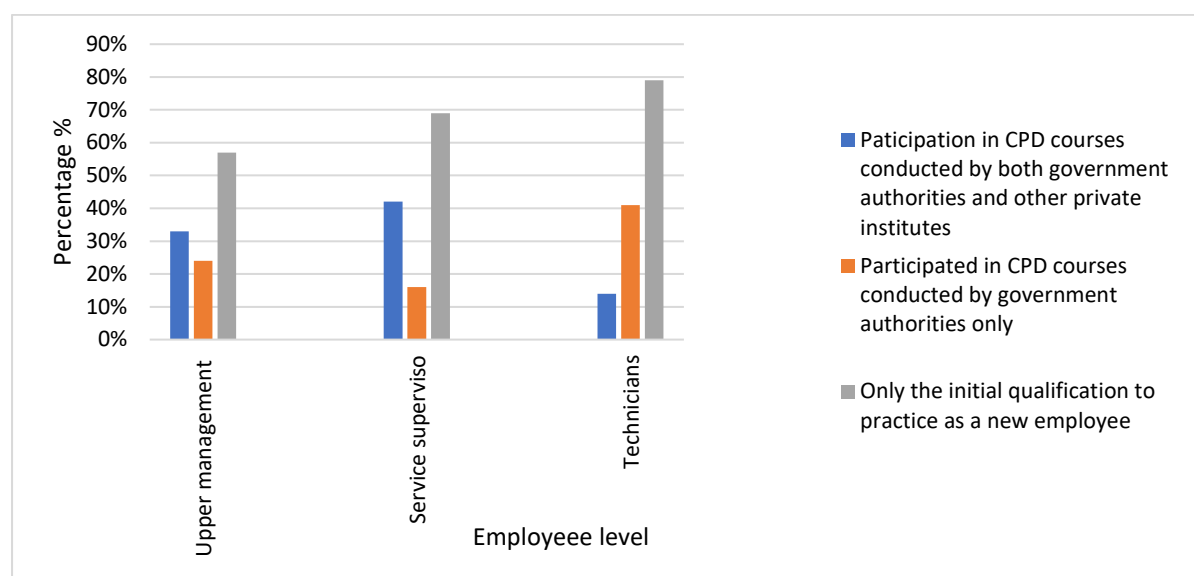


Figure 3.15: Participation in CPD programs by RAC service sector employees

Table 3.2: Foreign Departures for various Job Categories in the RAC sector 2015-2018

	Job Category	2015	2016	2017	2018
1	Engineers	1	2	1	0
2	Auto A/C Mechanics/Technicians	19	72	60	36
3	AC/Ref Technicians/Mechanics/Forman/ Assistant Technicians	825	658	456	315
4	A/C Electricians	13	18	29	12
5	Auto A/C Electricians	1	1	2	2
6	Helper/Laborer	6	28	85	11
7	AC Installer	4	2	0	0
8	Technicians-Cold Rooms/Chillers/Industrial/Fabricator(duct) /Insulator (duct)	11	17	10	20
	Total	880	798	643	396

Source: Central Bank Annual Report (2020; 2021); Sri Lanka Foreign Employment Bureau (2021)

Table 3.3 explains the number of vacancies received by the Foreign Employment Bureau and the number of vacancies filled during the period of 2019 to 2021. The table further incorporate departure data published by the Central Bank for same job categories. A noticeable aspect is that the foreign demand for RAC sector skilled technicians has never been met (2019-2021). Hence, there appears to be a significant skill gap that limits Sri Lanka's ability to supply skilled workers for existing foreign labor markets.

Table 3.3: Demand and Supply for Foreign RAC Jobs (Based on Central Bank and Foreign Employment Bureau data 2019-2021)

Job Category (Refer to job titles in Table 3.2)	2019			2020			2021		
	Vacancies (FEB)	Recruitments (FEB)	Departures (CB)	Vacancies (FEB)	Recruitments (FEB)	Departures (CB)	Vacancies (FEB)	Recruitments (FEB)	Departures (CB)
1	-	-	2	5	-	0	-	-	1
2	73	10	30	5	-	4	591	-	9
3	1126	86	294	453	17	97	1788	64	160
4	-		13	3	1	6	8	4	7
5	68	9	1	-	-	2	-	-	3
6	-		7	1	-	3	1	-	10
7	110		3	-	-	5	15	-	0
8	163	2	3	25		3	40	-	2
Total	1540	107	353	492	18	120	2443	68	192

Source: Central Bank Annual Report (2020; 2021), Sri Lanka Foreign Employment Bureau (2021)

Another interesting fact is that the demand for the RAC sector in the Middle East is almost as high as the demand comes from the rest of the world. When considering the demand for RAC service sector employees in foreign markets, Middle Eastern countries such as UAE, Oman, Qatar, Saudi Arabia and Bahrain offered more employment opportunities over the past 5 years. It was further revealed that Qatar offers the highest number of employments each year. This suggests that the job market for RAC is concentrated in Middle Eastern countries followed by the South Asian region (Table 3.4 to Table 3.10). In addition, Sub-Saharan Africa and Eastern Europe and Central Asia appear to be the new market regions that could be targeted for RAC sector employment^{9,10,11}.

Table 3.4: RAC service sector jobs by source regions - 2015

Job Category	Middle East	South Asia	Sub- Saharan Africa
2	17	2	
3	789	29	7
4	12	1	
6	4	2	
8	9	2	

Source: Central Bank Annual Report (2020; 2021); Sri Lanka Foreign Employment Bureau (2021)

⁹ Annual Report 2020 | Central Bank of Sri Lanka. (2020). Department of Technical Education & Training. <https://www.cbsl.gov.lk/en/publications/economic-and-financial-reports/annual-reports/annual-report-2020>

¹⁰ Annual Report 2021 | Central Bank of Sri Lanka. (2021). Department of Technical Education & Training. <https://www.cbsl.gov.lk/en/publications/economic-and-financial-reports/annual-reports/annual-report-2021>

¹¹ Foreign Departures by Employment. (2021). Home - Sri Lanka Foreign Employment Bureau. <http://www.slbfe.lk/>

Table 3.5: RAC service sector jobs by source regions - 2016

Job Category	Middle East	South Asia	Sub- Saharan Africa	Western Asia	Eastern Europe and Central Asia
2	66	4	1		1
3	610	40	4	2	2
4	15	2	1		
6	25	1			2
8	17	-			

Source: Central Bank Annual Report (2020; 2021); Sri Lanka Foreign Employment Bureau (2021)

Table 3.6: RAC service sector jobs by source regions - 2017

Job Category	Middle East	South Asia	Sub- Saharan Africa	Western Asia	Eastern Europe and Central Asia
2	51	8	1		
3	408	41	4	2	1
4	27	2			
6	83	2			
8	9	-			

Source: Central Bank Annual Report (2020; 2021); Sri Lanka Foreign Employment Bureau (2021)

Table 3.7: RAC service sector jobs by source regions - 2018

Job Category	Middle East	South Asia	Sub- Saharan Africa	Eastern Europe and Central Asia
2	32	3		1
3	266	45	2	2
4	11	1		
6	11	-		
8	20	-		

Source: Central Bank Annual Report (2020; 2021); Sri Lanka Foreign Employment Bureau (2021)

Table 3.8: RAC service sector jobs by source regions - 2019

Job Category	Middle East	South Asia	Sub- Saharan Africa	Eastern Europe and Central Asia
2	28	2		
3	246	43	3	2
4	12		1	
6	7	-		
8	2	-		1

Source: Central Bank Annual Report (2020; 2021); Sri Lanka Foreign Employment Bureau (2021)

Table 3.9: RAC service sector jobs by source regions - 2020

Job Category	Middle East	South Asia	Sub- Saharan Africa	Eastern Europe and Central Asia
2	4			
3	86	9	1	1
4	6			
6	3	-		
8	3	-		

Source: Central Bank Annual Report (2020; 2021); Sri Lanka Foreign Employment Bureau (2021)

Table 3.10: RAC service sector jobs by source regions - 2021

Job Category	Middle East	South Asia	Sub- Saharan Africa	Eastern Europe and Central Asia
2	3	6		
3	119	39	2	
4	6	1		
6	9	-		1
8	2	-		

Source: Central Bank Annual Report (2020; 2021); Sri Lanka Foreign Employment Bureau (2021)

The factors above are also supported by the Annual Reports of Central Bank (CB) in the last 5 years. According to CB (2020), it is indicated that the departures for foreign employment (for all job categories) declined sharply by 73.6 percent to 53,713 in 2020, from 203,087 in 2019 with the spread of COVID-19 pandemic. This sharp decline was due to the temporary ban imposed by Sri Lanka Bureau of Foreign Employment (SLBFE) on departures of migrant workers registered with them, travel restrictions at labour receiving countries, suspension of recruitment of foreign workers, and reduced demand for migrant labour. Male and female departures for foreign employment fell by 73.5% and 73.7%, respectively, in 2020 compared to 2019.

However, there is a significant growth of foreign departures (a growth of 127%) from 53711 in 2020 to 121,795 in 2021 with a substantial hike in departures towards the latter part of the year. As a result, 61,447 people left for foreign jobs in the fourth quarter of 2021, the largest number since the third quarter of 2016. This significant increase in departures for foreign employment was driven by relaxed travel restrictions and increased employment opportunities in labor-receiving countries, many prospective migrant workers who were waiting to travel overseas for jobs, and the rapid vaccination of prospective migrant workers.

In 2020 total foreign departures, including all skill categories, namely professional, middle level, clerical and related, skilled, semi-skilled, unskilled, and housemaid, decreased significantly compared to the previous year. However, in the next year, the total foreign

employment under all the employment categories increased where the major contributions were from the skilled, unskilled and housemaid categories. Meanwhile, the Middle East region remained the most popular foreign employment destination over the three-year period of 2019, 2020 and 2021, accounting for 82.0 and 84.8 percent of all foreign employment departures for 2020 and 2021 respectively. However, departures for foreign employment in the Middle East region fell by 74.5 percent in 2020 compared to 2019. The highest foreign departures (87.7%) in 2021 were recorded for Qatar, Saudi Arabia, the United Arab Emirates, and Kuwait. Meanwhile, departures for international employment are expected to increase significantly in 2022, with further improvements reported in the first quarter of 2022 ^{9,10}.

Expert views

In addition to published statistics, views of experts in the RAC sector were also sought to gain a broader picture of the foreign demand for RAC sector jobs. It was revealed that the international RAC job market is becoming increasingly competitive with many South Asian countries competing for the same jobs in major employment destinations. RAC technicians from countries with more organized vocational training systems that offer ‘paper qualifications’ with language skills are more likely to succeed in securing foreign employment. RAC technicians even with superior skills may fail to secure foreign employment due to these reasons. In this context, the information gap (lack of awareness), language barrier, work orientation and the limitations in offering qualifications that are on par with international standards (Internationally recognized qualification which meets the number of learning and practical hours) were found to be issues to address. At present, only a limited number of institutes such as German Tech offers such recognized qualification.

It was further revealed that a significant number of RAC service technicians leave the country for foreign employment under different “job titles”, thus the official statistics published by the Central Bank and Foreign Employment Bureau may not accurately reflect the real scenario.

3.7 Employability and Future Training Preferences of RAC Sector

Employees

The majority of the individuals who have received training in RAC had less than one month waiting period to find employment related to RAC in the job market (Figure 3.16). Over 80% of the individuals trained in RAC have been hired within three months of completion of their training. This possibly indicates the high demand for skilled personnel in the RAC sector.

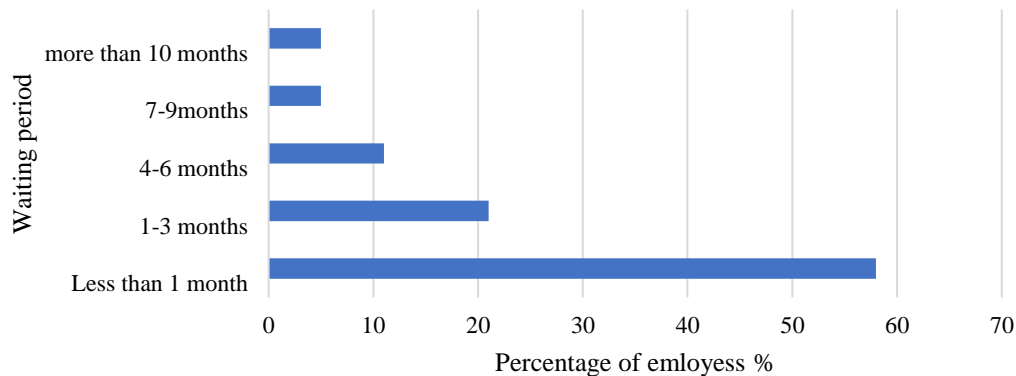


Figure 3.16: Waiting period for employment after RAC vocational training.

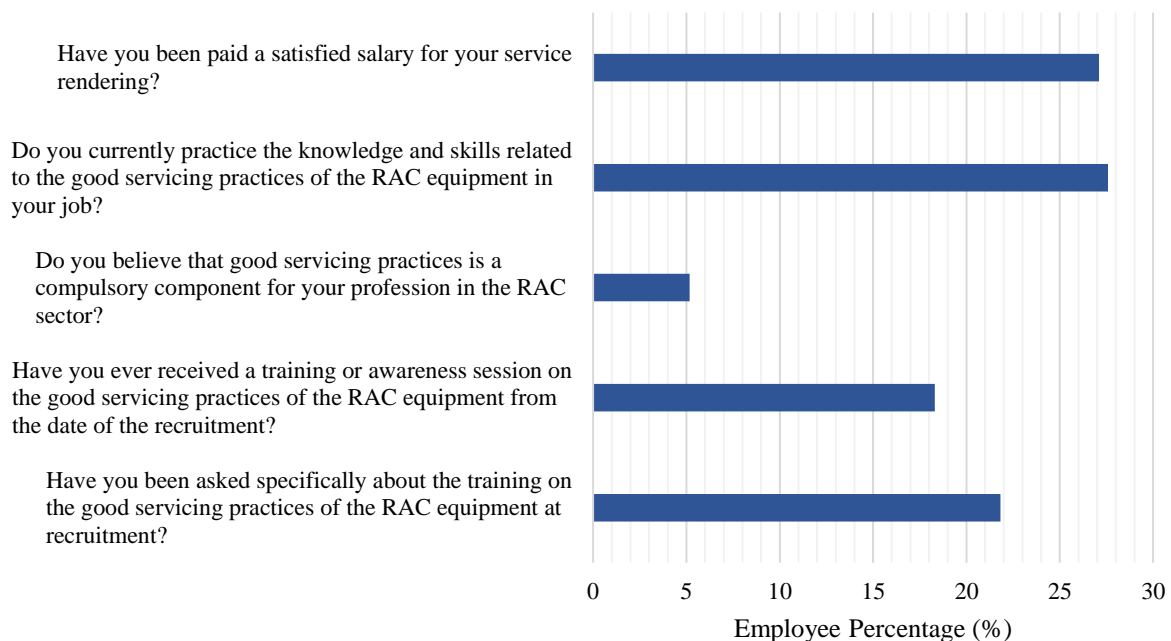


Figure 3.17: Employee perceptions on employment environment

Figure 3.17 shows further information on hiring employees, the applicability of RAC training on the job, and employees' perceptions of future training requirements. At the time of recruitment, about 22% of respondents had been specifically asked about their knowledge of RAC good servicing practices. This indicates the industry's moderate emphasis on the

knowledge of RAC good servicing practices at recruitment. Also, about 18% of employees have received training or awareness on RAC good servicing practices after recruitment. Only 5% of the employees believe that good servicing practices are a compulsory component of their profession in the RAC sector. Approximately 28% of the respondents were satisfied with the salary level they are getting in their respective profession/job.

Future training preferences

Figure 3.18 shows the most desired courses where RAC sector employees seek further training. When inquired about the type of course that the employees are willing to follow in the future, 40% preferred NVQ 4, followed by NVQ 5 (33%). NVQ levels (1, 2, 3, 6, and 7) and postgraduate level, and on-job/ off-job training courses received low response rates. It is apparent that employees are hesitant to achieve higher NVQ levels such as National Diploma Level (NVQ 6) and Undergraduate Level (NVQ 7) owing to longer time commitments.

Figure 3.19 shows the key training areas employees would like to obtain from a future course.

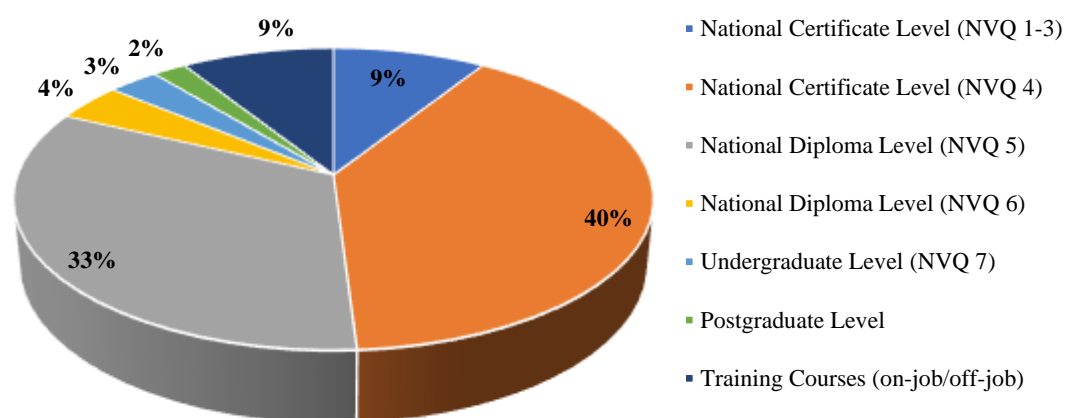


Figure 3.18: Employee preferences for RAC sector training by course type

The majority preferred area 1: refrigeration & AC sector, and area 7: good RAC and MAC services practices. This may be due to the lack of sufficient training received in good practices in RAC and MAC services. Commercial/industrial refrigeration installation and servicing training area also received comparatively higher preference, which is 14% of the sample. The lowest response rate was recorded for the training area of the Transport refrigeration system servicing sector.

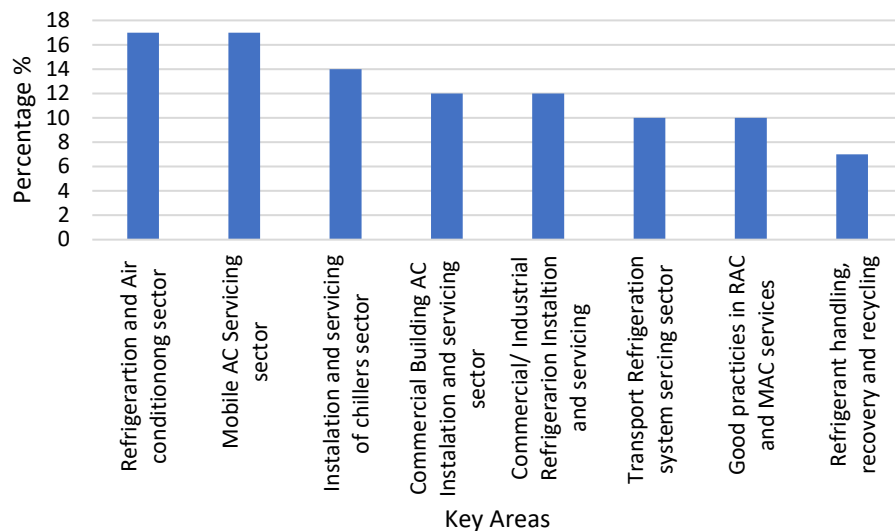


Figure 3.19. Training preference of RAC employees by subject areas

3.8 Future demand for RAC service sector human resources

As an outcome of the VET plan survey and the demand and supply analysis in the RAC sector, new occupations were identified. Though no such new occupations were identified, it was observed that the demand for some jobs have become stagnant for the past 2-3 years. Those categories include Auto A/C Mechanic (transport workshop), Operator - A/C Chiller (Ref.), Refrigerator Man, Sr. A/C Foreman, Technician- A/C Chiller Plant, Technician Class 1- A/C Electrical, Technician -Cold Rooms Ref. The current occupation opportunities in the RAC Sector in Sri Lanka are mainly from the servicing and manufacturing/assembling sectors. The other potential opportunities are limited and found in small scale food processing, fishing, transport and fire suppression sectors, etc.

The RAC servicing sector includes repair and maintenance of Domestic refrigeration, unitary Air Conditioning systems, Mobile Air Conditioning, Commercial Refrigeration, Commercial Air Conditioning, Industrial Refrigeration, and Industrial Air Conditioning. The RAC manufacturing/assembling sector includes Refrigeration Manufacturing/Assembling sector and Air Conditioning Manufacturing/Assembling Sector.

The RAC servicing sector has shown significant growth and an upward trend in recent years, while the RAC manufacturing/assembling sector shows slow growth. However, these two sectors mainly create continuous and increasing demand of the RAC sector job opportunities for technicians in Sri Lanka.

Based on the survey outcomes of RAC service sector firms, the total number of anticipated recruitments by the firm size was estimated. The anticipated recruitments under different job categories by small, medium and large firms are summarized in Table 3.11. Master technician and Mid/junior technician positions appear to have the highest demand followed by supervisors and service/sales jobs.

Table 3.11: Anticipated recruitments by the sampled firms under different job categories by RAC service firms.

Job category		Small	Medium	Large	Total number of individuals hope to recruit within next 5 years
1	Serviceman	16	34	35	105
2	Service Supervisors	25	33	37	113
3	Master technicians	69	54	53	202
4	Mid/Junior Technicians	122	127	101	393
5	Other (Trainees/ Labourers)	24	13	19	65
Total		267	292	295	354

Table 3.12 displays the anticipated recruitments projected for the entire population based on the sample. Accordingly, the highest employment opportunities will arise in medium-scale firms followed by large and small firms. The total employment in the RAC sector was estimated to be 7120 jobs.

Table 3.12: Projected recruitments in the RAC service sector for the next five years

Workshop Size		Number of Workshops	Number of recruitments (1) Sample (2) Projected for the population
Small	Sample	130	267 ⁽¹⁾
	Population	843	1973 ⁽²⁾
Medium	Sample	135	292 ⁽¹⁾
	Population	1617	3498 ⁽²⁾
Large	Sample	91	295 ⁽¹⁾
	Population	583	1890 ⁽²⁾
			7120

Predictions for the number of recruitments for the next five years based on past trends.

Based on the number of recruitments made each year within the period of 2016 to 2019 by the RAC sector firms/employers (revealed by the sample-based survey), the number of recruitments per workshop was computed as follows.

$$\begin{aligned} & \text{Number of Recruitment per company Per year} \\ &= \frac{\text{Number of Total Rcuitements}}{\text{Number of companies interviewd}} \end{aligned}$$

Accordingly, the number of recruitments per workshop per year is summarized below.

Year	Small	Medium	Large
2016	0.3	0.88	1.5
2017	0.35	1.15	1.44
2018	0.3	1.04	1.44
2019	0.35	1.15	1.56

The survey further gathered information on the requirements expected to be made by the firms for the next five years (2021-2025). The expected number of recruitments per company per year was determined as follows.

$$\begin{aligned} & \text{Expected number of recruitments per company per year} \\ &= \frac{\text{Expected number of total Rcuitements for the next 5 years}}{\text{Number of companies interviewd} * 5} \end{aligned}$$

Accordingly, the number of recruitments per workshop per year for the next 5 years is summarized below.

Size	Total Number of companies in the sample	Expected number of recruitments	The expected number of recruitments per company per year
Small	130	267	0.41
Medium	135	292	0.43
Large	91	295	0.65

It can be seen that except for the small sized companies the expected number of recruitments per company per year in 2021-2025 period (after COVID) are significantly lower than the number of recruitments per company per year in 2016-2019 period (Before COVID).

Predictions of future recruitments by small-scale RAC firms

In predicting the expected total number of recruits in the next 5 years, A Simple Linear Regression Models was fitted for data on 2016, 2017, 2018, 2019, and 2025 for small companies. Accordingly, the expected total number of recruits by small scale RAC workshops for the period of 2021-2025 is 1632 (Table 3.13).

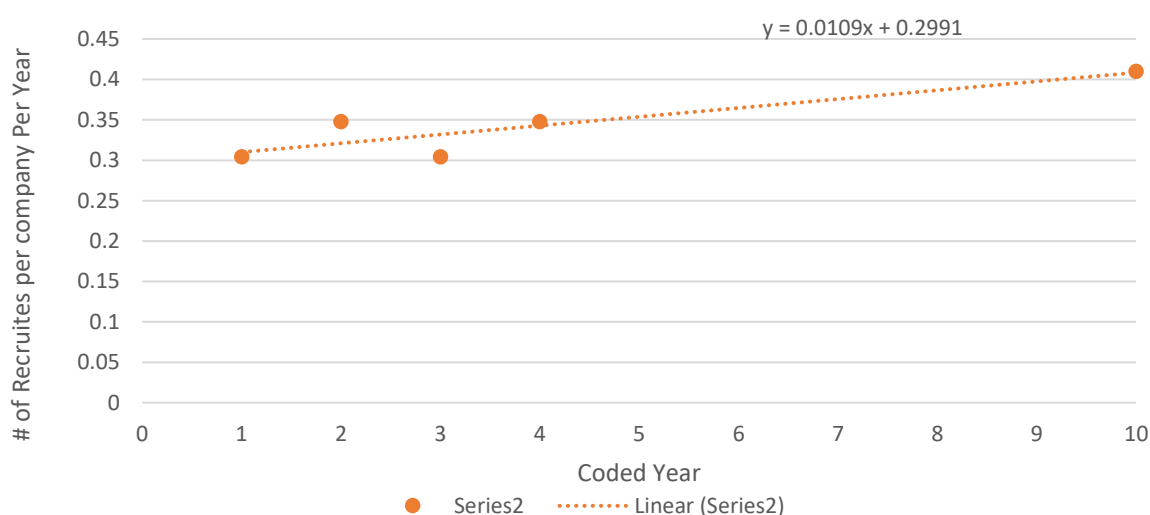


Figure 3.19: Model-predicted future recruitments by the small-scale RAC firms

Table 3.13: Annual demand/recruitment of RAC technicians by small-scale workshops

Year (coded year)	Prediction (Per company)	Prediction for all Small-scale companies
2021 (6)	0.36	304
2022 (7)	0.38	321
2023 (8)	0.39	326
2024 (9)	0.40	336
2025 (10)	0.41	345
Total		1632

Predictions of future recruitments by medium scale RAC firms

In predicting the expected total number of recruits in the next 5 years, a Simple Linear Regression Models was fitted for data on 2016, 2017, 2018 and 2019 for medium scale companies. Accordingly, the expected total number of recruits by small scale RAC workshops for the period of 2021-2025 is 11545 (Table 3.14).

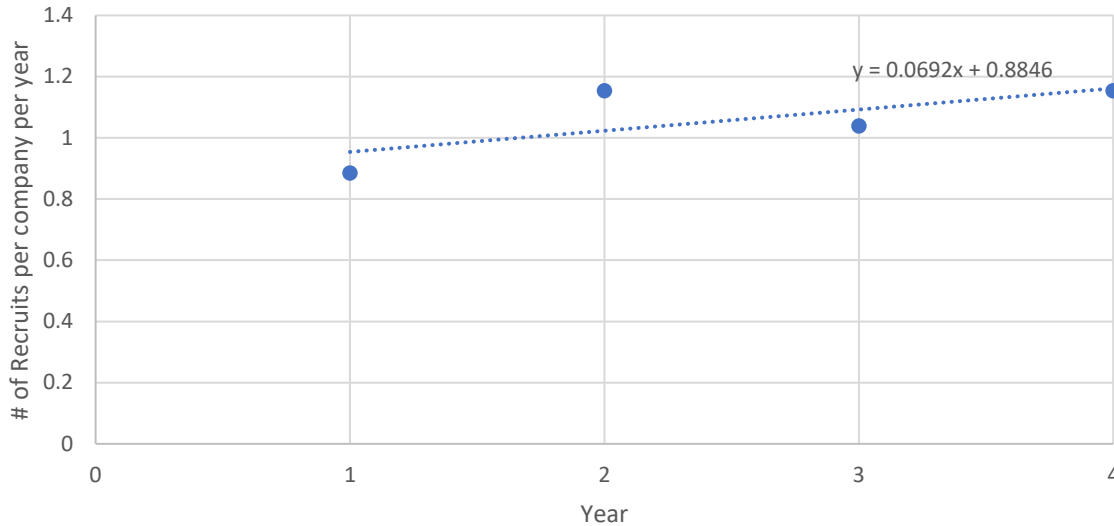


Figure 3.20: Model-predicted future recruitments by the medium-scale RAC firms

Table 3.14: Annual demand/recruitment of RAC technicians by medium-scale workshops

Year (coded year)	Prediction (Per company)	Prediction for all medium scale companies
2021(6)	1.30	2103
2022 (7)	1.37	2216
2023 (8)	1.44	2329
2024 (9)	1.51	2442
2025 (10)	1.58	2455
Total		11545
Weighted total	(0.4:0.6)	6717

However, due to the large deviations in predicted number of recruitments by the regression model and respondent-anticipated number of recruitments, an estimation was made based on a weight derived from expert opinion. From the sample survey of 135 medium scale employers were in the opinion of 292 recruits for the next 5 year. Therefore, it can be expected that 3498 ($292 \times 1617 / 135$) number of recruitments for all the medium scale companies for the next 5 years. Hence, the expected total number of recruits during 2021-2025 for medium scale firms was estimated based on the weighted average of predictions given by the regression and the sample survey (0.4:0.6). Accordingly, the predicted total recruitments by medium scale RAC workshops were 6717 ($3498 \times 0.6 = 11545 \times 0.4$).

Predictions of future recruitments by large scale RAC firms

The regression model predicted recruitments by large scale firms based on past data are indicated in Table 3.15. Using a similar weight-based approach as above, the predicted total recruitments by medium scale RAC workshops was 2992.

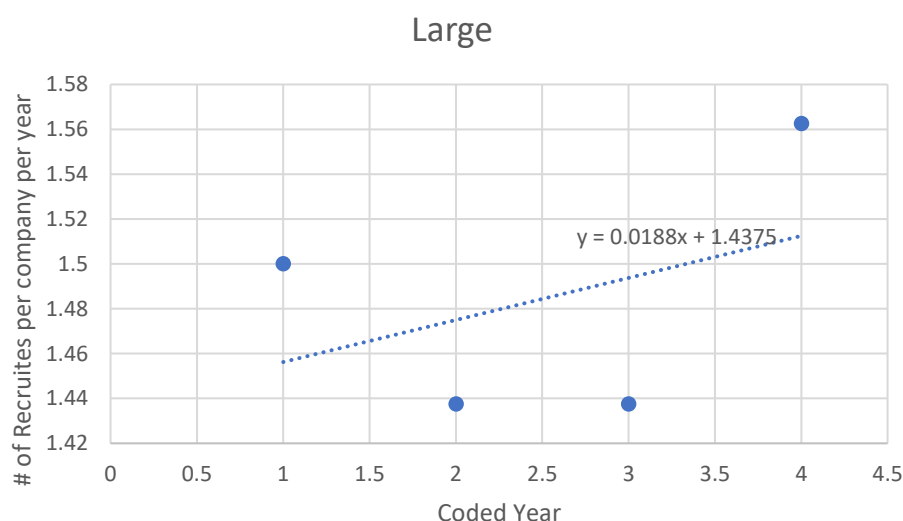


Figure 3.21: Model-predicted future recruitments by the large-scale RAC firms

Table 3.15: Annual demand/recruitment of RAC technicians by large-scale workshops

Year (coded year)	Prediction (Per company)	Prediction for all large -scale companies
2021 (6)	1.56	910
2022 (7)	1.57	916
2023 (8)	1.59	927
2024 (9)	1.61	939
2025 (10)	1.63	951
Total		4643
Weighted total	(0.4:0.6)	2992

Males were preferred by the RAC firms across all job categories (Figure 3.22). Difficulty in providing occupation-related facilities for female technicians (such as changing rooms, accommodation, transport and washrooms/ toilets) were cited as the main reason for low preference for females especially for ‘ground level’ service professions. Employment opportunities for females in the RAC sector is likely to show a slight growth where the respondent RAC service sector firms expect to recruit females in service and sales departments. Such positions may not require physically demanding work but require formal RAC training for effective delivery of the services.

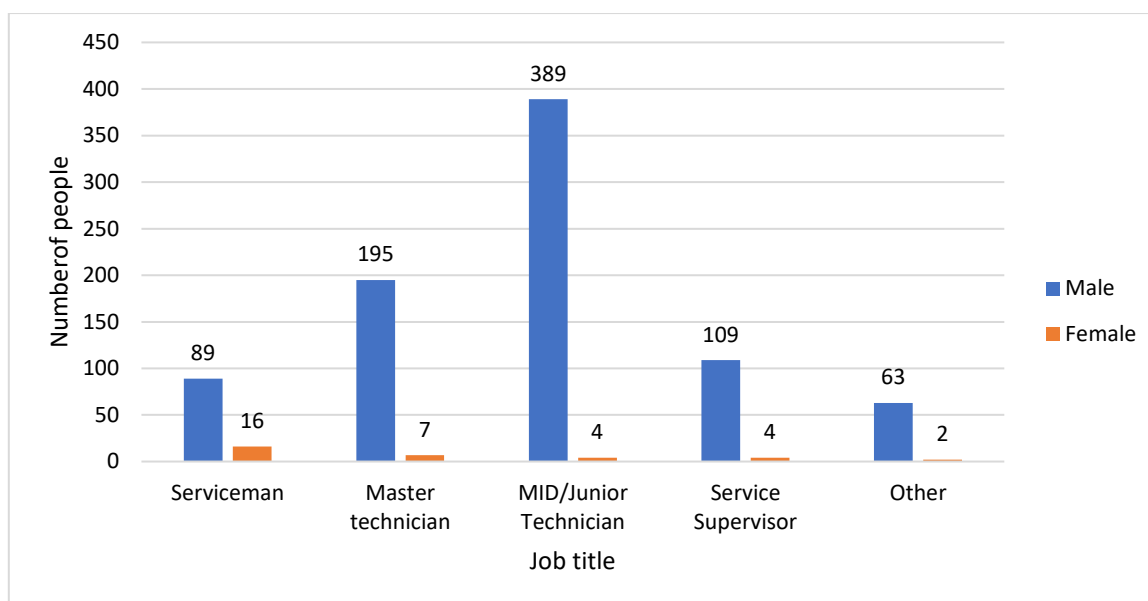


Figure 3.22: Anticipated recruitments by gender for the next five years (2021-2026)

3.9. Other future trends in the RAC service sector employment

During the key informant interviews and focus group discussions, the following matters were raised with respect to human resource requirements in the RAC service sector, which are worth considering in VET plan development.

- Due to the development of the shipping industry in the country (Colombo and Hambantota ports) there is new demand for Reefer man/Reefer Technicians in the Refrigeration industry. The same profession has high demand for foreign vessels (ships). Hence, skilled human resource development to cater such emerging jobs such as Reefer Man/Reefer Technicians should be considered.

3.10. Key Highlights

- There are over 6,500 individuals who have completed RAC sector training from state, private or NGO-managed vocational training institutes in the country. It is estimated that about 2,500 individuals who have not received formal training are further employed in the RAC sector.
- Approximately 47% of the employees were in the age group of 25 to 35. About 28% of the employees were in the age group of 24 years or below. 25% of the employees were in the age group of 36 or above. The middle-aged employees, possibly with years of experience in the RAC sector, seem to be better equipped to fit into existing job portfolios in the RAC sector.

- Males dominate the RAC service sector employments by accounting for 97% of the current job positions in the RAC sector. Females (3%) were employed at administrative levels. Females are likely to be employed in office-related work in the immediate future, rather than service-related positions.
- The highest percentage (42%) of employees are mid/junior level technicians, followed by the master technicians (37%). A significant percentage (24%) is employed in managerial and senior officer positions.
- More than 57% of the employees in different categories in the RAC workshops have not obtained any qualifications other than the initial levels. Between 15 to 40% of them have participated in one of the following Continuous Professional Development courses conducted by the government or private sector.
- About 18% employees have received training or awareness on RAC good servicing practices after recruitment.
- A higher proportion of workers in the informal RAC firms are more experienced across all three levels of job categories considered, but professionally less qualified compared to the formal sector.

Chapter 4

CURRENT TRAINING PROFILE

4.1 Introduction

This chapter provides an overview of the RAC sector vocational training providers currently offering various training options to shape the labor force's knowledge and skills to suit emerging RAC sector employment opportunities. The objectives of the TVET for the RAC servicing sector are to train the technicians to ensure efficient and effective refrigerant handling, installation, operation, maintenance, repair, and servicing of RAC equipment. Since the RAC servicing sector is the main consumer of refrigerants in Sri Lanka, the knowledge and skills of RAC technicians must be continuously updated in both theoretical and practical aspects. This will contribute to reducing the consumption and atmospheric emission of refrigerants.

4.2. Sri Lanka's TVET System

A survey conducted by the Department of Census and Statistics in Sri Lanka (2004 to 2016) showed that out of the total of 302,000 students who were admitted to Grade 1 in schools in Sri Lanka in 2004, only 18.87% followed a local/foreign degree and professional courses after G.C.E. Advanced Level examination. In addition, only 1.66% engaged in either government or employment in the private sector such as clerical, nursing, and banker jobs. Approximately, 21% of left out as unskilled workforce without proper training. A significant proportion of the left-outs join public or private TVET centers every year.

The TVEC of Sri Lanka operates under the Ministry of Skills Development and Vocational Training which was established to cater the increasing demand among the youth to provide with the required tertiary education. TVEC contributes to policy formulation, planning, quality assurance, coordination, regulation, and development of tertiary and vocational education. About 174 of public and private sector TVET courses are accredited by the TVEC in Sri Lanka. The National Policy provides the institutional framework of the TVET sector in Sri Lanka on Technical and Vocational Education. The annual intake quota of the public TVET institutions is approximately 140,000.

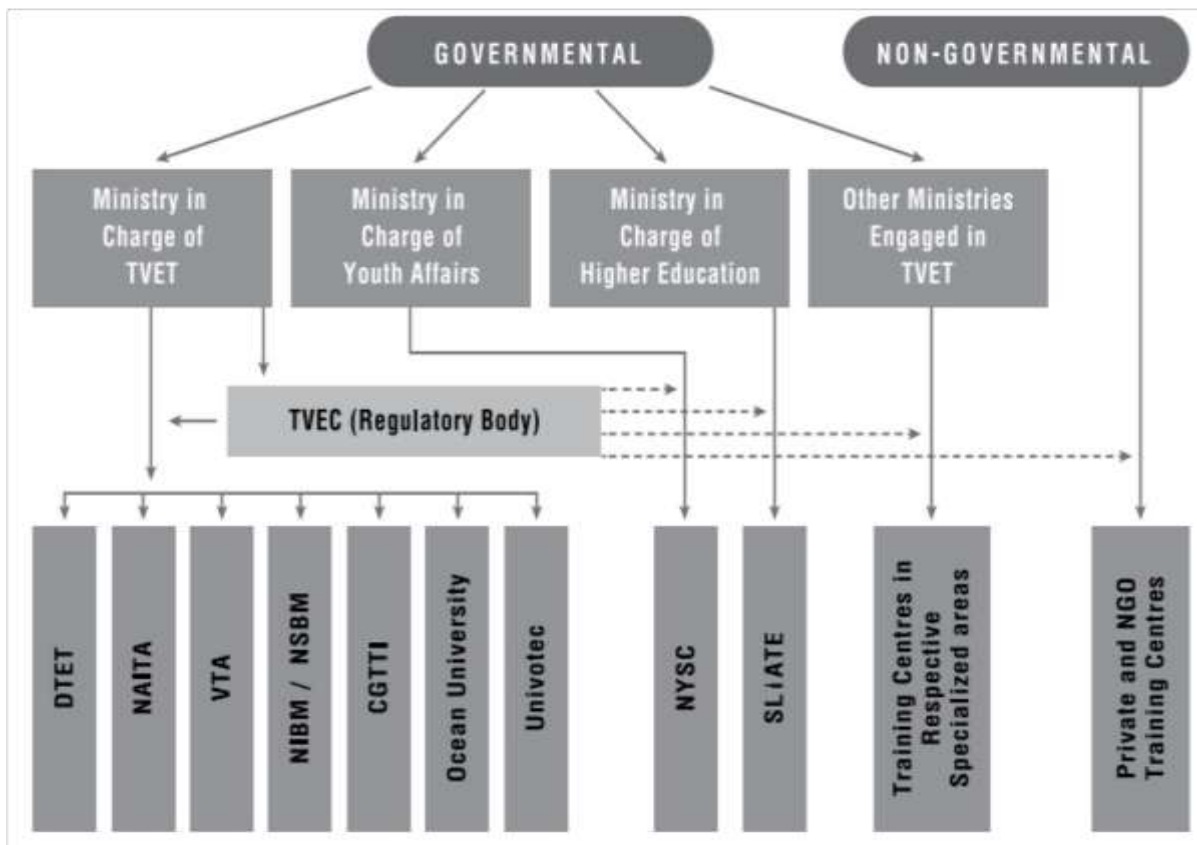


Figure 4.1: Sri Lanka's TVET System,

Source: Sri Lanka's TVET System. (2021). Department of Technical Education & Training publications. <http://dtet.gov.lk/en/download-categories/publications/>

4.3 Sri Lanka's Qualification Framework for TVET and Higher Education

The National Vocational Qualification (NVQ) Framework in Sri Lanka was developed by the TVEC and is based on the national competency standards identified by the industry and includes relevant technical and employability competencies, as shown in Table 4.1. NVQ 3 and NVQ 4 are generally accepted as the qualification for a technician.

Table 4.1: NVQ structure of Sri Lanka

NVQ Level	Qualification	Centralized Description
Level 1	National Certificate	Recognizes the acquisitions of entry-level competencies
Level 2, 3, 4	National Certificate	Recognize increasing levels of competencies. Level 4 qualification provides for full craftsman/workmanship
Level 5, 6	National Diploma	Recognize the increasing level of competencies of technicians, including supervision and process management
Level 7	Bachelor's Degree	Recognizes the vocational/technological competencies at bachelor's degree level

Source: Tertiary and Vocational Education Commission. (2009). National Vocational Qualifications Framework of Sri Lanka - Operations Manual. The Council of Technical Education & Training. <http://technicalcouncil.com/>

Sri Lanka Qualifications Framework (SLQF) was developed by the University Grants Commission (UGC) to create a nationally consistent framework for all higher education qualifications offered in Sri Lanka. The comparable NVQ levels are indicated in Table 4.2.

Table 4.2: Comparable SLQF and NVQ levels in Sri Lanka

SLQ F Level	Comparable NVQ Level	Qualification Awarded	Minimum Volume of Learning for the Award per Sri Lanka Qualification Framework (SLQF)
5	7	Bachelors	90 credits after SLQF 2 of which 60 credits after SLQF 3, of which 30 credits after SLQF 4
4	6	Higher diploma	60 credits after SLQF 2 of which 30 credits after SLQF 3
3	5	Diploma	30 credits after SLQF 2
2	4	National Certificate of Education Advanced Level (GCE A/L or equivalent)	
1	1,2,3	National Certificate of Education Ordinary Level (GCE O/L or equivalent)	

Source: Tertiary and Vocational Education Commission. (2009). National Vocational Qualifications Framework of Sri Lanka - Operations Manual. The Council of Technical Education & Training. <http://technicalcouncil.com/>

4.4. TVET in RAC sector

There are approximately 85 government, private or NGO-owned educational and vocational training institutions that offer vocational training courses in refrigeration and air conditioning. The number of institutions offering certificates, diplomas, or degrees in RAC in the country are indicated in Table 4.3.

Table 4.3: Number of institutions offering the certificate/diploma or degree in RAC.

Ownership	Institute	Number of Centers
Government	DTET	22
	NAITA	04
	NYSC	04
	Public-Other	09
	VTA	31
NGO	Private	04
Private	Private	13
Total		87

4.4.1. RAC sector training courses

Numerous vocational training institutes offer TVEC accredited NVQ level 3 to Level 6 courses in RAC. TVEC centres in all districts other than Mannar offer at least one L3 course in RAC. Vocational Training Centres in Colombo, Kalutara, Gampaha, Galle and Kurunegala offer the highest number of NVQ L3 courses. One NVQ L6 course is offered in Matara and Kurunegala districts. These Government-owned vocational training centres do not offer NVQ L1 and L2 courses. Total of 257 courses are offered by all the branches and these include, 171 NVQ L3 courses, 70 NVQ L4 courses, four NVQ L5 courses and two NVQ L6 courses (Figure 4.2). A summary of the active accreditation in the Refrigeration and Air Conditioning sector vocational training courses is provided in Table 4.4.

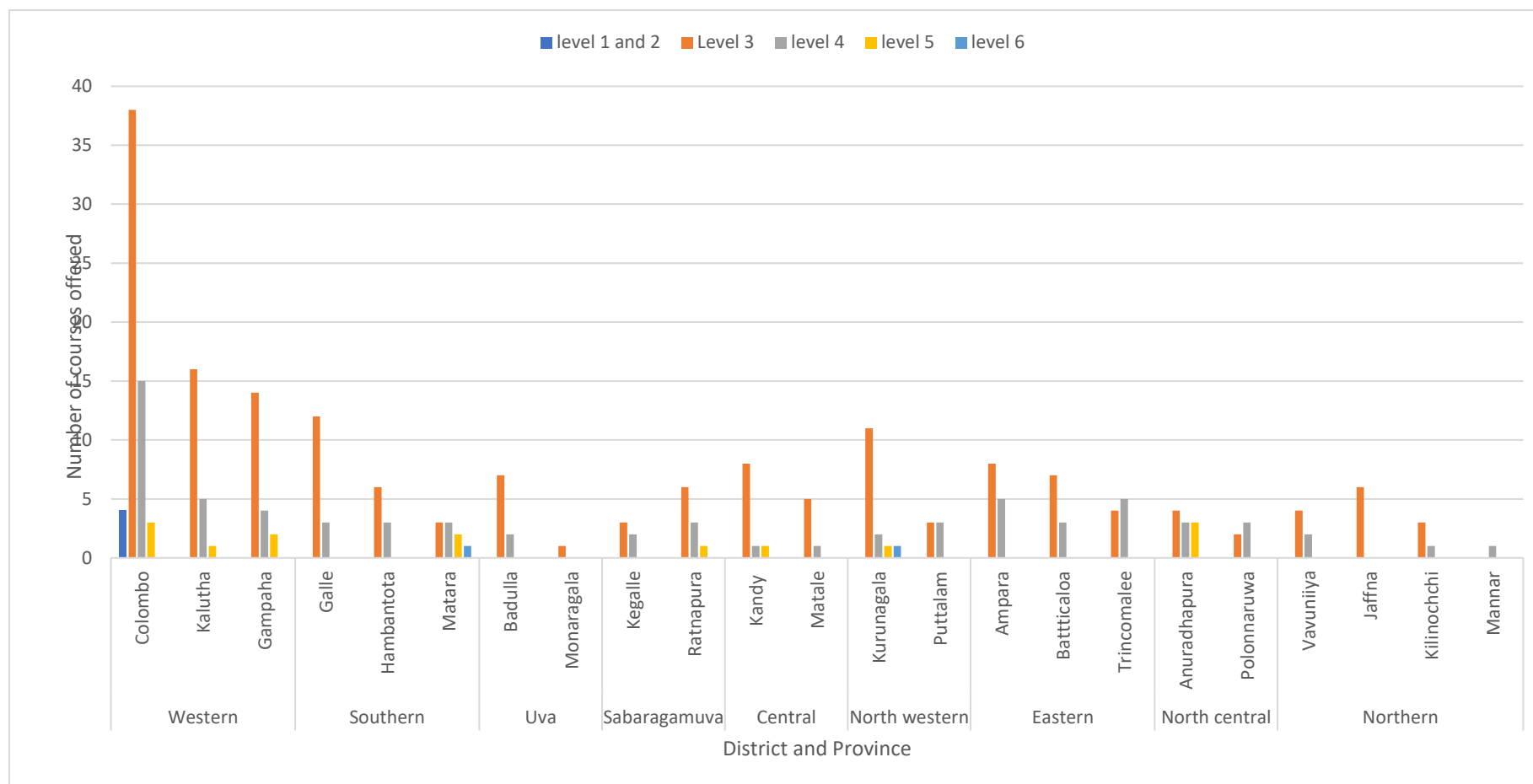


Figure 4.2: NVQ level courses offered by TVET centers

Source: Sri Lanka's TVET System. (2021). Department of Technical Education & Training - Publications. <http://dtet.gov.lk/en/download-categories/publications/>

Table 4.4: Active accreditation in the Refrigeration and Air Conditioning sector vocational training courses as of 31/07/2022

CODE	NCS	Ampara	Anuradhapura	Badulla	Batticaloa	Colombo	Galle	Gampaha	Hambantota	Kalutara	Kandy	Kegalle	Kurunegala	Matale	Matara	Monaragala	Polonnaruwa	Puttalam	Ratnapura	Trincomalee	Vavuniya	Grand Total
D29S002	Air Conditioning Mechanic	2		3	3	8	4	5	3	4	1	1	3	2		1	1	3	1	1	2	48
D29S002	Air Conditioning Technician	2		2	3	6	2	3	2	2	1	1	1	1			1	1	1	1	1	31
D29S002	Refrigeration & Air Conditioning Technician					2	1	2		1				1						1		8
D29S002	Refrigeration and Air Conditioning Mechanic					1																1
D29S002	Refrigeration and Air Conditioning Technician				1				1													2
D29S002	Refrigeration Mechanic	2		2	3	8	4	5	3	3	1	1	2	2		1	1	3	1	1	2	45
D29S002	Refrigeration Technician				1	3	1	2	2	1				1				1		1		13
G50S001	Automobile Air Conditioning Mechanic	1	1		1	4			1	2			2						1			13
G50S001	Automobile Air Conditioning Technician					1			1	1									1			4
G50S024	Automobile Refrigeration and Air Conditioning Technician										1											1
G52T001	Refrigeration and Air Conditioning Technology					2		1		1	1		1		1				1			8
Grand Total		7	1	7	12	35	12	18	13	15	5	3	9	7	1	2	3	8	6	5	5	174

Code represents the national competency standard. *Source: Tertiary and Vocational Education Commission.*

4.4.2. Student enrolments and completions

The issuance of NVQ L3 to L6 courses by vocational training institutes are shown in Figure 4.3. NVQ L3 courses appear to have the highest demand and completion rate. Table 4.5 further shows a breakdown of NVQ level certificates offered by course title.

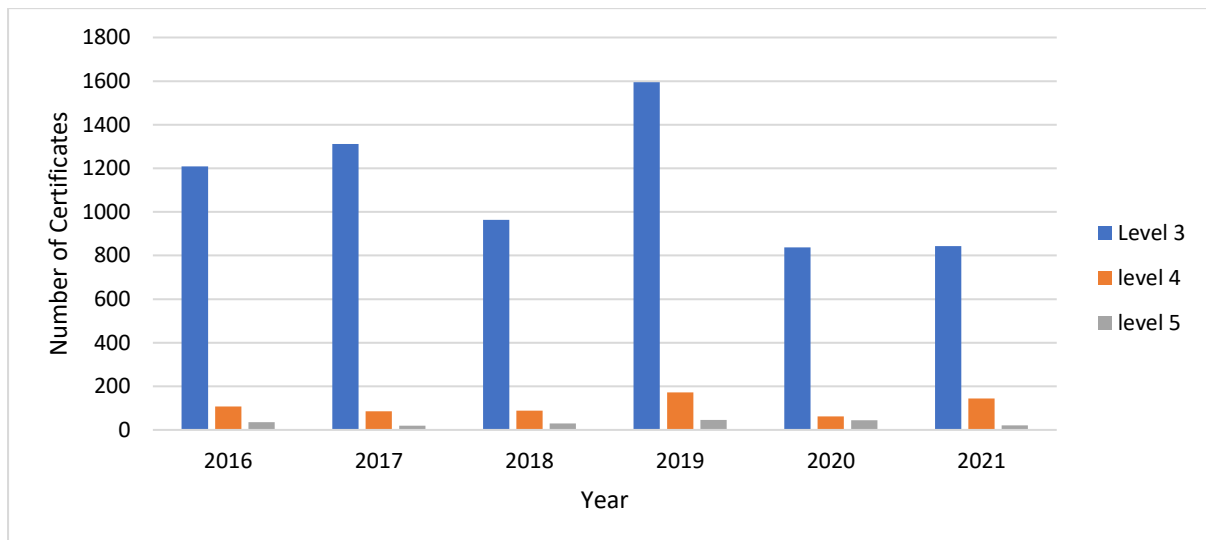


Figure 4.3: Issuance of NVQ Certificates in the RAC courses by NVQ level

Table 4.5: Issuance of NVQ Certificates (completions) in the RAC courses as of 31/07/2022

NCS	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022 (As of July)	Grand Total
Air Conditioning Mechanic				41	70	239	421	545	369	766	456	475	347	3729
Air Conditioning Technician									5	9	4	37	73	128
Refrigeration & Air Conditioning Technician													16	16
Refrigeration and Air Conditioning Mechanic	434	649	559	704	637	632	579	477	369	304	57	111	171	6497
Refrigeration and Air Conditioning Technician											3	2		5
Refrigeration Mechanic				40	73	172	316	374	310	688	379	360	316	3028
Refrigeration Technician												2	11	13
Automobile Air Conditioning Mechanic	69	44	19	58	53	86	133	151	284	294	182	184	196	1864
Automobile Air Conditioning Technician													18	18
Refrigeration and Air Conditioning Technology	9		21	6	5	19	36	19	29	46	55	21	14	280
	512	693	599	849	838	1148	1485	1566	1366	2107	1136	1192	1162	15578

Source: Statistical Handbook Technical Education (2017; 2018; 2019)

The demand for specific RAC sector NVQ courses appears to be growing. For instance, Table 4.6 displays the total annual enrolment for each RAC course offered by institutes registered under the DTET (Technical colleges and Colleges of Technology). The enrolments for certificate level courses are particularly high in Vavuniya District.

Table 4.6: Annual total enrolment for each RAC course offered by institutes registered under the DTET.

Course	Institute	Total Enrolment		
		2017	2018	2019
National Diploma in Refrigeration and Air Conditioning Technology (NVQ L5 and 6)	COT - Anuradhapura	54	56	43
	TC - Gampaha			19
	TC - Kalutara	19	30	22
	COT - Kandy	35	28	33
	COT - Ratnapura	36	29	19
	TOTAL	144	143	136
National Certificate in Engineering Craft Practice (Refrigeration & Air Conditioning Mechanic) (NVQ Level 3 and 4)	COT - Anuradhapura	18	12	13
	COT - Badulla	14	14	14
	TC - Balapitiya	16	12	6
	TC - Bandarawela	23	14	
	TC - Batticaloa	21	18	19
	TC - Beliatta			9
	COT - Galle	20	18	23
	TC - Gampaha	18	16	21
	TC - Hasalaka		7	
	TC - Homagama	13	18	10
	TC - Kalutara	15	12	14
	COT - Kandy	25	33	21
	TC - Kegalle	15	19	17
	TC - Kulupitiya	17		
	COT - Kurunegala			13
	COT - Maradana	19	17	14
	TC - Matale	10		
	TC - Matara	14	12	18
	TC - Polonnaruwa	15	18	18
	TC - Ratmalana	10	14	17
	COT - Ratnapura	22	20	17
	TC - Trincomalee	19		
	TC - Sammanthurai	11	14	12
	TOTAL	335	288	276
	COT - Anuradhapura	19	19	19

National Diploma in Technology and Education (Refrigeration & Air Conditioning Technology)	TOTAL	19	19	19
Certificate for Refrigeration and Air Conditioning Mechanics	TC - Matale		34	32
	TC - Vavuniya	37	50	39
	TC - Homagama	24		
	TOTAL	61	84	71

Source: Statistical Handbook Technical Education (2017; 2018; 2019)

When considering the student enrolments for NVQ level courses offered by the Technical Colleges, the demand for Diploma in RAC Technology (NVQ L5) and Certificate for RAC mechanic (NVQ L3 and L4) appears to be growing steadily (Figure 4.4). The enrolments for National Certificate in Engineering Craft Practice (RAC Mechanic) shows a declining trend. It appears that NVQ L3 and 4 courses have the highest demand.

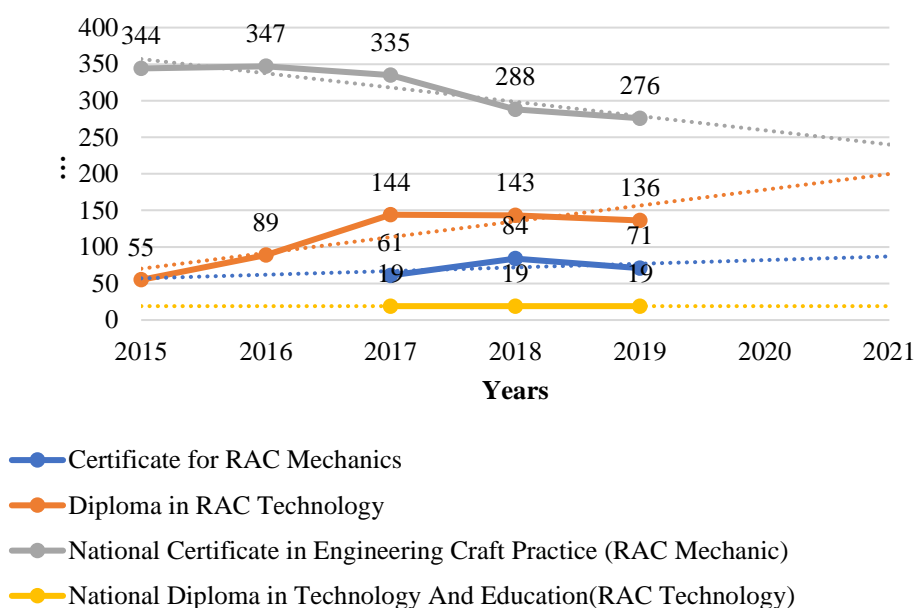


Figure 4.4: Enrolments for NVQ level RAC courses offered by institutes registered under the DTET,

4.5. The survey Outcomes from RAC Training Providers

To understand the RAC sector vocational training landscape, a sample-based survey of RAC sector training institutes and trainers (teachers) was undertaken. The survey was conducted among a representative sample of 38 training institutes. Annexure III provides a list of 38 training institutes contacted for the survey.

The majority of training centers in the sample was located in the Western Province. Furthermore, 100% of the training institutes in the sample are registered with the TVEC. The surveyed training institutes covered well established institutes as well as newly formed institutes (registered between 1979 and 2020). All the institutes surveyed are local training institutes, however, their ownership varies, as shown in Figure 4.5. Approximately 82% of RAC training institutes in the sample are publicly owned. Private and NGO owned training centers are accounted for 13% and 5% respectively.

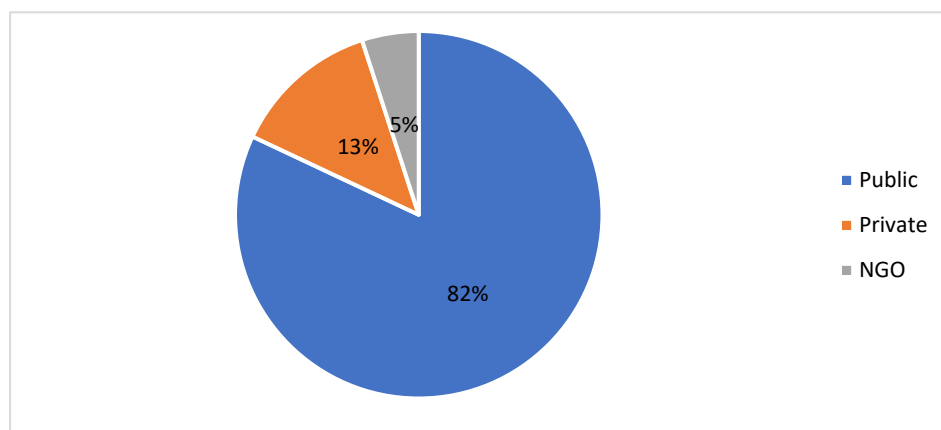


Figure 4.5: RAC training center composition by ownership

4.6 Courses offered in RAC.

4.6.1 Types of courses offered.

The education and training institutes captured in the sample provide different types of training courses varying from NVQ L1 to L6.

- NVQ 1-3 National Certificate Courses
- NVQ 4 National Certificate Courses
- NVQ 5 National Diplomas
- NVQ 6 Higher National Diplomas

NVQ 4 National Certificate courses were the most popular among various course offerings, where 18 out of the 38 RAC training institutions (48%) offered NVQ 4 National Certificate level courses. Almost half of the respondents offer NVQ 4 National Certificate Courses followed by NVQ 1-3 National Certificate Courses (35%). Only two training institutes offer NVQ level 6 and 5 courses.

Table 4.7: Percentage of course types offered by RAC training institutes

Type of course	No. of offering Institutes	Percentage
NVQ 1-3 National Certificate Courses	13	35%
NVQ 4 National Certificate Courses	18	48%
NVQ 5 National Diplomas	4	11%
NVQ 6 National Diplomas	2	6%

4.6.2 Number of courses offered.

The 38 institutes offered 49 different RAC related courses in the selected sample. NVQ 4 National Certificate courses were the most common RAC-related training type offered (Figure 4.6).

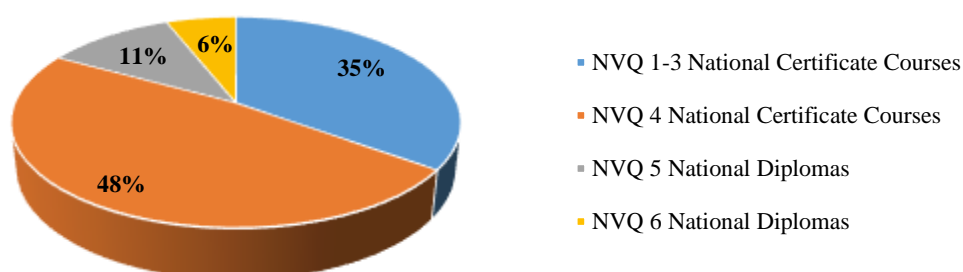


Figure 4.6: Proportion of NVQ level 1-6 RAC courses offered by institutes.

Entry-level qualification of the National Certificate of RAC Mechanic courses is “passes for six subjects in local GCE O/L examination” including Sinhala/Tamil, Mathematics, and Science. NVQ 1-3 National Certificate and NVQ 4 National Certificate level programs may be more popular among potential employees seeking job opportunities in RAC sector since they do not require stringent entry qualifications. On the other hand, the duration of these National Certificate Courses is 12 to 18 months, either on a full-time or part-time basis. Such short-term courses can be easily undertaken on a part-time basis by individuals who are already employed but looking for added qualifications in RAC.

Figure 4.7 indicates the course offerings by geographical region. Accordingly, the highest number of RAC courses are currently offered through vocational training centers registered in the TVEC.

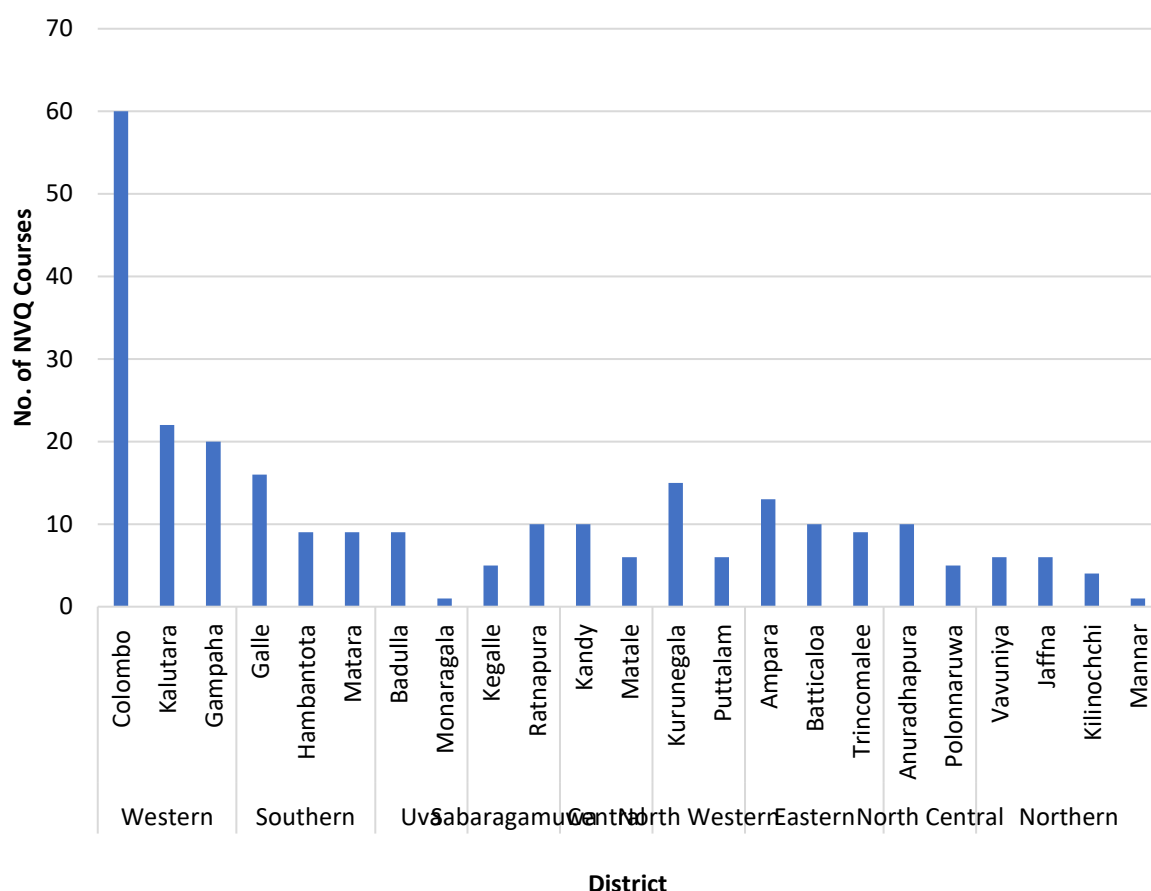


Figure 4.7: NVQ courses offered for the REF and AC sector-by district.

4.7 Course Structure and Content

4.7.1. In-plant Practical training

The institutes in the sample have their programs set to provide internal and or external training as well as on-the-job training along with teaching. NVQ level 4 courses are typically scheduled with on-the-job training component of 06 to 12 months. NVQ 1-3 level courses are designed with more internal training/theoretical training than external and on the job training (Figure 4.8). NVQ level 5 and 6 courses are designed with more on-the-job training to provide trainers with hands-on experiences in the RAC sector. On the job training is provided through internships or industrial training placements in RAC sector companies.

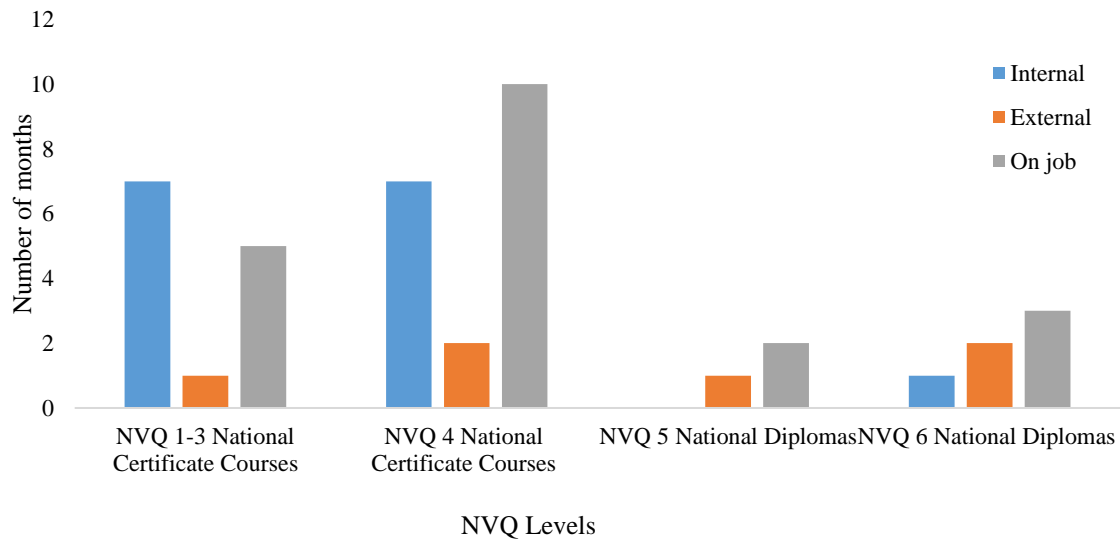


Figure 4.8: Structure of training

4.7.2. Refrigeration service-related courses

The following key areas were identified in the currently offered Refrigeration service-related courses, and these are listed below. NVQ L4 or above courses typically cover most of these components.

- A. Principles of refrigeration Systems and refrigerant types
- B. Montreal protocol, climate change and energy efficiency
- C. Component selection for repairs
- D. Handling, recovery and reuse of ODP refrigerants
- E. GWP and ODP levels of available refrigerants and their impact to the environment.
- F. Pinch and Brazing/ debrazing of pipes/ ports
- G. Performing leak tests (dry Nitrogen and soapy water)
- H. System Evacuation (perform vacuum and hold vacuum)
- I. Charging of refrigerant by weighing
- J. Checking performance
- K. Management of unwanted refrigerant
- L. Handling of tools and machinery related to refrigerant charging, recovery and storage etc.
- M. Retrofitting to alternative refrigerants
- N. Replacing of end-of-life ODS equipment to modern technological equipment

4.7.3 Air conditioning sector

The following key areas were identified in the Air-conditioner service-related courses, and these are listed below. NVQ L4 or above courses typically cover most of these components.

- A. Principles of refrigeration systems and refrigerant types
- B. Montreal protocol, climate change and energy efficiency
- C. Component selection for repairs
- D. Handling, recovery and reuse of ODP refrigerants
- E. GWP and ODP levels of available refrigerants and their impact on the environment.
- F. Flushing
- G. Choke testing
- H. Performing NVQ tests (dry Nitrogen and soapy water)
- I. Copper tube operations
- J. System Evacuation (perform vacuum and hold vacuum)
- K. Charging of refrigerant by weighing
- L. Checking performance
- M. Management of unwanted refrigerant
- N. Handling of tools & machinery related to refrigerant charging, recovery and storage etc.
- O. Retrofitting to alternative refrigerants
- P. Replacing of end-of-life ODS equipment to modern technological equipment

4.8 Curriculum revisions in line with the current and future RAC sector trends

Curriculum revisions are essential to enhance the relevance and quality of the courses offered in the RAC sector. When inquired about curriculum revisions, 50% of the respondents stated that the curriculum and training were revised in line to the new RAC trends, while the rest 50% have not done so. However, the TVEC, apex body of the training institutes, has done three major curriculum revisions in 2019 to revise the existing curricula considering the remarkable growth of the RAC sector internationally.

Qualitative analysis of the revised curricula revealed that the following key areas had been introduced within the last five years.

- **Green Technology for Refrigeration and Air conditioning**

Green Technology (GT) is the application of one or more of environmental science, green chemistry, environmental monitoring, and electronic devices to monitor, model and conserve the natural environment and resources and to curb the negative impacts of human involvement. Many GT aim to reduce emission of carbon dioxide and other greenhouse gases in order to prevent climate change. .

- Variable Refrigerant Volume (VRV)/ Variable Refrigerant Flow (VRF) System
- Inverter Technology
- Motor control systems (DOL)
- Single and three phase wiring system.
- Refrigerant recovery

About 60% of the institutes have professional partnerships for job placements of passed out students, with organizations and companies.

4.9. Specific skill requirements for foreign jobs in RAC sector

In most freeing markets, Heating, Ventilation, Air Conditioning and refrigeration (HVAC & R) are collectively considered under this profession the key labor markets for HVAC demand specific skills in recruitments. These requirements for selected markets are summarized in Table 4.8.

Table 4.8: Specific skill requirements in selected foreign RAC job markets.

Job Category		Dubai - United Arab Emirates	Korea	India	Singapore	USA
Project Engineer - HVAC	Experience	10 - 15 Years (preferably in the Gulf region) Work experience in large scale projects (Malls, Hospitals, High rise buildings)	1 to 7 years 5 years of related and progressively more responsible experience in Mechanical Engineering field Major in related department or related experience	Minimum 10 years of experience		
	Education	Bachelors in mechanical engineering or relevant field.	Bachelor's degree in mechanical or architectural Engineering from an accredited university	Primary degree in Mechanical Engineering	Primary degree in Mechanical Engineering	Bachelor's degree in mechanical engineering
	Key skills	Good communication skills. Leadership personality. Driving license HVAC equipment commissioning and troubleshooting. Equipment inspection and preparation of construction documents Project management	Good command in the language Maintenance and replacement of chillers, air conditioners (AHU), and other HVAC equipment HVAC service engineering (PSA, L&M, Retrofit) HVAC equipment commissioning Equipment inspection and completion document preparation Service parts management Emergency service request response	Pharma HAVC design Project delivery HVAC system Load and system calculations. HVAC system modelling. Hydraulic analysis of air and water systems. Conceptual and detailed design of HVAC systems. Development of system schematics through all design stages.		

			<p>Technical sales support</p> <p>Installation and commissioning of chillers, air conditioners (AHUs), and other HVAC equipment</p> <p>Project Management</p> <p>HVAC equipment commissioning and troubleshooting.</p> <p>Equipment inspection and preparation of construction documents</p> <p>Sales reporting and management</p> <p>Emergency service request response</p> <p>MS Office and ACAD user</p> <p>Driver's license holders</p> <p>LEED Accredited Professional preferred</p> <p>Must have proficiency in Korean language (speaking, reading, writing)</p> <p>Proficiency with Revit, AutoCAD and Trane Trace 700</p> <p>Excellent written and verbal communication</p> <p>Strong attention to detail</p>	<p>Formulate and lead design of mechanical systems including HVAC, piping, plumbing, and fire protection</p> <p>Perform and/or review calculations, formulate design of mechanical systems including HVAC, piping, plumbing, and fire protection</p> <p>Create engineering documents using computer aided design (CAD) technology utilizing Autodesk (Revit and AutoCAD)</p>		
HVAC Supervisor	Experience	<p>Over 7 years of experience in the sector</p> <p>About 5 years' experience in the Gulf region</p>	<p>Minimum of 10 years-complex HVAC-R systems and have worked at the master's level for 5 of those 10 years.</p>			<p>8+ years of progressive experience as a technician/-6 years of relevant experience and 0-2 years of leadership / management experience, required. Prior experience managing technicians or employees in a similar role</p>
	Education	<p>Bachelor of Technology/Engineering (Electrical, Mechanical)/Diploma</p>				<p>4 Year Bachelor's Degree</p>

		(Electrical/ HVAC Mechanical)/ Bachelor's degree of Mechanical Engineering				
	Key skills	Knowledge on Auto Cad and worked on Designing. Professional knowledge on Microsoft applications. Driving License/ability to drive to locations and perform repairs.	Related experience, with large water chiller systems, cooling towers, CBRNE filter systems, smoke evacuation systems, CO2 scrubbing systems, automated intake louvers and screens, Direct Digital Control (DDC) systems, and calibrating Building automation sensors. Good command in the language			
HVAC Technician	Experience	2 to 5 Years' experience Operation & maintenance experience in a facility maintenance.	Minimum 5 years		Minimum 2 years	
	Education	Graduation/Diploma (Electrical, Mechanical)/ Diploma in HVAC/ mechanical/ electrical with OR ITI in HVAC			NITEC in Electrical or Mechanical Engineering or equivalent	

(Source – Sri Lanka Bureau of Foreign Employment, verbal communication with foreign agencies 2022)

It is apparent that specific skill demands for specific RAC job categories are not fully covered in the existing curricula of RAC training courses. The highly demanded NVQ Level 4 RAC course curriculum does not include modules on Heating and Ventilation at present. NVQ Level 5 and 6 course curricula include a single module on ventilation with no separate modules to cover heating systems. Hence, to fully exploit the existing foreign labor markets, it is necessary to consider integrating modules in 'heating and ventilation systems' in respective curricula. Essential aspects in 'heating systems and maintenance shall include Building regulation requirements, thermal comfort & loads, heat flow, design, heat generation and distribution, heat emitters, operation, control and maintenance. Essential aspects to cover under ventilation systems shall include behavior of air and chemical contaminants in the air, make-up and supply air ventilation systems, dilution ventilation systems, selection and design of exhaust hoods,

ducts, and fittings, fans and air cleaners (including Fan Laws), basic troubleshooting ventilation system techniques.), basic troubleshooting ventilation system techniques.

4.10 Training Facilities

Training facilities are essential to provide productive training for the trainees and trainers. During this survey, questions were included in the questionnaire to assess the training facilities in terms of physical, human, and financial resources available within the education or training institutes. The satisfaction levels of the respondents with the existing learning environments are indicated in Table 4.9. Although most respondents were satisfied with general training facilities, availability of training equipment, availability of expert trainers outside the institute (during in-plant training) were identified as areas for improvement. Specialized equipment/facilities to demonstrate and experience new technologies in RAC are particularly limited.

Table 4.9: Views on the training facilities available within the premises

How satisfied are you?		Very satisfied (%)	Satisfied (%)	Neutral (%)	Dissatisfied (%)	Very Dissatisfied (%)
1	Physical Resources	42.3	34.6	23.1	0	0
	a. Availability of a place within the company/ institute premises					
	b. Availability of training materials/equipment	26.9	40.2	19.2	6.0	3.8
2	Instruction	34.6	38.5	26.9	0	0
	a. Availability of expert trainers in your company/institute					
	b. Availability of expert trainers outside the institute	26.9	46.2	19.2	7.7	0
3	Financial facilities	34.6	26.9	15.4	3.8	26.9
	Allocation of enough financial aids for training sessions					

The majority of training centers are equipped with facilities needed to conduct their programs (from trainer perspective). However, the majority of institutes did not have student support facilities such as scholarships or providing accommodation for outstation students (Table 4.10).

Table 4.10: Other facilities for students

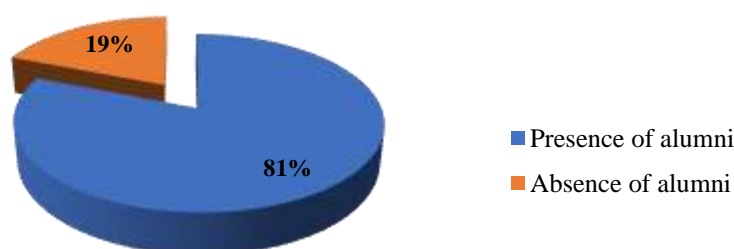
Facility Attribute	Yes (%)	No (%)
Providing workshop facilities for training	84.6	15.4
Providing computer facilities	76.9	23.1
Conducting necessary field visits	92.3	7.7
Following a mechanism for job placement for the passed-out students	88.5	11.5
Implementing career guidance programmers	96.2	3.8
Provide scholarships	46.2	53.8
Providing accommodation for outsiders/outstation students	11.5	88.5

According to the results, more than 60% and 80% of the respondents/students are very satisfied and satisfied with the available physical facilities and human resources, respectively, which can be considered a positive aspect. However, the respondents were dissatisfied with the financial aid available for trainees. Around 77% of the institutes provide laboratory facilities to the students, and about 85% offer computer laboratory facilities. About 93% of the institutes conduct necessary field/plant training. Nearly 89% of the institutes follow a mechanism for job placement for the students passing out from the institute. Approximately 96% of the institutes maintain career guidance programmes for students. However, only 46% of the institutes offer scholarships. About 12% of the institutes provide accommodation facilities to the students enrolled.

4.11. Alumni and networking

Communication and engagement with alumni are vital to help students find employment opportunities and improve their landing a job offer. Therefore, the questionnaire also explored the presence of alumni networks associated with the training institute (Figure 4.9).

Of the 81% of training institutes with the alumni network, the majority (80%) offer support finding RAC-related job opportunities, mainly by collaborations with other companies.

**Figure 4.9: the presence of alumni networks associated with the training institute.**

4.12 Type of new RAC related courses expected to offer in the future

The questionnaire also aimed to gather information on future developments in RAC education and training. The respondents were asked about their willingness to offer or continue offering RAC-related courses in the future. About 60% of respondents indicated their willingness to offer RAC courses in the future. Furthermore, 50% of respondent training institutes are planning to expand the current RAC courses and programs in the future, which is a positive outlook on the prospects of the RAC sector. The potential future courses planned to be implemented by the respondent institutes are listed below.

- National Certificate in Engineering Craft Practice (refrigeration & Air Conditioning Mechanic) – NVQ level 4
- National Diploma in Refrigeration and Air Conditioning Technology – NVQ level 5
- Higher Diploma in Refrigeration and Air Conditioning – NVQ level 6

4.13 Professional qualifications of trainers

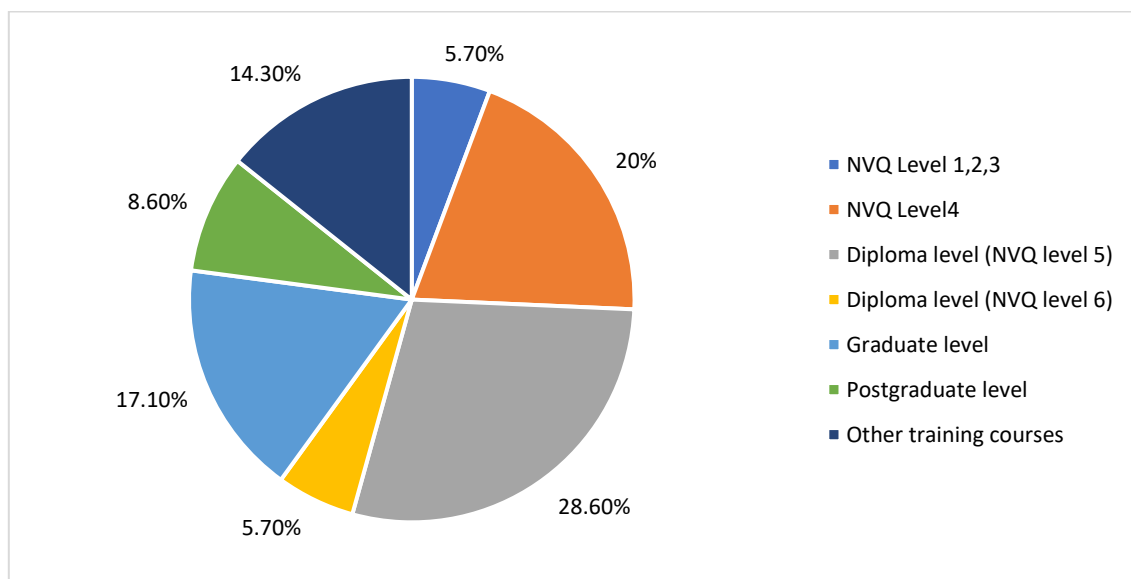


Figure 4.10: Highest professional level completed by RAC sector trainers/teachers.

The survey of the trainers also aimed to collect information on the professional levels of the trainers conducting Refrigeration and Air Conditioning courses. Figure 4.10 depicts the professional levels completed by the trainers (such as national certificate, national diploma, other training, graduate, and postgraduate levels). According to the survey findings, NVQ 4 and NVQ 5 are the most commonly acquired professional qualifications. The NVQ level 5

national certificate course is the most common (28.6%) professional qualification the trainers have obtained.

The proportions of the RAC employees who participated in the various CPD courses have been mentioned in section 3.5. Comparatively higher proportions of the trainers participated in the same CPD courses. According to Figure 4.11, around 46% have participated in the CPD courses conducted by government authorities and private sector companies, followed by about 36% in the CPD courses conducted by government authorities only. In contrast, only a minor amount (18%) is practicing as freshly recruited trainers with the initial level of qualifications in the RAC training sector.

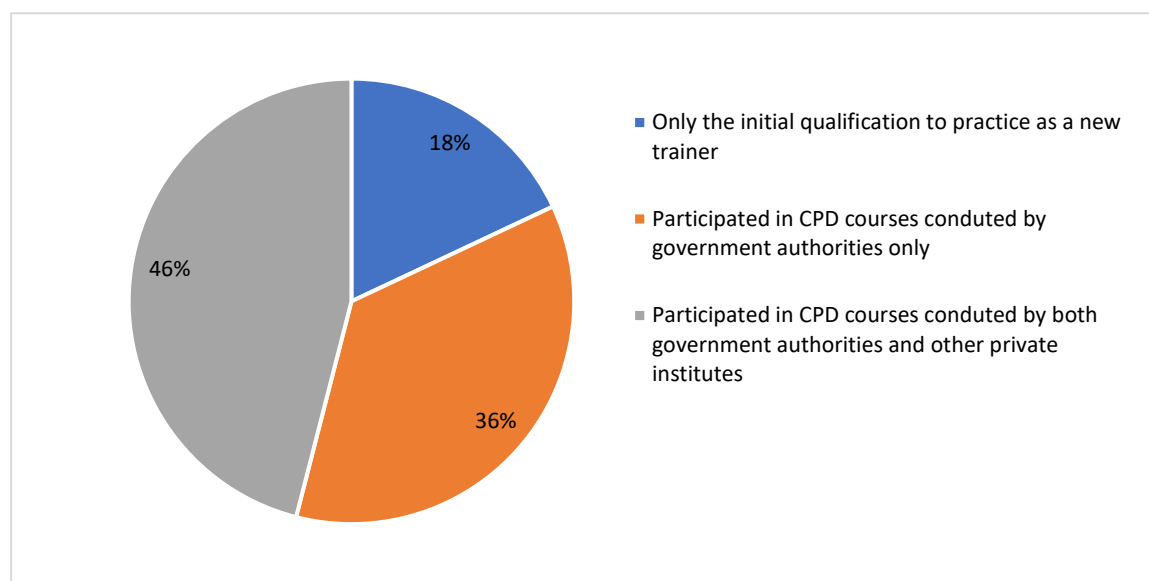


Figure 4.11 Participation in professional and continuous training programs by RAC sector trainers/teachers

4.14 Specified subject areas of the trainers conducting training program in the RAC sector.

A sample of trainers who were selected for the current study in the RAC training sector is specified for different subject areas as depicted in figure 4.12. Accordingly, the percentage of trainers (30%) delivering the lectures in Maintenance and servicing of refrigerators, domestic ACs, industrial ACs was the highest. Although trainers delivering training on good practices in RAC and MAC services was 10%, there was zero response for conducting training on Refrigerant handling, recovery and recycling.

Sri Lanka has taken national decision on recovery and reuse of refrigerant in order to phase out certain refrigerant and reduce the usage Refrigerant handling, recovery and recycling should be an integral part of programs offer. Furthermore, the trainers specified for conducting training

on “Introduction to inverters and Variable Refrigerant Volumes (VRVs)/Variable Refrigerant Flow (VRFs)” and “Repairing refrigerator, deep freezers, display units, bottle coolers and water coolers” recorded similar percentages (10%) in the sample. Zero responses were received for replacing components in high and low pressure, installation of AC, welding techniques and basic workshop training for RAC sector. Study findings reveal the gaps in the courses offer.

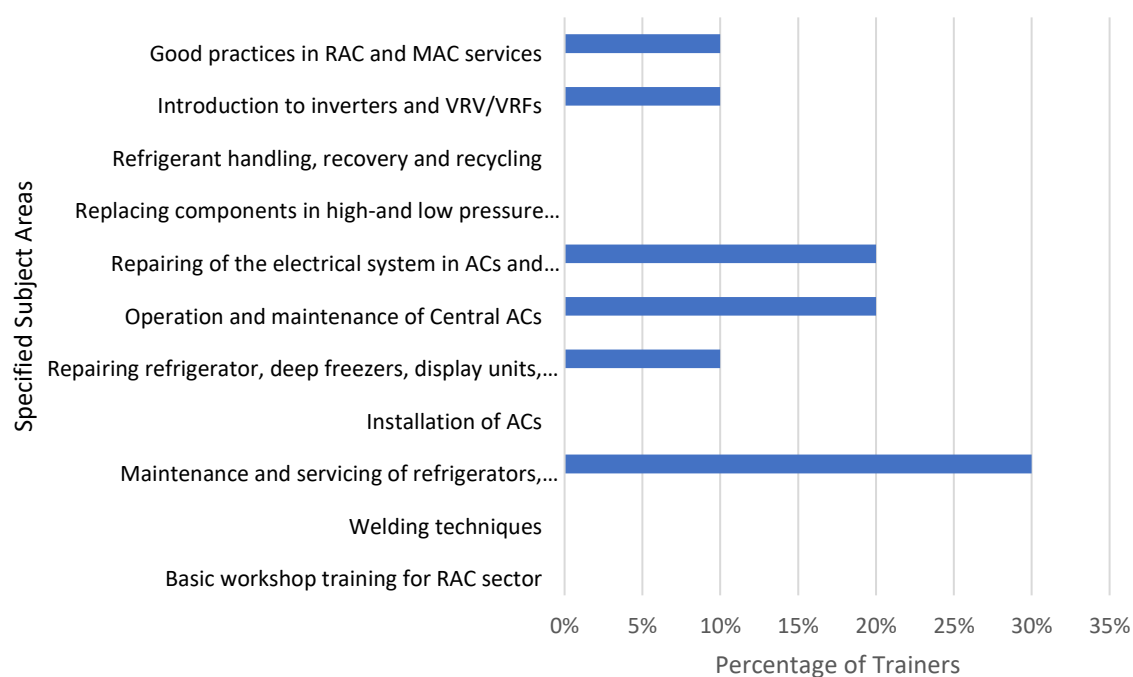


Figure 4.12: Subject areas taught by RAC sector trainers/ teachers.

4.15 Experience of the trainers in the RAC sector

Figure 4.13 depicts the level/years of experience in the profession of RAC service sector trainers. A higher percentage (55%) of trainers were found to have more than 20 years of experience in the RAC sector. About 15% of trainers had 6 to 10 years of experience in the RAC sector.

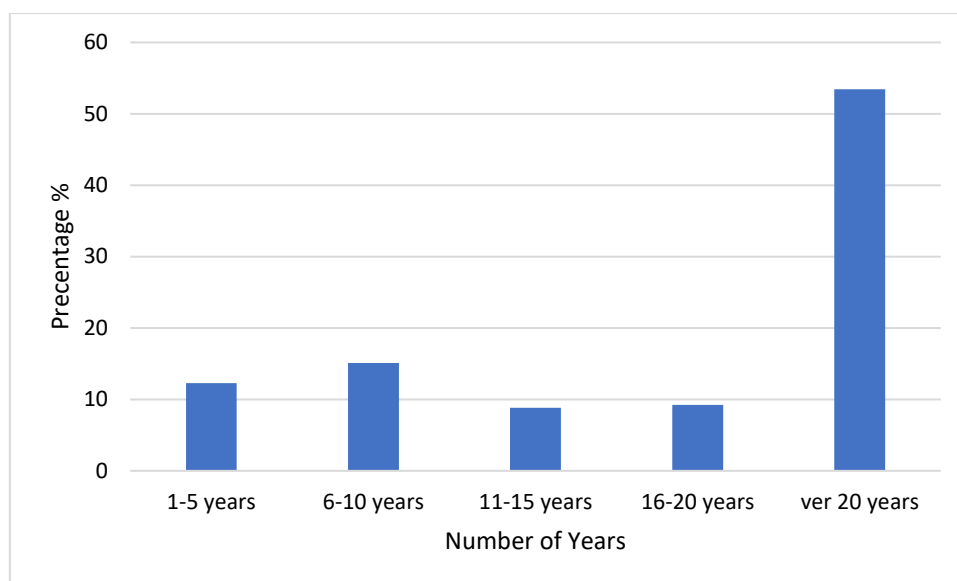


Figure 4.13: Years of experience in the profession of RAC service sector trainers

4.16 Student to trainer ratio

Number of students newly enrolled for RAC courses and number of instructors teaching RAC courses in leading training institutes Sri Lanka during last 6 years are indicated in Table 4.11. The student to trainer ratio at VTA training centers varies from 13 to 19 while the same ratio at DTET training centers varied from 16 to 31. CGTTI institutes has the lowest Student to trainer ratio.

Table 4.11: Student enrollments and student to trainer/teacher ratios at vocational training institutes

Year	Institute	No of centers	No. of students registered for RAC courses	No. of instructors teaching RAC in the institution
2016	DTET	21	436	23
2017		21	529	25
2018		20	439	25
2019		20	484	25
2020		20	671	25
2021		24	719	23
2016	CGTTI	01	50	8
2017		01	48	8
2018		01	54	8
2019		01	54	8
2020		01	50	8
2021		01	60	8
2016	VTA	32	605	32

2017		35	658	33
2018		32	620	33
2019		32	604	33
2020		27	511	34
2021		28	565	34
2016	NYSC	05	310	05
2017		05	286	05
2018		05	272	05
2019		05	252	05
2020		04	136	04
2021		03	97	03
2016	NAITA	04	630	04
2017		05	483	04
2018		04	459	04
2019		03	433	04
2020		04	364	04
2021		03	296	04

4.17. Anticipated trends in demand for RAC courses

Based on the responses received in the sample-based survey of RAC sector training institutes, the trends in enrolments for RAC courses offered by different institutes are depicted in Table 4.12. The mean student enrolment for RAC service sector training courses was 2105 students per year. Accordingly, the demand/student enrolments for RAC courses offered by different institutes for the future (next five-year period- 2025) is estimated as 10525 (Table 4.12).

Table 4.12: The mean student enrolment for RAC service sector training courses

Institute	Number of average students per year (2016-2021)	Number students for the next five years
CGTTI	53	265
DTET	546	2730
NAITA	444	2220
NYSC	226	1130
University College	30	150
VTA	594	2790
Private	212	1060
Total	2105	10525

When considered the existing curriculum in NVQ level RAC courses, expert consultations revealed that the most appropriate student to trainer ratios to effectively deliver a vocational training course are.

- NVQ L1-3L: 1 trainer to 15 students
- NVQ L4: 1 trainer to 15 students
- NVQ L5 – 6: 1 trainer to 25 students

Thus, the recruitment of qualified trainers in the RAC is necessary to cater the future demand.

4.18 Difficulties faced by the trainers while conducting the RAC courses and their suggestions for improvement.

Table 4.13 lists the difficulties and the suggestions given by trainers during the survey conducted among the RAC trainers who are currently delivering lectures and conducting training sessions for the RAC trainees in the tertiary training institutes in Sri Lanka.

Table 4.13: The difficulties faced and the suggestions to improve the RAC courses by the trainers

Difficulties	Suggestions
I. Lack of adequate workshop facilities, classroom facilities.	I. Improve workshop facilities and equipment/ materials.
II. Lack of equipment and materials for training.	II. Provide more training opportunities to trainers and students who are passing out.
III. Recruitment of apprentice who do not have adequate minimum qualifications.	III. Maintaining on NVQ level 4 course with all facilities for several NVQ level 3 courses and admitting only qualified NVQ level 3 students.
IV. Accreditation for higher NVQ levels without proper facilities.	IV. Course units on new technologies should be included in syllabus and provision of facilities. Strengthening accreditation system
V. Influencing top officers that all recruits (trainers and other supportive staff) at least should have NVQ level 4	V. The syllabus should contain the repairing, handling and maintenance of following equipment; package A/C, small central chillers and cooling towers.

VI. There are no training units to transfer knowledge about new technologies.	VI. Establishment of two or three training institutes only for the RAC sector and improve the facilities of that institutes.
VII. Though some course units cover the refrigerant recovery technologies there is insufficient resources for a proper training.	VII. Provide module-based training.
	VIII. Encourage students to follow the course with the same interest as training, because for an overall outcome knowledge and the experience is equally important.

4.19 Issues raised during KIIs and FGDs

During the key informant interviews and focus group discussions, the following matters were raised, which are worth considering in VET plan development.

- An unfavorable economic background, poverty-induced family issues and other personal issues cause students to drop-out from vocational training courses. As a solution, incentive schemes, allowances and payment/salary during in-plant training shall be arranged.
- At present, there is no uniform criteria in enrolling students into vocational training courses as some vocational training institutes recruit students with insufficient qualifications and motivation in order to continue their courses with minimal number of students. Some students enroll in courses without motivation, desire to continue or little information. To recruit highly motivated and determined students who wish to make a career out of the RAC training, an aptitude test or alike can be recommended, so that the best student group can be recruited. Stringent entry requirements shall be enforced across all registered training institutes.
- To enhance the employability and impart required skills on students, minimum duration for RAC service-related training courses of different NVQ levels shall be introduced. Length of the In-plant training in L4 courses shall be increased to at least 10 months with proper supervision and mentoring schemes in place. In-plant training in L5/6 courses shall be increase to 12 months.

- To update the knowledge of trainers and expose them to latest technologies, RAC trainers shall be given 2-to-4-week paid leave and place them in private sector industries where they can learn new technologies.
- At present, limited or no physical resources are available in most training centers to teach/train students on specialized RAC sectors such as servicing of freezer trucks and chillers.
- The skills knowledge and competencies required by the industry for a RAC technician locally and globally are
 - Health and safety skills Selection and operation of tools and equipment
 - Safe and appropriate use of materials
 - Install heating and cooling and ref equipment.
 - Perform basic maintenance and service
 - Perform a system inspection
 - Perform repairs and servicing
 - Perform preventative maintenance procedures
 - Perform maintenance related to different area related concerns
 - Understand and use theory applied to operating systems
 - Communicate and work with peers, employers, and customers
 - Think logically and make decisions
 - Work independently or as part of a team
 - Demonstrate the ability for life-long learning to enhance the skills
 - Manage time
 - Demonstrate mechanical aptitude and manual skills
 - Solve problems
 - Demonstrate employability skill
 - Advancement, technological progression, and emerging trends related to RAC.

Hence these aspects should be prioritized in curriculum restructuring.

4.20. Key Highlights

- There are approximately 85 government, private or NGO-owned educational and vocational training institutions that offer vocational training courses in refrigeration and air conditioning.

- Numerous vocational training institutes offer Tertiary and Vocational Education Commission accredited NVQ level 3 to Level 6 courses in RAC, and these are available in most districts. Vocational Training Centers in Colombo, Kalutara, Gampaha, Galle and Kurunegala offers the highest number of NVQ L3 courses.
- About 60% of the institutes have professional partnerships for job placements of passed out students, with organizations and companies.
- The enrolments for RAC sector training courses have remained more or less the same for the last five years and the demand/student enrolments for RAC courses for the future (next five-year period)- 2026) is estimated as 10525 at an average of 2105 student/year.
- Student to trainer ratio at VTA training centers varies from 13 to 19 while the same ratio at DTET training centers varied from 16 to 31.
- The desired student to trainer ratios to effectively deliver a vocational training course are 1:15 for NVQ L1-3 courses, 1:15 for NVQ L4 courses and 1:25 for NVQ L5/6 courses.
- To enhance the employability and impart required skills on students, minimum duration for RAC service-related training courses of different NVQ levels shall be introduced. Length of the In-plant training in L4 courses shall be increased to at least 10 months with proper supervision and mentoring schemes in place and the In-plant training in L5/6 courses shall be increased to 12 months.
- At present, limited or no physical resources are available in most training centers to teach/train students on specialized RAC servicing such as servicing of freezer trucks and chillers.

Chapter 5

SITUATION ANALYSIS AND GAP ANALYSIS

5.1. Introduction

The availability of workers and enterprises with the right skills for RAC service sector jobs plays a critical role in triggering the green transformation and facilitating transitions that enhance the efficiency of the sector. RAC employees investing in new green technologies need to be able to find workers with the right skills. Based on the current and future trends in the RAC sector industry, training and employee profiles, and other information gathered through surveys and secondary data, this chapter critically evaluates the present status of Sri Lanka's RAC sector and presents the outcome of the gap analysis.

5.2. SWOT Analysis of the RAC Training Sector

SWOT (strengths, weaknesses, opportunities, and threats) analysis is a framework used to evaluate a company/industry's competitive position and to develop strategic planning. SWOT analysis assesses internal and external factors, as well as current and future potential. A SWOT analysis pulls information internal sources (strengths of weaknesses of the specific company) as well as external forces that may have uncontrollable impacts to decisions (opportunities and threats).

Effective Training Plan preparation requires a clear understanding of the strengths, weaknesses, opportunities, and threats of Sri Lanka's RAC sector. Hence, a SWOT analysis was performed to facilitate a realistic, fact-based, data-driven look at the strengths and weaknesses of the RAC training sector in the country, considering the changing future technological and regulatory landscape. This is outlined in Figure 5.1.



Strengths

- Growing human resource base with primary or secondary education
- The growth of the HR profile every year through NVQ qualifications.
- Availability of standardized, accredited courses from NVQ 3 – NVQ 6, in 85 centers across the country.
- On-the-job training options
- Ratified and secured system through various international policies and protocols.
- Diversified skill and employment profiles.



Weaknesses

- The lack of skilled workforce for the growing demand in the sector
- Gaps in coordination, monitoring, quality assurance and review in implementing the accredited courses.
- Lack of modern equipment and state-of-art facilities in the technical institutions.
- Post recruitment training and KPI setting in the industry is reportedly low
- Gender bias in employment and enrolment (97% males).
- Student to trainer ratio is greater than the recommended ratio of 1:15
- Lack of uniform student recruitment criteria
- Lack of student support
- Insufficient training of trainers, failure to recruit and retain quality trainers
- Lack of novelty themes in the current curriculum.



Opportunities

- **The local and foreign demand for RAC service technicians** is expected to grow
- Availability of foreign employment opportunities.
- Emerging sectors would create more than 7,000 job opportunities in the 5 years.
- About 60% of the institutes have professional partnerships for job placements of passed out students, with organizations and companies.
- Growth of the customer industries (construction, engineering) which would create opportunities in the RAC sector.
- Collaborative opportunities with the private sector for effective industry training and to upgrade skills of trainers
- New jobs such as Reefer man/Reefer Technicians in the Refrigeration industry



Threats

- **Lack of public awareness about the available courses with minimum entry requirements.**
- Low awareness of stakeholders in the sector regarding modern technological advancements and future/trends.
- Unauthorized practices carried out by the informal sector causes issues in reliability and credibility.
- Inflation and economic crisis affecting the import of essential tools and equipment
- Possibility of shrinking of the RAC industry due to import restrictions and economic recession
- Recruitment of demotivated students leading to increased drop-outs
- Trainers less motivated to participate in continuous skill enhancement programs
- Absence of formal instructor qualifications in teaching knowledge at RAC VET centers periodically.

Figure 5.1: SWOT analysis

5.3 The Gap Analysis

Gap Analysis involved comparing the RAC sector's current situation/performance with potential or desired performance. This tool was employed to identify key gaps that hinder the effective development and delivery of vocational training in the RAC sector. This Gap Analysis was mainly based on industry surveys, employees, RAC training providers and trainees, and focus group interviews. Interviews and focus group questions drew upon structured, semi-structured, and informal discussions with key stakeholders from the state and private sectors actively involved in RAC sector workforce development. The Gap Analysis identified several core gaps relevant to vocational education training in the RAC sector (Table 5.1). Figure 5.2 further summarizes the key gaps pertaining to the labor force, industry and the training institutes/trainers.

Table 5.1: Gaps of RAC sector

Gap 1	Issues with quality and relevance of RAC course contents	<ul style="list-style-type: none"> • Numerous state and private sector institutions are currently offering training programs in RAC. State institutes include advanced technical colleges and institutes attached to various Government Departments. As described in previous chapters, course objectives, learning outcomes, course curricula, duration, the composition of theoretical components, and practical training components show a similarity, even when different institutes offer a particular training course in the same field. • The TVEC has developed National Competency Standards for RAC professions. • There is a need for curricular revisions for some areas such as handling novel refrigerants, new technologies associated with inverter systems, and systems repairing in the Centralized ACs, which are outlined under national certificate courses in RAC. • With the GOSL aiming to phase out HCFC and HFC emissions in the RAC sector, training on the recovery and recycling of refrigerants becomes part and parcel of the tasks at all skill levels. Hence, such training also needs to
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		<p>be incorporated into many existing lower-skill level RAC professions. On the other hand, although the TVEC has revised the existing competencies and the curricula, some trainers are not aware or satisfied with the modified content.</p> <ul style="list-style-type: none"> • Building automation / Building Management systems by which we the operations of Chillers, pumps, cooling towers, AHU, and other HVAC equipment are automated in order to get maximum efficiency are currently given less weight in training programs. • TVEC and NAITA revise NCS and curricula every 3 years taking into account the new developments in the RAC sector. However, there are gaps in delivering the revised curricula through VTEC centers. There is a poor enrollment of students for some of the courses with revised NCS and Curricula.
Gap 2	Limitations in focus on imparting employability skills	<ul style="list-style-type: none"> • As evident in survey results, a variety of institutions are currently offering vocational training courses in RAC. However, many training institutions and courses lag in effectively imparting employability skills/practical skills/hands-on training despite satisfactorily delivering theoretical knowledge. On the other hand, vocational training is strongly focused on imparting the necessary competencies required for a profession. This existing disparity between RAC training courses and actual skill requirements in the job market is a crucial gap that should be addressed immediately through course restructuring. • Despite students getting placements in the industry after completing qualifications, the industry is not fully satisfied with skill levels of their recruits to perform the expected

		<p>tasks especially in areas where the technology is rapidly evolving.</p> <ul style="list-style-type: none"> • The formal and large-scale RAC service firms prefer technicians with formal training (at least NVQ L3 and preferably L4), hence the student enrolment gap for higher skill level courses needs to be bridged. • Informal interviews with potential RAC sector stakeholders revealed that their new employees, specifically at lower levels, had insufficient skills to undertake RAC-related work, especially recovery and recycling refrigerants. As such, employers have to provide short-term internal or on-the-job trainings for their new recruits. Hence, the relevance and focus of new RAC-related training courses should be based on market requirements. However, the SMEs and informal service providers in RAC tend to prefer/recruit unskilled labor and train them on the job under a qualified technician. • Stakeholder consultations and employee surveys further revealed a high demand for qualified RAC technicians in the foreign labor markets. The technicians produced from current training centers cannot fully meet the qualifications in such markets. This is primarily due to the RAC sector in many temperate countries requiring training in broader scope. For instance, “Ventilation and Heating systems” are not discussed in local curricula. Hence, there is a need to include such components into the curriculum to cater to foreign labor markets. • Language barriers, poor soft skills (communication, and interpersonal skills, lack of workplace orientation) weaknesses in course structures (learning objectives, outcomes, learning hours and practical training and self-learning hours clearly specified with respect to each skill level offered by the course), weaknesses in accreditation of
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		<p>courses further contributed to widen the demand and supply gap for foresing RAC service sector jobs.</p> <ul style="list-style-type: none"> • To enhance the employability and impart required skills on students, minimum duration for RAC service-related training courses of different NVQ levels shall be introduced. • Pre-employment training opportunities are currently limited.
Gap 3	Lack of Resources for effective delivery of RAC service sector training	<ul style="list-style-type: none"> • Information from the training institute survey revealed that not all have the required physical training facilities to deliver effective RAC training. For instance, it was revealed that only the Ceylon German Technical Training Institutes has state-of-the-art facilities for RCA training. Thus, the industry has higher preference for technicians graduating from such institutes. • If improved and modernized RAC training programs are to be introduced through the vocational training centers, the existing facilities may need to be upgraded to facilitate practical trainings. Such new course development and facility upgrading will require adequate financial resources from government and other sources. • Although most respondents were satisfied with general training facilities, availability of training equipment, availability of expert trainers outside the institute (during in-plant training) were identified as areas for improvement. Specialized equipment/facilities to demonstrate and experience new technologies in RAC are particularly limited in relation to: <ul style="list-style-type: none"> ○ Chillers/central ○ Cooling towers, AHU ○ Freezer trucks • Absence of student support schemes - Unfavorable economic background, poverty-induced family issues and

		<p>other personal issues cause students to drop-out from vocational training courses.</p>
Gap 4	<p>Lack of industry, worker and public awareness on emerging trends and opportunities in the RAC sector</p>	<ul style="list-style-type: none"> • The industry survey revealed good awareness among large-scale RAC service provider firms on changing technologies and emerging opportunities in the sector. The small and medium enterprises (SMEs) in RAC were less aware of changing technologies and were more focused on domestic sector service provision. Employees in these SMEs were further characterized by middle-aged technicians, thus having less awareness on changing technologies and opportunities. On the other hand, large-scale RAC service providers were characterized by younger skilled labor with satisfactory knowledge and skills. • Although SME firms and technicians are aware of the environmental regulations pertaining to greenhouse gas (GHG) emissions/refrigerants, they seem to have little understanding of how it would affect their business in the future. Large-scale firms are concerned about environmental regulations mainly because of their scale of operation and the existing legislative framework that affects their businesses. Potential employees on the other hand are generally aware of the RAC job opportunities and trends, which is reflected in their rising demand for RAC training. However, lack of awareness on where to obtain different levels of RAC training, especially outstations, is a gap to be addressed. • The industry survey revealed a significant proportion of formally unqualified/untrained craftsmen (though they may be experienced) particularly in the informal RAC service facilities. Qualifying these informal RAC service sector craftsmen through skills upgrading and RPL assessment should be encouraged through proper awareness.

		<ul style="list-style-type: none"> • Lack of awareness about Flexible learning method. For instance, there is flexibility in obtaining Record of Achievement (ROA) certificates for any unit of NCS (Ex; Refrigerant Recovery and recycling) • School leavers are less aware about NVQ certificate courses and enroll requirements. For instance, Ref & Air conditioning serviceman NCS available with TVEC. But no students get NVQ certificate for this course and therefore it needs to be popularized among school leavers (enroll for NVQ L 3)
Gap 5	Lack of external collaborations	<p>The RAC sector vocational training is affected by lack of external collaboration with partners, employers and stakeholders who could support the system. The weak linkage between the vocational education training institutes and the private sector firms is behind the insufficient RAC practical training needs. The core of a robust VET system is industry engagement, whereby employers, industry associations, and the TVEC are involved in joint planning to improve the relevance of RAC VET courses to match the labour market.</p> <p>The Gap Analysis found that:</p> <ul style="list-style-type: none"> • The linkage between the RAC sector VET trainers and industry is weak, resulting in an overall absence of training packages prepared with and by industry. Such collaborations are especially required for RAC training centers with fewer facilities to provide hands-on training. • TVEC centers or other RAC training providers generally do not have a job placement scheme supporting career guidance with a strong relationship with the private sector. However, progress is being made in this area at upper training levels (diploma and undergraduate). • Paid internships and in-plant training (for enrolled students at centers with less facilities) for students as well as

		<p>periodical skill upgrade programs for trainers can be arranged in collaboration with the industry. Organizations such as Abans, GTA refrigeration private limited, ElectroRef Engineers PVT Ltd are willing to support/provide such arrangements.</p> <ul style="list-style-type: none"> • Lack of collaboration/networking with alumni which hinders knowledge and skill sharing options. (eg. guest lectures, industrial training, in-plant training)
Gap 6	Gender inequity RAC sector employment	<ul style="list-style-type: none"> • Present RAC service sector job market gives higher preference for male technicians. Even though there are females who are willing to take up a career in the RAC service sector, the current job market does not encourage female technicians entering the job market (mainly due to the sector's inability to provide occupation-related facilities for females). Therefore, lack of sufficient opportunities for female students who would like to pursue a career in the RAC field is a significant weakness. The gender inequity gap in the RAC sector needs to be addressed.
Gap 7	Training of trainers	<ul style="list-style-type: none"> • A significant gap is the absence of formal instructor qualifications in teaching and mechanisms to update the trainers' knowledge at RAC VET centers annually. Because of this the RAC workforce prepared at VET centers does not have up to date knowledge. The issue has been exacerbated by the absence of sound practical training/in-plant training schemes. Therefore, RAC vocational trainers should be specifically trained and updated. When trainers/teachers all receive training simultaneously, using the same modules and curricula, it leads to uniformity of instruction and an assurance that they are teaching the same, standardized lesson plans.

		<ul style="list-style-type: none"> • Incentives and reward schemes to recruit and retaining good quality trainers. • In-plant training programs to expose trainers to new technologies can be arranged with private sector collaborations
Gap 8	Training program administration, management and recognition	<ul style="list-style-type: none"> • Absence of uniform criteria in enrolling students into RAC vocational training courses - some vocational training institutes recruit students with insufficient qualifications and motivation in order to continue their courses with minimal number of students. Some students enroll in courses without little motivation, desire to continue or little information. • The recommended and accepted student to trainer ratio is 15 students per trainer. New recruitment is necessary to maintain this ratio for effective delivery of RAC craftsmen training courses (Initially up to 20 numbers may be recruited allowing for any dropouts). • Accreditation of courses and institutions by the TVEC needs to be streamlined and continuously monitored to ensure quality assurance across courses. • Unfavourable course administrative and procurement policies - inability to provide required resources and consumables in time are creating severe difficulties in properly conducting training programs

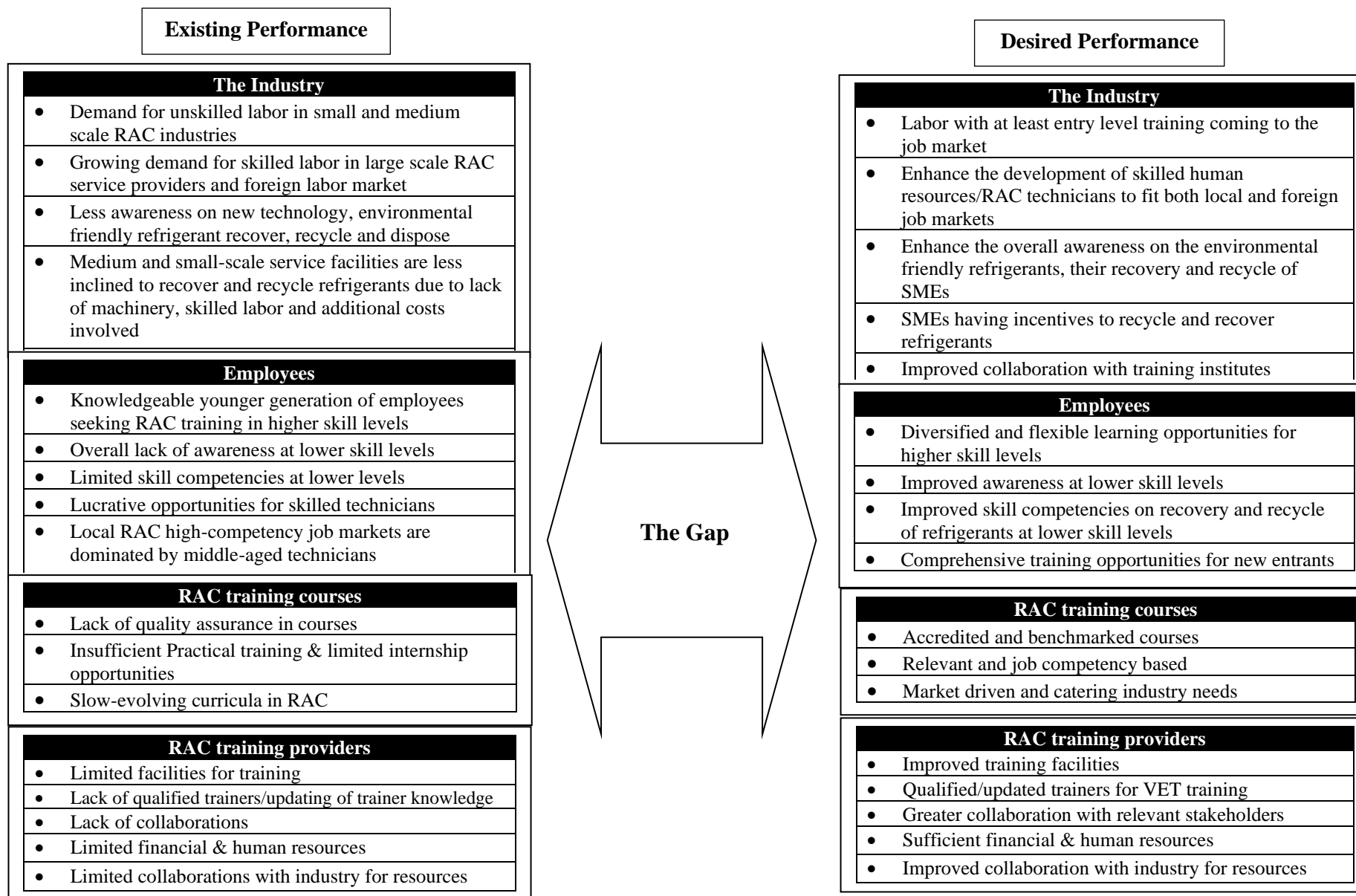


Figure 5.2: Gap analysis for the growing demand for the RAC sector

Chapter 6

TRAINING PLAN

6.1 Overview

In order to assess the future market demand in the Refrigeration and Air Conditioning service sector and the identification of training needs under the project on “Enabling Activities” for HFC phase down globally, the Government of Sri Lanka and the TVEC have identified the need of reskilling the RAC service sector workforce and initiated the preparation of a VET plan for the Refrigeration and Air Conditioning sector.

The RAC sector has a growing demand for skilled labor, both locally and internationally. The booming construction industry before the pandemic has propelled the demand for qualified RAC technicians in the local job market. In addition, growing environmental concerns and government regulations have increased the need for new knowledge and training needs in the RAC sector. Considering the gaps identified and to bridge the existing gaps, strategies and action plan for the RAC sector is provided in Table 6.1.

The training plan for the period 2022-2026, elaborated in terms of competency levels as per NVQ standards 3-5/6 adopted from TVEC, is available in Table 6.2. The statistical data which were supported to prepare Table 6.2 are appended in the Annexure-II and III.

Table 6.1: Summary of strategies and action plan for RAC sector

Goal 1: Enhance the relevance and quality of RAC-related VET					
Objective	Strategy	Activities	Time Horizon and Priority	Responsible Agencies	KPI
A. To improve competencies related to RAC service through VET	Revision of curricula based on the expected outcome/ competencies and ensure the delivery of up-to date RAC education	Implement and undertake curriculum revisions every 2 years.	Short to mid term	TVEC	No. of curricular revisions held within a 2-year period.
		Include following areas into existing VET program curricula pertaining to RAC services. <ul style="list-style-type: none"> • Environmental aspects of RAC, recovery and recycling of refrigerants. • Refrigerant recovering, refrigerant recycling. • Safety requirements for handling flammable and toxic refrigerants. • Maintain the energy efficiency of RAC systems. • National environmental regulations and laws • Heating/Ventilation systems • Global trends • Building automation / Building Management systems to enhance efficiency. • Industrial AC system service and maintenance • Update NSC for RAC technicians by including GSP and refrigerant recovery/ recycle. 	Short to mid term	TVEC/ VTCs	Modules reflecting specified components.
		Essential aspects in ‘heating systems’ designing, and maintenance shall include Building regulation requirements, thermal comfort & loads, heat flow, design, heat generation and distribution, heat	Short to mid term	TVEC/ VTCs	Modules reflecting specified components.

		<p>emitters, operation, control and maintenance. essential aspects to cover under ventilation systems shall include behavior of air and chemical contaminants in the air, make-up and supply air ventilation systems, dilution ventilation systems, selection and design of exhaust hoods, ducts, and fittings, fans and air cleaners (including Fan Laws), basic troubleshooting ventilation system techniques.</p> <p>Include modules/activities to enhance soft skills such as communication and interpersonal skills that would enhance employability of trainees</p> <p>NVQ level 4 accredited courses to include a minimum 12-month mandatory in-plant training component – this can be done with effective collaboration with leading public and private sector firms</p> <p>NVQ level 5/6 4 accredited courses to include a minimum 8-month mandatory in-plant training</p> <p>Introduce a well-structured module for in-plant training clearly specifying mentoring guidelines, mentor qualifications, training requirements in terms of learning hours, monitoring, and reporting to ensure that students gain the expected level of competencies during their in-plant training</p>	Short to mid term	TVEC/ VTCs/Pvt. sector firms offering placement	Availability of a well-structured module for in-plant training
	Improve equipment facilities at RAC training centers to enhance practical training / hands-on training	Set up at least one fully fledged RAC training facility equipped with state-of-the-art equipment/facilities on provincial/district basis (essential facilities to train students on chillers, cooling towers, central systems, freezer trucks, industrial refrigerators, refrigerant recovery and recycle reclaim	Mid to long term	TVEC/ VTCs	Number of central training facilities established by region.

		<p>The priority shall be given to districts where there is higher demand for RAC service training.</p> <ul style="list-style-type: none"> • North-central province - Anuradhapura • Southern province – Galle/Matara • North-western province – Kurunegala • Northern province– Kilinochchi • Uva province – Monaragala/Badulla <p>Allocate additional funding to enhance existing training facilities (at least in selected RAC training centers with high student enrolments to cover each district/province)</p>	Mid to long term	TVEC	<p>Number of training centers with improved facilities</p> <p>Amount of money allocated for facility improvement.</p>
B. To leverage the standards of RAC VET and Occupation	Development of standards of occupations and curricula for RAC related VET programs	<p>Identify RAC related courses offered by VT institutes, professional bodies, and universities globally and develop standards for accreditation.</p> <p>Accreditation and monitoring of RAC training providers and their course offerings</p> <p>Periodically evaluate accredited courses and RAC training providers to identify discrepancies</p>	<p>Mid term</p> <p>Short to Mid term</p>	<p>TVEC</p> <p>TVEC RAC training providers</p>	<p>No. of courses registered for accreditation</p>
C. To sustain the quality and relevance of RAC VET	Periodical identification of future training requirements	Periodic communications and consultation of key RAC sector stakeholders to identify novel trends in the sector	Short to Mid term	<p>TVEC</p> <p>RAC training providers</p>	No. of consultations/training

Goal 2: Recruitment, Retention and Enhancement of skills and knowledge of RAC service sector trainers					
A. Improve competencies and knowledge of current RAC trainers.	<p>Establish mechanisms, procedures and programs to upgrade the skills and knowledge of RAC service sector trainers in vocational training institutes.</p> <p>Training programs on changing regulatory framework, environmental concerns and technological changes in collaboration with other state and private sector agencies.</p>	<p>To update the knowledge of trainers and expose them to latest technologies, RAC trainers shall be given 2-to-4-week paid leave and place them in private sector industries where they can gain knowledge on new technologies.</p> <p>Organize regional workshops on changing regulatory framework, environmental concerns and technological changes.</p>	<p>Short to Mid term</p> <p>Short/Mid/Long term (on need basis)</p>	<p>TVEC RAC training providers</p> <p>TVEC RAC training providers Govt (eg. NOU) and Pvt Institutes</p>	<p>Number of trainers trained.</p> <p>Number of training programs held.</p>
B. Increase the number of trainers.	Recognition and incentive/reward schemes	<p>Recruitment of qualified and experienced trainers to cater the future demand for RAC service sector training and to maintain the recommended trainer to student ratio in programs</p> <p>Introducing a Licensing scheme (Licensed Trainer) for trainers to recognize and assure the quality of trainers</p>	Mid term	<p>TVEC</p> <p>TVEC</p>	<p>Number of new recruitments</p> <p>Availability of licensing program</p>
C. Increase the retention of existing RAC trainers.	<p>Attractive remuneration and performance-based incentive schemes</p> <p>Mechanisms for trainer evaluation and promotion</p>	<p>Reconsideration of remuneration packages for trainers</p> <p>Performance-based incentives on timely course completions and high completion rate (minimal dropouts)</p> <p>Allowances based on participating in continuous skill upgrade programs.</p>	Mid/Long term	Government/ministry TVEC	Availability of schemes

Goal 3: Raising awareness of emerging career opportunities in RAC sector					
Objective	Strategy	Activities	Time Horizon & Priority	Responsible Agencies	KPI
A. To increase RAC industry awareness	Industry scale specific programs to build awareness	Enhance RAC business awareness on novel trends and environmental regulations that affect businesses	Short to Mid term	TVEC RAC training providers	No. of Consultations
B. To increase public awareness	Diversified media campaigns to reach and educate public/school leavers on the RAC opportunities	<p>Public awareness sessions and workshops to educate youth on emerging RAC jobs and available VET programs in RAC.</p> <p>For instance, there are emerging opportunities Reefer man/Reefer Technicians in the shipping industry.</p> <p>Students are to be given good exposure to industry and opportunities on the first day of enrolling for the course.</p> <p>Awareness programs to aware and encourage females to take up employment in RAC sector.</p> <p>Substantial proportion of unskilled and professionally untrained individuals are employed in informal sector. Awareness programs on flexible training opportunities targeting this segment will help to ensure the professional quality and service of the entire sector.</p>	Short to Mid term	TVEC RAC training providers	<p>No. of sessions covered.</p> <p>No. of areas covered</p>
Goal 4: Offer more diversified and flexible training opportunities in RAC and reduce dropouts					
Objective	Strategy	Activities	Time Horizon & Priority	Responsible Agencies	KPI
A. To sustain the variety and	Introduction of new and updated training programs	Introduce RAC service sector courses of different durations (at present less opportunities to follow short-duration NVQ L1-L3 RAC courses exists through training centers) to cover all regions.	Short to Mid term	TVEC RAC training providers	No. of courses introduced.

flexibility in RAC training		<p>Opportunities to follow L1 to L3 short courses are necessary attract unskilled servicemen currently working in the informal sector as well as those who cannot dedicate longer durations for training</p> <p>Flexible training courses that can be completed part-time and through distance learning</p>			No. of institutes introduced new courses.
B. To reduce the number of dropouts enrolling in RAC training courses	Incentives, support, and recruitment policies	<p>Incentive schemes, allowances, and payment/salary during in-plant training - Unfavorable economic background, poverty-induced family issues and other personal issues cause students to drop-out from vocational training courses.</p> <p>Aptitude test or alike to recruit highly motivated and determined students who wish to make a carrier out of the RAC training</p> <p>Provide scholarship during training period.</p> <p>Stringent entry requirements enforced across all registered training institutes.</p>	Short to mid term	TVEC RAC training providers	<p>Availability and implementation of student support and recruitment policies</p> <p>No. of dropouts reduced</p>
Goal 5: Improve the stakeholder collaboration in the RAC sector					
Objective	Strategy	Activities	Time Horizon & Priority	Responsible Agencies	KPI
A. To uplift the quality and the skills of RAC trainers	Training the trainers	<p>Initiate VET teacher training programs in collaboration with industries.</p> <p>Make such training qualifications mandatory for all trainers.</p> <p>Public and Private sector institutes can be contacted to make such arrangements.</p>	<p>Short to Mid term</p> <p>Short to Mid term</p>	TVEC	<p>No. of sessions</p> <p>No. of participants</p>

		<p>Close collaboration with private sector to find Student placements for in-plant training and job placements after completing the course.</p> <p>In cases where centralized training facilities are unavailable to provide hands-on training, such course modules can be covered in public and private sector firms where such facilities are available.</p> <p>Public and Private sector institutes can be contacted to make such arrangements.</p>			
B. To standardize the RAC education	<ul style="list-style-type: none"> Combined courses and NVQ accredited professional course offerings 	Collaborate with universities and other professional institutes to develop and deliver NVQ accredited RAC course and enhance curriculum	Short-term	TVEC Universities GBCSL	No. of sessions No. of participants

Table 6.2: Training plan for the period 2022-2026

Training area	Training activity	NVQ Level		Preparatory arrangements needed	Required resources	Target (no. of persons)			2022	2023	2024	2025	2026	Responsibility
		Available	Proposed			Existing	Predicted	Total						
Pre-Employment VE training for beginners (e.g. school leavers)	Install, service and repair Split type Air Conditioners	4	-	<ul style="list-style-type: none"> Create awareness to attract school leavers to the RAC industry. Testing methods Literature Transfer appropriate knowledge and technology 	<ul style="list-style-type: none"> Funds Skilled trainers PPE and work permit Tools, equipment, accessories, and spare parts Instructional manuals 	-	11341 (Total)	11341	2268	2268	2268	2268	2268	<ul style="list-style-type: none"> RAC training providers TVEC
	Install packaged Air Conditioning Systems	4	-				1632-small		326	326	326	326	326	
	Check operation of the air conditioners	4	-				6717-Medium		1343	1343	1343	1343	1343	
	Repair Domestic and Light Commercial Refrigerators and Deep Freezers	4	-				2992-Large (Table 3.13-3.15)		598	598	598	598	598	
Skill and knowledge upgrading of the employers of RAC sector (SMEs and Micro)	Skill upgrading of employers to manage workplace information	5	-	<ul style="list-style-type: none"> Establish the required level of skill upgrading. Testing methods Transfer appropriate knowledge and technology 	<ul style="list-style-type: none"> Funds Skilled resource personnel Software and ICT facilities 		5230	5230	1046	1046	1046	1046	1046	<ul style="list-style-type: none"> TVEC
	Skill upgrading of employers to manage workplace communication	4	-				(This is predicted based on the RAC employee data collected during							
	Training to plan the work to be performed in the workplace	5	-											

							the survey)							
Skill and knowledge upgrading of the employers of RAC sector (Large)				•	•		1890 (Table 3.12)	1890	378	378	378	378	378	•
Skill and knowledge upgrading of supervisory grades	Training to calculate cooling loads and select air conditioning units	5	-	<ul style="list-style-type: none"> • Testing methods • Transfer appropriate knowledge and technology 	<ul style="list-style-type: none"> • Funds • Skilled resource personnel • Software and ICT facilities • Literature, training aids • Tools, equipment, accessories, and spare parts 	978	956		387	387	387	387	387	• TVEC
	Training to calculate cooling loads and select refrigerators for medium and low temperature applications	5	-											
	Manage installation of industrial refrigeration systems	5	-											
	Supervise operation of industrial RAC systems	4	-											
	Manage installation of mechanical and hydronic systems of air conditioning plants	5	-											
	Manage installation air handling systems	5	-											

	of air conditioning plants													
	Manage installation of ventilation systems	5	-											
	Perform pre-commissioning testing and balancing of ventilation systems	5	-											
Skill and knowledge upgrading of employees (technicians/mechanics, trainees and labourers) (SMEs)	Install, maintain and service RAC equipment	4	-	<ul style="list-style-type: none"> Establish the required level of skill upgrading. Testing methods Transfer appropriate knowledge and technology. New competency levels to be determined 	<ul style="list-style-type: none"> Funds Skilled trainers and resource personnel PPE and work permit. Tools, equipment, accessories, and spare parts Instructional manuals/ circuit diagrams 	8,142 (Local)	5,189 (Local - This is predicted based on the RAC employee data collected during the survey)	15323	3,065	3,065	3,065	3,065	3,065	<ul style="list-style-type: none"> RAC training providers TVEC
	Install, maintain & repair industrial refrigeration systems	4	-											
	Perform refrigerant recovery	4	-											
	Prepare estimates on installation and/or maintenance of RAC systems	4	-											
	Service and maintain Refrigerated Truck Refrigeration Unit	4	-											
	Install, maintain and repair Central Air Conditioning Systems	4	-				1992 (Foreign) Predicted based on average							

	Practice occupational health and safety measures	4	-		<ul style="list-style-type: none"> • PPE and work permit. • Skilled trainers and resource personnel • Literature, training aids • Internet and ICT facilities • Curricular requirements 		e FEB Vacancies							
	Carryout workplace communication	4	-											
	Training in occupational literacy and numeracy	4	-											
	Training to work in teams	4	-											
	Knowledge upgrading in environmental concerns related to RAC sector	-	4											
Training of trainers from the training institutes	Upgrade technical and training skills			<ul style="list-style-type: none"> • Establish the required level of skill upgrading. • New competency levels to be determined 	<ul style="list-style-type: none"> • Funds • Skilled resource personnel • Tools, equipment, accessories, and spare parts • Instructional manuals/ circuit diagrams • Curricular requirements 	68	95	27	68+9=77	77+9=86	86+9=95	95	95	<ul style="list-style-type: none"> • TVEC • RAC training providers
	Knowledge upgrading in environmental concerns related to RAC sector													

6.2 Mechanism for Coordination

The proposed VET plan requires a strong collaboration of many Government and private sector stakeholders to achieve the objectives specified in the training plan. The proposed VET plan has identified improving the inter-institutional collaboration among relevant higher education and vocational training institutes as well as other relevant stakeholders in delivering the RAC related trainings.

As the apex body in the tertiary and vocational education training sector in the country, the Tertiary and Vocational Education Commission needs to take the leadership in following key tasks.

- To develop, review, and reformulate national policies on tertiary and vocational education and training.
- Implement the VET plan for the RAC sector.
- Ensure the quality assurance of VET training programs in RAC sector through registration of institutes and accreditation of training courses.
- Ensure the establishment and maintenance of standards by VT institutions.
- Develop and maintain training facilities at VET centers.
- Periodical consultation of key stakeholders of RAC sector to identify the new training requirements in RAC.
- Maintain a good communication, regular discussions and coordination between key partners (Universities and other higher education institutes, professional organizations and private sector organizations offering RAC training)

Private sector RAC training providers, Universities with RAC specialization, Professional Bodies for business studies, Sri Lanka Standard Institution, Environmental Certification bodies, and Professional institutes related to RAC sector could be identified as some of the other key partners to collaborate in successfully implementing the training plan.

- Inter-institutional collaboration is specifically important in maintaining an up-to-date and relevant VET training programs and curricula for RAC sector.
- Initiating RAC sector VET teacher training programs (as most RAC sector experts are currently in universities and other professional institutions)
- Conducting collaborative RAC sector VET training courses with universities and other professional institutes (when relevant expertise is unavailable with TVEC)

- When the required facilities are not available with TVEC, sharing resources/ facilities in delivering RAC related training.

6.3 Monitoring and Review

Monitoring is a routine process of data collection for tracking the program inputs, processes and outputs. Evaluation/review is conducted periodically as a systematic assessment of the effectiveness of VET plan in reaching its aims and objectives. Monitoring and reviewing provide evidence that informs decisions regarding VET plan implementation and ensures effective and efficient use of resources. Major responsibility of monitoring the success of the VET plan shall be taken by the TVEC. Monitoring the progress of each key strategy can be measured through the proposed set of indicators, and the relevant information shall be collected by TVEC and its network of VTCs island wide. Based on the information, TVEC can introduce necessary measures to revise and streamline the VET plan to achieve the main goals and objectives.

The monitoring and review plan is summarized in the table below. Key strategies, indicative timelines, monitoring indicators and responsible agencies are provided in the summery. This general monitoring and evaluation framework can be applied separately to each key sector identified in the RAC field.

Table 6.3: Monitoring and review mechanism

Strategy	Indicative timelines					Indicators	Responsible monitoring agencies
	2022	2023	2024	2025	2026		
Enhance the relevance and quality of VET programs							
Revision of curricula based on the expected outcome/ competencies to incorporate general refrigeration and air conditioning education and awareness into existing courses.	➡		➡		➡	Curriculum revision workshops conducted. Number of course curricular revised Number of courses accredited.	TVEC

Development of standards of occupations and curricula for RAC related VET programs	⇒	⇒	⇒	⇒	⇒	<p>Number of occupations where existing standards revisions completed.</p> <p>Number of occupations where new standards introduced</p>	TVEC
Periodical identification of future training requirements			⇒	⇒	⇒	<p>Number of stakeholder meetings with relevant industries</p> <p>Stakeholder feedback records</p>	TVEC VTCs
Improve equipment facilities at RAC training centers to enhance practical training / hands-on training.			⇒	⇒	⇒	<p>Number of central training facilities established by region.</p> <p>Number of training centers with improved facilities</p> <p>Amount of money allocated for facility improvement.</p>	TVEC VTCs
Recruitment, Retention and Enhancement of skills and knowledge of RAC service sector trainers							
Establish mechanisms, procedures and programs to upgrade the skills and knowledge of RAC service sector trainers in vocational training institutes						Number of trainers trained	TVEC RAC training providers
ToT programs on changing regulatory framework, environmental concerns and technological changes in collaboration with other state and private sector agencies						Number of training programs held	TVEC RAC training providers Govt (eg. NOU) and Pvt Institutes

Recognition and incentive/reward schemes						Number of new recruitments Availability of schemes	TVEC
Attractive remuneration and performance-based incentive schemes							TVEC
Raising public awareness on emerging career opportunities in RAC sector							
Industry awareness	⇒	⇒	⇒	⇒	⇒	Number of industry awareness sessions Conducted Inquiries by industries for information on new RAC sector training	TVEC VTCs
Public awareness	⇒	⇒	⇒	⇒	⇒	Number of awareness sessions for <ul style="list-style-type: none"> • School children • School leavers • People already employed • General audiences Public media announcements Inquiries by individuals for information on new RAC sector training	TVEC VTCs
Offer more diversified and flexible learning opportunities							

Introduction of new RAC sector training courses	⇒	⇒	⇒	⇒	⇒	Number of new courses introduced	TVEC VTCs
Incentives, support and recruitment policies	⇒	⇒	⇒			Availability of student support	TVEC VTCs
Improve the inter-institutional collaboration							
Training the trainers			⇒	⇒	⇒	Number of TOT workshops held Number of teachers trained and qualified	TVEC VTCs
Knowledge sharing	⇒	⇒	⇒	⇒	⇒	Number of partnerships established with • Universities • Professional institutes	TVEC VTCs
Combined courses and NVQ accredited professional course offerings	⇒	⇒	⇒			Number of new courses with • Universities • Professional institutes	TVEC Other higher education institutes
Sharing resources and facilities	⇒	⇒	⇒	⇒	⇒	Number of partnerships established with • Universities • Professional institutes	TVEC

6.4 Recommendations and Suggestions

6.4.1 Suggestions to improve the current RAC training profile.

According to the findings of the study and the stakeholder meetings with RAC industries and educational institutes, it was found that in most of the National Certificate courses (NVQ 1, 2, 3, 4), and National Diplomas (NVQ 5,6) the on-the-job training is playing a vital role. However, the fresh trainees graduated from different RAC courses appear to have less competency in some of the key RAC service activities. Hence, it is worth suggesting that the training institutes should collaborate with the private sector to provide in-plant training and hands-on experiences for trainees in the RAC sector. Arrangements should be made to provide financial incentives for the trainees during the training period by the private sector companies. This will ensure the transfer of current knowledge to the trainees in the sector. Moreover, as the technology in the RAC sector is continuously evolving, proper mechanisms/programmes should be arranged to train the trainers in the RAC sector with especial emphasis on practical/industry exposure. Certain training institutes are already providing a standard level of training which the local and international RAC sector demands, the Ceylon German Technical Training Institutes (CGTTI) is a good example with regards to being equipped with a high standard of training tools and equipment on par with the industry requirements. Therefore, other technical institutions should be equipped with modern cold rooms and equipment as it has been observed that most trainees trained through these institutions are not familiar with the latest technologies while lacking the essential knowledge.

6.4.2 Suggestions to improve the existing curriculum of the RAC courses/diplomas.

The subject areas covered by the existing curriculum of the RAC courses/diplomas are already described under the Chapter 4, however the suggestions given by the stakeholders and the experts in RAC sector industry and educational/training institutes are listed below.

- Air conditioning and refrigeration is initially designed by considering a constant load, but it is always varying once installed in the actual conditions. Hence, a control system is mandatory in order to regulate output of the air conditioning system, so that it will meet the prevailing load. If not, over-cooling or under-cooling will occur causing energy wastage or uncomfortable climate conditions leading to complaints or financial losses. Therefore, some knowledge of the control systems used in the Air conditioning systems are essential for all personals involved in the air condition field.

- The following contents shall be introduced to the syllabus.
 - ✓ Control Concepts (open loop, closed loop)
 - ✓ Controls used in Refrigeration and Air conditioning industry (Pressure, temperature, humidity, etc)
 - ✓ Sensors and actuators
 - ✓ Energy saving concepts and strategies.
 - ✓ Controls for Chilled water system
 - ✓ Introduction to Building Automation System (computer-based Air conditioning control system for large scale multistory buildings)
- While including all the key areas mentioned above, it should be also included a few practical sessions accordingly (E.g., Site visits on Building Automation System).
- The curriculum in RAC should also include formal training on electronic aspects of AC/Ref. as it is a vital component in Ref./AC vocation.
- The course curricula need to enrich the knowledge of students on the effects of thermodynamics in artificial environments such as building interiors for the occupants and cold storage of products, how it varies with changes in ambient conditions and resulting feelings to the occupants as well as goods in storage.
- Good knowledge on the right conditions for human thermal comfort so that the technicians are well aware of how to satisfy the customers / occupants despite all independent functions being in operating condition.
- The technical terms used in RAC sector should be included to the curriculum in English medium to facilitate the communication (E.g., Three phase electricity).
- Introduce certified distance learning tools such as digital median and Youtube content to raise the knowledge and awareness of stakeholders (students, trainees, employees) in the sector regarding modern technological advancements and future trends.
- The current curriculum lacks the recycling and reusing of the RAC electronical devices, components and some chips (E.g., Printed Circuit Board (PCB)) hence, this part is playing a vital role in the sector as the sector is heading towards the smart concepts (devices, electronics and buildings), it should be included to the curriculum of current and future courses and proper training should also be provided.
- Issuing the internationally recognized diploma certificate compatible with the skill and knowledge requirements overseas.

6.4.3 Training the trainers

It is essential to equip current RAC trainers with the knowledge and skills necessary to effectively teach others about the principles, techniques, and best practices in the field of refrigeration and air conditioning. To update the knowledge of trainers and expose them to latest technologies, RAC trainers shall be given 2-to-4-week paid leave and place them in private sector industries where they can gain knowledge on new technologies. Periodical workshops shall be arranged to make the RAC trainers aware of changing regulatory framework.

Trainers shall be further equipped with effective teaching methodologies, instructional techniques, and assessment methods to deliver engaging and impactful training sessions. They should be educated on adapting their teaching style to different audiences and create interactive learning experiences.

6.4.4 RPL and RDL scheme

The National Ozone Unit (NOU) has covered the assessment fee for Recognition of Prior Learning assessments at institutes as a means of supporting individuals with knowledge in the RAC sector. The NOU consistently undertakes this approach to incentivize those with pre-existing expertise.

Implementing an RDL licensing system and prioritizing the safe handling of flammable and alternative refrigerants is essential for maintaining a secure and environmentally conscious approach to refrigeration practices.

6.4.5 technician licensing scheme

The technician licensing scheme is currently in the proposal stage, and is being planned by the Public Utilities Commission of Sri Lanka (PUCSL), with ongoing support from the National Ozone Unit. Having a well-structured technician licensing scheme would ensure the competence of professionals in the field. To establish these licensing schemes effectively, it is advisable to base the licenses on National Vocational Qualifications (NVQ) and established best practices. Furthermore, developing an efficient and streamlined process for issuing these licenses is crucial for their successful implementation.

Key Highlights

- According to the findings of the questionnaire surveys conducted and the stakeholder meetings with RAC industries and educational institutes, it was found that in most of the National Certificate courses (NVQ 1, 2, 3, 4), and National Diplomas (NVQ 5,6) the on-the-job training is playing a vital role.
- Arrangements should be made to provide financial incentives for the trainees during the training period/internship. This will encourage trainees/students to not drop-out from courses.
- As the technology in the RAC sector is continuously evolving, proper mechanisms/programmes should be arranged to train the trainers in RAC sector with especial emphasis on practical/industry exposure.
- Other technical institutions should be equipped with modern cold rooms and equipment as it has been observed that most trainees trained through these institutions are not familiar with the latest technologies while lacking the essential knowledge.
- The course curricula need to enrich the knowledge of students on the effects of thermodynamics in artificial environments such as building interiors for the occupants and cold storage of products, how it varies with changes in ambient conditions and resulting feelings to the occupants as well as goods in storage.
- Introduce certified distance learning tools such as digital media and video content to raise the knowledge and awareness of stakeholders in the sector regarding modern technological advancements and future trends.
- According to study predictions, the demand and supply of RAC sector technicians for the next five-year period appears to be more or less balanced (number of student enrolments on RAC courses and expected recruitments by the industry). Hence, more emphasis should be placed on enhancing the quality and relevance of RAC courses rather than proliferation of courses or training centers. This shall be ensured with proper training of trainers, curriculum upgrades, enhancing training facilities and industrial training programs.