Industry Skills Australia

Space Transport and Logistics

Skills Gap Analysis

Prepared for: Industry Skills Australia (www.industryskillsaustralia.org.au)

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Date: December 2024

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Acknowledgements: C4 Space acknowledges and thanks representatives of the space industry that provided their assistance in developing this publication with assistance from Industry Skills Australia Limited and the Department of Employment and Workplace Relations under the Jobs and Skills Council Program. C4 Space also acknowledges the contribution of our dedicated staff and contractors, Dr Todd Dearing (Genius Authoring Pty Ltd) and David Thompson (Silverback Consulting Pty Ltd) for their support in the writing, analysis and compilation of this report. In addition, we would also like to thank the Space Industry Association of Australia (SIAA) team, Dr Anuja Cabraal, and the team at Industry Skills Australia for their guidance, insights and support which were instrumental in preparing this report.

Front cover image: The ATSpace Kestrel I rocket being craned into position on the launch pad, Southern Launch Whalers Way Orbital Launch Complex, Eyre Peninsula, South Australia. Image used with permission, courtesy of Southern Launch.

This report should be cited as: Industry Skills Australia Limited, *Space Transport and Logistics Skills Gap Analysis*, Department of Employment and Workplace Relations, 2024.

Australian Government
Department of Employment and Workplace Relations

Industry Skills Australia

C4 SPACE

SIAA Space Industry Association of Australia

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Executive summary

The Australian space industry has experienced significant growth in recent years, driven by innovation, experimentation, and overcoming the challenges of a relatively new sector. Many startup and small business leaders have entered the industry from adjacent fields such as aviation, construction, defence and mining. Leveraging their existing skills and determination, they have successfully established thriving companies.

In the absence of formal space-related qualifications, these pioneers often relied on learning through experience. Their methods included conducting extensive independent research, engaging specialist consultants, hiring international experts, and seeking advice from others within the space community who had faced similar challenges.

Building a skilled workforce for the space industry has remained a significant challenge. As the industry is still developing, roles are often not clearly defined. In Australia, space-specific training programs are limited at both the Vocational Education and Training (VET) and Higher Education levels. While there is a strong foundation in engineering and science, a thriving space industry also demands expertise in a broader range of disciplines.

To build these foundations and gain maturity, the Australian space sector needs to address its skills gaps and training needs. It needs access to clear, consistent, implementable training products that can train the existing workforce and aspiring students with the skills and knowledge needed for a career in space logistics.

This study has consulted widely with the space industry and education sectors to understand these skills gap and knowledge requirements. It has focused on augmenting, adapting and developing vocational training and higher education pathways to meet the present and emerging Transport and Logistics needs of the space industry. It offers comprehensive recommendations to address these challenges, to support the growth and development of the industry.

At a time when technology is advancing globally to new frontiers, implementing effective training products in Space Transport and Logistics will provide the Australian space industry with the skills and knowledge needed to build an agile and futureproof workforce to truly advance and establish itself as a player in the global space economy.

Acronyms and terms

AQF	Australian Qualifications Framework
ASQA	Australian Skills Quality Authority
EAR	Export Administration Regulations
HE	Higher Education
ISA	Industry Skills Australia
ITAR	International Traffic in Arms Regulations
OSOM	Oversize Overmass
RTO	Registered Training Organisation
SME	Subject Matter Expert
STEM	Science, Technology, Engineering and Mathematics
ST&L	Space Transport and Logistics
TAFE	Technical and Further Education
TLI	Transport and Logistics Training Package
TSA	Technology Safeguards Agreement
T&L	Transport and Logistics
VET	Vocational Education and Training

Terms

Restricted items	In the context of items, technologies, equipment and so on, those which are defence-export controlled.
Sensitive items	In the context of items, equipment, components and so on, those which are easily damaged due to movement, vibrations, temperature and other environmental factors.

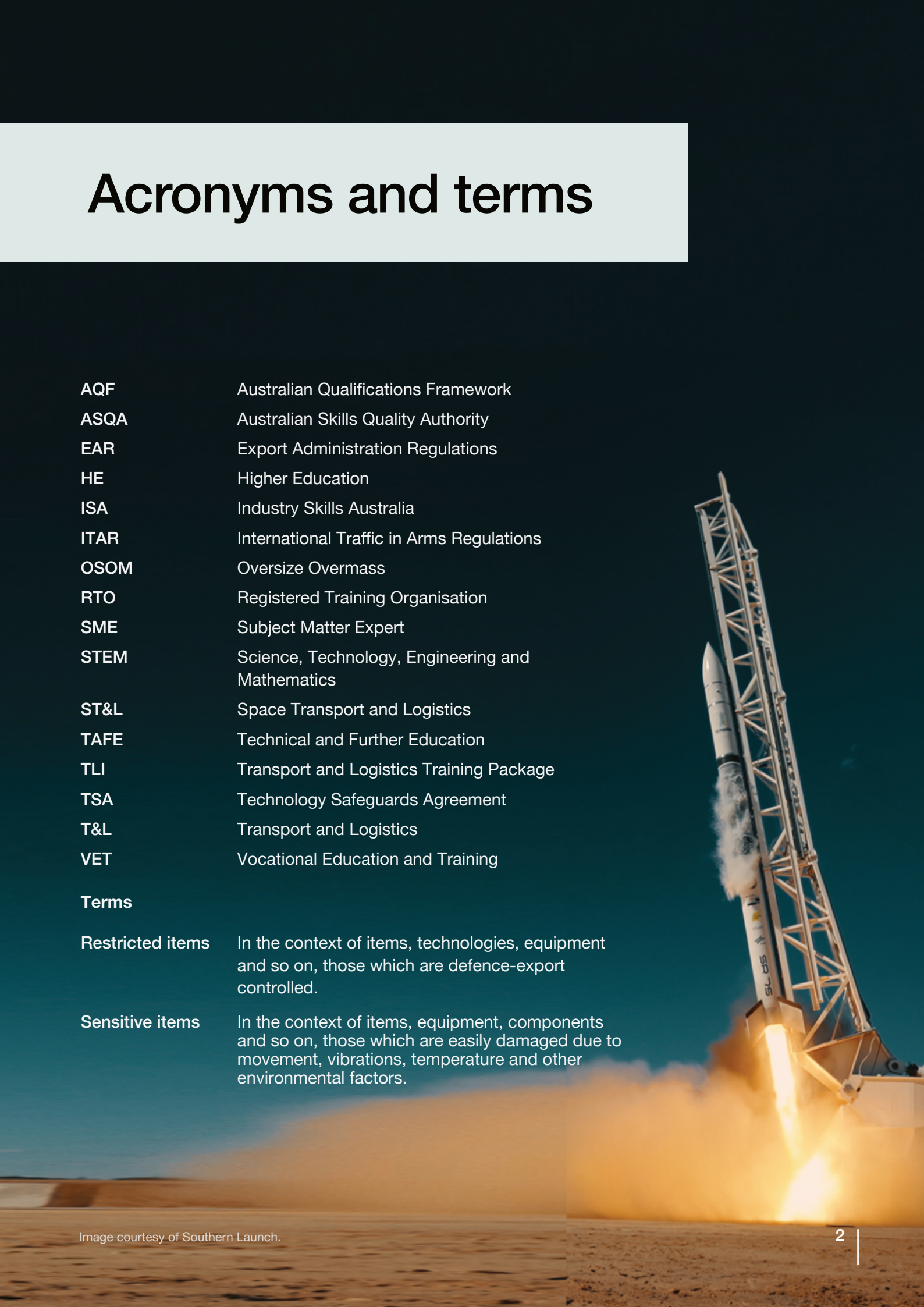


Image courtesy of Southern Launch.

1 About the research

The tiSpace 'Hapith-I' rocket at Whalers Way Orbital Launch Complex. Image courtesy of Southern Launch.

Context:

Industry Skills Australia has commissioned this study to identify the skills required for Transport and Logistics within the Australian space industry.

Gap:

In both the vocational and university sectors, there are significant training gaps in the skills and knowledge needed to deliver Transport and Logistics for ground-based supply-chain activities in the Australian space industry.

Solution:

Through consultation with industry and education providers, and analysis of the information obtained, this study has contextualised these training gaps and provides recommendations to the vocational sector for addressing them.

This report was developed through primary research into the Transport and Logistics (T&L) activities of Australian space organisations. The research involved a series of interviews and focus groups with T&L personnel within these organisations, to understand their needs and challenges in relation to Space Transport and Logistics (ST&L) tasks, skills and training.

The research also involved a series of interviews with leading T&L authorities within Australian universities, to understand the needs and opportunities to support ST&L pathways from vocational training into Higher Education degrees and for Higher Education Apprenticeships and Traineeships.

The data collected from this research has been analysed alongside existing VET training packages, courses, units and qualifications to find ST&L skills gaps. This has resulted in a number of recommendations, presented in this report, which provide VET solutions for ST&L industry skills gaps and for pathways to Higher Education.

1.1 The Australian Space Transport and Logistics industry

While ST&L activities have been conducted in Australia since the earliest space operations of the Cold War era, a viable commercial space industry did not develop until the twenty-first century. This industry was consolidated by the formation of the Australian Space Agency in 2018.[1]

The Australian space industry has largely developed out of adjacent sectors, drawing its workforce and their skillsets from the Australian aviation, construction, defence, engineering and mining industries, or otherwise from those with space industry experience from overseas. In recent years, many Australian space companies have started viable businesses, larger international companies have established their space industry footprint in Australia, and the Australian Government has sought committee recommendations, supported the national industry and engaged with allied nations to establish agreements to boost the Australian space industry.[2,3]

As in many other industries, T&L is an indispensable component of the Australian space industry. It encompasses tasks such as coordinating components and materials, maintaining inventory, warehousing and distribution, transporting parts and products, and managing returns, repairs, and recycling. While general T&L operations can address

many of these tasks, the space industry often requires specialised skills and knowledge due to the dangers, stringent security regulations and unique challenges associated with space technologies and materials.

However, understanding the requirements, regulations, best practices, and other essential aspects of establishing and operating a space business—particularly its T&L elements—remains challenging in the current environment. The industry faces significant uncertainty due to limited formal training, steep learning curves, lengthy product development cycles, high risks, and short funding runways. Many startups rely on community knowledge and trial-and-error approaches. This situation reflects the industry's relative immaturity amid rapidly evolving technologies, shifting regulatory requirements, and geopolitical uncertainties.

Educators, whether in the VET or Higher Education sectors, are also relatively new in providing industry-driven space training and education. While a broader foundation of training in T&L is available, the specific requirements for ST&L as defined by industry needs are not addressed. Similarly, structured learning pathways for those interested in a career in ST&L do not exist.

The growth and maturity of the Australian space sector depends upon an agile and futureproof workforce to support its ST&L requirements.

1.2 Defining Space Transport and Logistics

Developing a clear, current definition of ST&L was an important first step for this research. Upon commencement, there was no widely accepted definition of ST&L in Australia. Recent reports on the space industry have tended to refer to logistics as its own industry, distinct from the space industry.[4,5] While this study found this distinction to be accurate, it also identified a unique cluster of skills and knowledge specific to ST&L. Although individually these skillsets and knowledge are often shared with adjacent industries, such as agricultural or energy sectors, their combination in support of the space industry contributes to a sub-industry within the wider T&L sector.

This highlights an opportunity to support the space industry through access to structured ST&L vocational training and Higher Education pathways. Hence, this research engages with the intersection of the space and logistics sectors, with a focus on how T&L can support space activities.

The research began with the following five areas of logistics:

A **Procurement and supply coordination -** coordinating materials, parts, products and services from suppliers for manufacturing and producing goods and services

B **Inventory maintenance -** maintaining inventory for raw materials, parts and products

C **Warehouse management -** handling and storing materials, parts and products for distribution

D **Transportation -** transporting parts and products via sea, land, and air in a compliant manner

E **Returns, repairs and recycling -** managing returns, repairs and recycling economically and environmentally.

These five areas were then considered within the context of the Australian space sector value chain, based on a framework developed by the Australian Space Agency, as shown in Figure 1.[6]

Figure 1. Australian space sector value chain

Ground segment manufacturing and services - *e.g. control facility construction*

Space segment manufacturing and services - *e.g. satellite manufacturing*

Space operations

e.g. transmitting instructions to satellites and receiving data, launching a satellite

Space applications

e.g. producing the hardware and software for earth observation imagery, DTH TV

Regulation and essential service delivery

e.g. regulating launch safety

Infrastructure and capabilities

e.g. Maintaining access to a launch facility, education and training

Research, development and engineering

e.g. research into new extreme temperature resistant technologies

Specialised support services

e.g. Legal services

This resulted in the following five segments being used within this report, with the bottom section of Figure 1 being combined into a single category, space enablers and support services:

1. **Ground segment manufacturing and services -** building and integrating ground facilities and equipment to perform space-related activities

2. **Space operations -** launching to space, managing objects in space, and associated space activities, including remote operations

3. **Space segment manufacturing and services -** building and integrating objects to go to and be used in space

4. **Space applications** - creating useful products and services from space resources

5. **Space enablers and support services -** facilitating and contributing to the delivery of the other space value chain segments through products and services (such as regulation and essential service delivery; infrastructure and capabilities; research, development, and engineering; and specialised support services).

Photo by Gino Marcelo Hernandez Sanchez on Unsplash

This research combines the five areas of logistics (A-E) with the five segments of the space sector value chain (1-5) to produce a grid of alphanumerical combinations, as shown in Table 1.

Table 1. Combining Transport and Logistics areas with space sector segments

T&L area → / ↓ Space value-chain segment	**A** Procurement and supply coordination	**B** Inventory maintenance	**C** Warehouse management	**D** Transportation	**E** Returns repairs and recycling
1 Ground segment manufacturing and services	A1	B1	C1	D1	E1
2 Space segment manufacturing and services	A2	B2	C2	D2	E2
3 Space operations	A3	B3	C3	D3	E3
4 Space applications	A4	B4	C4	D4	E4
5 Space enablers and support services	A5	B5	C5	D5	E5

This grid is used to structure this report and for discussion of the various aspects of ST&L. Data collected from the organisations interviewed was mapped according to this table and is discussed in Section 1.6, 'Summary of data collected'.

Space T&L lacks robust specialised training programs, making it an underdeveloped sector with significant skills gaps. To develop recommendations for T&L training, a broad foundation that addresses the whole industry seems much more useful at this point in its development. Rather than splitting the industry into smaller space value-chain segments and seeking to develop specialised training recommendations for each of these, this study has sought to address the space industry as a whole and focus on the differences across areas of logistics. Hence the sections of this report are structured according to the five areas of logistics, not the five space value-chain segments.

As this research developed through national engagement with the space industry, the data collected informed a working definition of ST&L. This resulted in a definition of ST&L that is current and aligned with the practical needs of the space industry:

Kanyini satellite boxed for transit to the Netherlands

Image courtesy of Inovor Technologies

Space Transport and Logistics is any activity within the space value-chain that involves supply coordination, procurement, inventory maintenance, handling and storage, transportation or returns/ repairs/recycling.

1.3 Aim

The aim of this research was to understand existing and emerging roles and skills needs within the ST&L industry and compare these to current VET training packages, units and qualifications in order to identity skills gaps in available training. This report was then to provide recommendations for modifying existing training products and developing new training products or pathways, based upon industry demand for and viability of such training.

1.4 Scope

This study examined ST&L within Australian space organisations. This included examining aspects of ST&L such as activities, organisational requirements, roles and hiring, skills development, training methods, qualifications, third-party suppliers and emerging needs. The specific focus was upon skills gaps and training needs within the ST&L industry.

The study also focused on T&L education within Australian universities, specifically with regard to the viability for ST&L pathways from VET into Higher Education.

As very little research has been conducted into Australian ST&L, this study was careful not to impose a priori assumptions upon what ST&L might include. ST&L is a relatively new and underdeveloped niche within Australia, therefore the study began by using general T&L as a context for understanding ST&L. It then focused on the specific requirements of T&L within the space industry, as revealed through the interview data, and the training gaps that industry presented.

The study did not focus on how space can benefit the logistics industry through applications of space technology. While the space industry is expected to provide ongoing benefits to the logistics industry—an example being satellite weather and traffic monitoring to ensure efficient supply chains and support automated transportation for logistics companies [7]— the study was focused on how T&L vocational training and Higher Education pathways can be augmented, adapted or developed to meet the present and emerging needs of the space industry.

1.5 Method

Planning stakeholder engagement

The research began with planning stakeholder engagement among industry, to ensure that participation and support from critical space organisations was achieved. The study used an extensive list of over 500 Australian space organisations from all states and territories in Australia. While some states may have minimal direct impact on national ST&L outcomes, ensuring coverage of all states and territories was necessary for a national study.

A level of engagement (out of five points) was determined for each stakeholder based upon:

1. their level of interest in the project—priority was given to organisations with a direct interest in ST&L activities

2. the level of influence on the successful outcome of the project—priority was given to those organisations that are significantly involved in ST&L.

Next, a priority was given to each stakeholder, based upon:

1. their level of engagement

2. their industry sector, based on their predominant activity using the Australian and New Zealand Standard Industrial Classification (ANZSIC) code

3. the size of the organisation.

This process allowed the sorting and prioritisation of hundreds of space organisations into a list of 58 organisations that were most suitable for conducting interviews and focus groups on their ST&L involvement and training requirements.

For consultation with the Higher Education sector, planning began with a list of 56 contacts within Australian universities, categorised as follows:

- **Category 1**—universities that deliver VET courses and include Transport and Logistics related full Australian Qualifications Framework (AQF) qualifications

- **Category 2**—universities that deliver VET courses and do not include Transport and Logistics related full AQF qualifications

- **Category 3**—universities that do not deliver VET courses but may provide credit in some form for VET graduates entering university courses

Prioritising the higher categories (1 and 2), universities were identified from each state and territory and appropriate contacts were invited to participate in interviews.

Developing and conducting interviews

The next phase of the project involved developing a process for interviewing priority stakeholders. This included developing questions, planning the interview approach, and scheduling and conducting interviews.

The interview questions for space organisations covered five main areas: the nature of the organisation, T&L roles and responsibilities, existing training, training and skills gaps, Higher Education, and potential solutions.

After obtaining consent, the team conducted interviews with 20 organisations from the prioritised list (the total engagement being restrained by the availability of participants and the timeframe for the project).

The first interview with a space organisation was a pilot study that served to test the interview process and analyse the resultant responses. This step served to calibrate the process and refine the interview questions. Data from the interview was extracted and qualitatively analysed, with the conclusions providing feedback to shape and improve the interview process.

By conducting semi-structured interviews, this allowed flexibility to ensure the focus remained on the topics most relevant to ST&L and applicable to the organisation being interviewed.

The study conducted 5 interviews with Australian universities. Questions focused on how the university considered credit from VET courses, including eligibility, strategies, and challenges; the observed performance and outcomes of students studying at university after having completed a VET course; and whether the university offered T&L related courses. Those who answered yes to the latter question were then asked whether they offer, or have considered offering, courses for T&L that include topics on T&L for the space industry. They were also asked what further thoughts they may have on how the university sector could work with the Australian space industry to support education for ST&L requirements.

Analysing data

Interviews were initially recorded as audio, then transcribed into text and anonymised. All identifiable information for a given organisation or individuals was removed and replaced by de-identified markers and the original audio files were deleted. The anonymised transcripts were then analysed to extract information that was relevant and useful to ST&L, VET and Higher Education. Key findings from the anonymised interview transcripts were collected, and the analysis process was supported by software that enabled thematic analysis of the interview transcripts.

The training package curriculum at training.gov.au was searched extensively for the skills and knowledge identified from analysis of the interviews.[8] The search was conducted using a tool developed by Industry Skills Australia (ISA) that enabled searches on all training package content. Each search result was analysed by reviewing the information about the training package curriculum to assess to what degree it covered the identified skills and knowledge.

HyImpulse SR75 rocket at Southern Launch's Koonibba Test Range
Image courtesy of Southern Launch

Training packages are a key part of Australia's VET system. They contain VET qualifications aimed at covering all industries in Australia. They are nationally accredited, meaning they meet national standards for development and quality, and therefore qualifications and statements of attainment of nationally accredited training are recognised across Australia.

When comparing the space organisation interview data with existing VET material, matches between a skill or area of knowledge and training indicated that vocational training existed that was suitable to the requirements and competencies needed for that ST&L skillset. Partial matches indicated that vocational training existed that met some but not all requirements and competencies for a given ST&L skillset. In such cases, training insufficiencies for that ST&L skillset were considered, leading to the development of recommendations as to how existing training could be adjusted to meet the ST&L requirements. Where there was a gap for ST&L skillsets in existing training, with no partially matching training available, recommendations for developing new training material were provided. In some cases, deeper analysis into VET course material was required to ascertain gaps.

The analysis of Higher Education interviews commenced slightly later in the project, running parallel to the analysis of space organisation interviews. Using thematic analysis to identify recurring patterns and key themes from the interview data, the study sought to identify opportunities and recommendations for pathways from VET to Higher Education. These pathways were largely examined within the framework of generalised T&L courses, as the interviews revealed there is no existing curriculum specifically on ST&L within either the VET or Higher Education sectors within Australia.

Industry Skills Australia provided a preliminary research report, *International scan to identify examples of existing roles within space transport and logistics*. This report sought to map existing ST&L job roles and industry programs. The *International scan* found no space-specific training in the VET sector and concluded that clarity around ST&L roles and skills needs 'will be a significant step in leveraging the potentials of the VET sector to develop a skilled and capable workforce ready to meet future challenges'.[9] While this present study was able to identify skills needs within ST&L, it became quickly apparent that roles within the industry were not always clearly defined and role names were often misleading in indicating the scope of actual tasks an individual performed—this is discussed further in Section 1.7, 'Project limitations'.

Writing the report

Findings and recommendations from the analysis phase were then collected and reviewed. These were mapped across the five space sector segments and the five areas of logistics (see Table 1) where possible, noting that many findings spanned multiple categories. Using this categorisation to show the relevance of findings to specific aspects of ST&L, tables were created for each logistics area (corresponding to the main sections of this report, Sections 4-8). Conclusions on the viability and recommended approach for developing ST&L pathways from VET into Higher Education were also added to the report.

The findings for each section were written, along with the opening (Sections 1-3) and concluding (Section 9) sections of the report. This report was then edited and reviewed by project leads and industry experts.

1.6 Summary of data collected

The primary sources of data for this study were interviews with organisations involved in ST&L and interviews with Higher Education providers that teach T&L.

Table 2 shows a heat-map of which space value chain segments and areas of T&L the space organisations are operating within, according to the interview data. Colours range from orange (least active) to green (most active). This data does not necessarily indicate the complete range of space segments and T&L areas spanned by the industry, only those segments and areas which were revealed from the interviews. Organisations often covered several T&L areas and space segments, with some larger organisations covering all—or nearly all—categories.

Table 2. Relative proportions of the space value-chain segments involved in areas of Transport and Logistics

T&L area → / ↓ Space value-chain segment	**A** Procurement and supply coordination	**B** Inventory maintenance	**C** Warehouse management	**D** Transportation	**E** Returns repairs and recycling	Average
1 Ground segment manufacturing and services	8	9	7	10	6	8
2 Space segment manufacturing and services	6	8	5	9	7	7
3 Space operations	11	9	5	12	7	8.8
4 Space applications	12	11	5	14	9	10.2
5 Space enablers and support services	6	4	3	8	4	5
Average	8.6	8.2	5	10.6	6.6	

This heatmap shows that transportation was a prominent focus among the organisations interviewed, reflecting Australia's space industry as a growing supplier of space equipment and technologies overseas, and as well as through national transportation. Warehouse management was the least active area—the reason for this is simple: many companies said they were not yet operating at a scale that warranted their own warehouse, but hoped to do so one day. Returns, repairs and recycling was the second least active area of logistics, which may be due to the typically long product development cycles combined with the nascent stage of the Australian space industry.

Of the space segments, enablers and support services was least covered. This was expected from the organisations that were prioritised for interviews. Enablers and support services were of lower priority as they tend to have less logistics requirements than other segments. The most prominent space segment was space applications, showing that many Australian space companies are contributing to the industry through applications that often augment and rely upon existing space infrastructure and projects, which can require a more established industry to develop. This can often occur through exporting to more established overseas space companies.

Variation of activity across different T&L areas (standard deviation σ=1.38) was greater than variation of activity across space segments (σ=1.32), suggesting the interviewed space organisations have more in common across different space value-chain segments than they do across areas of logistics. In other words, there is some logistical uniformity in the industry regardless of which space segments companies operate within.

From the interview transcripts, findings were analysed in relation to a database of VET training packages, courses, units, and qualifications, to identify skills gaps within existing training material and possible pathways through such training towards Higher Education.

Secondary sources of data, which are discussed within this report (and referenced in the End Notes), include reports from industry, government and other organisations; journal articles and other publications; and selected data from research organisations. This secondary data was used to support, contextualise, and augment the findings from the primary data.

1.7 Project limitations

This research was conducted on a sample of 20 organisations operating within the space industry, therefore does not represent the entire industry. However, the sample was chosen deliberately based on several factors (see Section 1.5, 'Method'), to maximise national representation of the ST&L industry. Interviewees were selected based on their interest in and influence upon ST&L, to ensure the most relevant sample of the industry. This means the results of this research are indicative of the ST&L industry, though not necessarily indicative of the entire space industry. This, however, meets the aim of this research, as it required understanding of skills gaps and training needs specifically within the ST&L industry.

Another limitation of this project is its timespan. The findings of this report are a snapshot of the space industry and the education sector in 2024. Even while the study sought to understand the emerging needs of the space industry, these needs can be uncertain and unpredictable, especially when the industry is relatively new and maturing in a rapidly changing world. Because of this, the needs of

the industry are likely to change over the course of time. This does not mean the findings are any less relevant in the period following this study; to the contrary, this study provides a link between the space industry and the education sector that informs their cooperative development into the future. Nonetheless, to reduce attenuation over time, the study focused on those needs from industry that are most prominent, enduring, and integral to industry growth.

A final limitation was a lack of clearly defined roles within the space sector. While many companies that were interviewed described their staff working within T&L as having a strong background within a clearly defined profession, that same individual would very often adopt responsibilities and complete tasks based on whatever the company required to be done, rather than being constrained by their designated role. This was especially true for smaller startups, where an employee or executive performed multiple roles—and in some cases, almost all the roles. Even some of the larger companies mentioned that their entire logistics team consisted of a single individual. In these circumstances, job titles did not adequately describe the kinds of tasks being done. To accommodate for this, this study has focused less on roles or job titles and more on the skillsets and areas of knowledge required for tasks within the industry.

2 Vocational Education and Training for the space sector

Context:

The Australian space industry requires a range of skilled personnel to support the practical requirements to develop the industry, including its Transport and Logistics needs, which presently lack guidance and coherence.

Gap:

There are no space-specific vocational training courses available within Australia that provide nationally recognised qualifications, practical industry skills and the job-readiness needed for current and anticipated roles within the space industry.

Solution:

Through this study's recommended changes to VET, the space industry can build a workforce skilled in Transport and Logistics specific to its needs, gain maturity and increase efficiency.

> "Training that is aligned with the industry, that's very specific to the industry, is something that if we don't get on top of soon, it's going to hinder the development of the industry.
>
> – Interview participant

2.1 An overview of Vocational Education and Training

Vocational Education and Training provides practical knowledge and technical skills across many industries and trades. The VET system is a significant contributor to Australian skills development. It has consistently delivered vocational education to 1.25 million students on average every year for the past 20 years.[10]

VET courses are taught within government-owned Technical and Further Education (TAFE) institutes, independent Registered Training Organisations (RTOs), and dual-sector universities that offer VET and Higher Education programs.[11] The VET system is regulated by the Australian Skills Quality Authority (ASQA), which includes applications for registering as an RTO and course accreditation.

Qualifications within the VET system are regulated nationally under the Australian Qualifications Framework (AQF). They range from Certificate I through to Certificate IV, Diploma and Advanced Diploma.

Qualifications are obtained by completing prescribed training packages or accredited courses. Training packages are developed with government funding and cover most Australian skills needs. Accredited courses, on the other hand, typically fill gaps in skills and knowledge not covered by training packages. Both training packages and accredited courses are nationally recognised.[12]

Training packages and accredited courses consist of units of competency or modules, assessment requirements, qualifications (aligned to the AQF) or a statement of attainment, and credit arrangements.

VET courses are designed to instil practical industry preparedness and job-readiness and are taught by industry experts. They use high quality learning environments and equipment, are future focused with the latest technology, and can offer exit pathways into university degrees.[13]

2.2 Vocational Education and Training for the Australian space industry

The Australian space sector has experienced rapid expansion over the past decade. Yet in the context of global industry, it remains underdeveloped. Amid a nation-wide skills shortage, having suitably qualified people to fill the specialised roles that space requires remains a challenge.

The Industry Skills Australia report *International scan to identify examples of existing roles within space transport and logistics* describes the current state of the industry in relation to VET. The report states that the Australian space industry is emerging, with limited specialised VET courses available, and that identifying space-related skills and occupations within the T&L sector is crucial for creating a sustainable workforce pipeline. While there are no space-specific courses listed on yourcareer.gov.au, the report suggests that courses like drone piloting, warehouse management, and heavy vehicle driving could have cross-functional applications relevant to the space industry. Many space industry jobs require technical expertise, and integrating space education into vocational training can clarify the relevant skills need; however current education approaches focus on producing graduates with broad, transferable STEM skills rather than space-specific skills.[14]

Specific skills to facilitate growth in the Australian space industry were also highlighted by an earlier study, the *South Australian Space Industry Skills Demand Study* (April 2023). This study found that to support the growth of the space industry within South Australia, by 2028:

- vocational training for the space industry would need to increase 12-fold
- 106 new VET-based space skills would be needed (a 176% increase).[15]

At the time of this study, only one space logistics role was recorded, although the study anticipated a need for 34 logistics roles within South Australia by 2028.[16]

This is a significant increase, generally recognised across the entire nation on a similar scale. Such growth was encouraged by an Australian Government review of Australia's space industry, conducted in 2017, which set a strategy for the industry to triple its size (to AU$10-12 billion per year) and provide 10,000-20,000 new jobs by 2030.[17]

To reach such growth, Australia's space industry can leverage the expanding opportunities of the international market, as an article from *Australian Space Outlook*, 'From classroom to cosmos: space training in Australia' highlights:

> Based on recent projections, the 2023 global space market was worth $547 billion and will reach more than US$1 trillion by 2030. Australia provides significant opportunities for supporting this growing global demand for space-related services. We have strong international partnerships and agreements, unique geographic advantages, and a civil space industry that is actively developing products and services.[18]

There are additional challenges for vocational training needed for the space sector. Australian universities provide higher education in space-related topics (including degrees in space science, space engineering, astrophysics, astronomy, interdisciplinary space studies) and there is an active culture of innovation hubs around the country supporting students, startups, research and recruitment. Yet there are no space-specific vocational training courses available within Australia that provide nationally recognised qualifications, practical industry skills and the job-readiness needed for current and anticipated roles within the space industry.

Vocational training is currently available for broad technical roles, such as CAD drafters and designers, engineering technicians and technologists, machinists, assemblers, test technicians, electricians, and automation and robotics technicians.[19] However, this study has indicated that even after completing such courses, a skills and knowledge gap remains for the unique technical requirements and challenges that apply within the space industry. Apprenticeships and traineeships can somewhat reduce this gap due to students gaining some industry experience. Yet as long as vocational training does not directly cover the unique requirements of space, additional time and resources will be required to make new employees job-ready—with this cost taken on by space organisations.[20] Reducing this gap could significantly improve the operational efficiency of the space industry.

Previous work conducted by C4 Space identified several approaches for reducing training gaps to meet current and emerging space industry needs.[21] These are:

- **Contextualisation**—adding examples from the space industry into existing training materials and activities
- **Short courses**—offering focused skills or knowledge in areas of space industry demand
- **Expanding electives**—developing materials to expand elective units through industry consultation
- **Offering new skills standards**—creating groups of nationally recognised units of competency around a skillset that industry requires
- **Bespoke training programs**—creating bespoke training courses that develop skills and knowledge to meet industry requirements.

Each approach in this list requires more extensive changes than the preceding approach. The best approach for addressing an identified training gap that is beneficial to industry depends on the specific circumstances and demand from industry. In some cases, adding space context to training material may be the best solution; in other cases, new training units for developing new skills or a bespoke training program may be necessary. Targeted, effective changes that meet industry needs, rather than exceed them, are likely to be the most efficient approach.

2.3 How VET training can help support Space Transport and Logistics in Australia

This report seeks to highlight recommendations to quicken the pathways through training to job-readiness in the ST&L industry.

At the time of this study, there were no VET courses directly addressing the specialised skills and knowledge needed within ST&L.

As one interview participant remarked:

> “We find it very, very difficult to find the correct courses, units of competency, that fit with our industry.

There are, however, a number of general T&L training products available through the VET system. There are also many existing qualifications and units that are relevant to adjacent industries (mining, aviation, construction, defence etc.) that are potentially useful to ST&L requirements, although they were not specifically designed for this purpose. This study has examined both general T&L training products and space-adjacent industry training products, to understand their potential for adaptation to meet the T&L needs of the space industry.

The following T&L qualifications are listed in National Training Register:

- TLI11321 – Certificate I in Supply Chain Operations
- TLI20421 – Certificate II in Supply Chain Operations
- TLI30321 – Certificate III in Supply Chain Operations
- TLI40324 – Certificate IV in Supply Chain Operations
- TLI41522 – Certificate IV in Materiel Logistics
- TLI50224 – Diploma of Logistics
- TLI50422 – Diploma of Materiel Logistics
- TLI60122 – Advanced Diploma of Materiel Logistics
- TLI60222 – Advanced Diploma of Supply Chain Management [22]

Such existing training could be adapted or augmented through varying approaches to meet Australia's ST&L needs. If such changes were to lead to a body of nationally-recognised space-specific T&L training, this would also highlight a learning pathway for those interested in pursuing a career in the space sector and would enable the development of crucial skills to support the growth and maturity of the Australian space industry.

Because Australia lacks space-specific T&L training and the space industry is still immature, new workforce entrants are unlikely to align well to the requirements of the role for which they are hired. Pathway courses, Australian apprenticeships and work placements that are specific to ST&L would provide foundations for career development and could greatly support alignment between industry and education. Combining ST&L training and education with industry experience can help graduates be job-ready for the space sector. Space organisations can also save time and resources in training recruits in the basics (and perhaps even complexities) of ST&L.

Skills from space-adjacent industries such as aviation, defence, and communications could also support the development of space-specialised training packages and accredited courses. These space-adjacent industries, which includes also the wider Transport and Logistics sector, disaster management, even medical research and agriculture, would in turn be better supported through a more robust space industry through access to space technologies.

Space T&L is intrinsic to the coordination, efficiency, and sustainability of the entire space sector, hence its vital role in the success of the sector. While ST&L may seem a very specific skillset, as the space industry matures, it in turn becomes a facilitator for scaling the entire industry. Space promotes the development of new technologies, exposes humankind to greater understanding of our environment and ourselves, and may well bring solutions to many previously intractable ground-based problems. Developing the necessary skills in ST&L is a key to unlocking these potentials.

3 Higher Education pathways for the space sector

Context:

The space industry has the potential for greater expansion through the development of programs, advanced facilities, and collaborative research with the university sector.

Gap:

Currently there are very few options for clearly defined and extended career paths in the space industry, much less in ST&L.

Solution:

Implement the proposed student pathways enhancement strategies to facilitate vocational pathways to Higher Education.

> "You should be always advancing the future or doing the cutting-edge research and activities.
>
> – Interview participant

3.1 An overview of Higher Education pathways

The *Australian Universities Accord Final Report* emphasises the value in improving the university sector alongside similar development for VET.[23] With this present study's focus on understanding and supporting the growth of ST&L within Australia, it is vital to address how both the VET sector and Higher Education sector can contribute.

This study included a series of interviews with Higher Education providers around how they consider pathways from VET qualifications into university courses. This included a focus on the potential for pathways in T&L Higher Education and, more specifically, ST&L Higher Education. This section discusses some of the context around this aspect of the project and then explores the main findings from the Higher Education interviews. Recommendations and supporting actions from these findings are provided at the conclusion of this section.

Australian universities are experiencing pressure to expand and improve, adapt to new technologies, meet global changes, educate the next generation and produce world class research.[24] Apart from significantly lower levels of commencing domestic undergraduate students over the past two years, overall university commencements remain relatively stable in a 10-year period.[25]

What appears to have changed, however, is the level of national demand for a skilled workforce. Amid a nationwide skills shortage across health, education, engineering and trades, the *Universities Accord* report asks, 'Where are the highly educated and trained experts needed to modernise our energy grid, improve our agricultural capacity and protect our water supplies going to come from?'[26]

With space technologies already enhancing a variety of industries, focusing on growth for ST&L can accelerate not only the growth of the space industry, but also those industries that benefit from its growth. Space is a game changer. It adds a whole new dimension to how human beings operate on Earth and—in time—above it.

The *Universities Accord* report has detailed a number of recommendations to grow and strengthen the tertiary education system, one of which is to establish seamless pathways between VET and Higher Education:

> Pathways between Vocational Education and Training and Higher Education are currently fragmented and misaligned, making navigation across sectors very difficult. Admission, credit transfer and recognition of prior learning practices are inconsistent and can act as a barrier to further study. These transitions should be made as seamless as possible.[27]

VET pathways into Higher Education offer those who have completed a relevant VET certificate or diploma the potential to receive academic credit toward a university degree.[28] Industry, government and universities are currently collaborating to create opportunities for what is coming to be known as higher or advanced apprenticeships, where students can complete an applied industry diploma or associate degree where study loads and work schedules are balanced.[29] These pathways make university degrees more accessible while also supporting industry experience and practical vocational training for students. Such an approach can contribute to a well-rounded, skilled workforce.

VET pathways into Higher Education serve to flexibly align Australian skills supply with industry demand, thereby facilitating greater industry development and national growth.[30]

Case study – Swinburne University's Industry 4.0

One example that provides a pathway into Higher Education is Swinburne University's Industry 4.0. Industry 4.0 is a relatively new but common term referring to the current fourth industrial revolution that humanity is experiencing. It encompasses technologies such as autonomous systems, artificial intelligence, virtual reality, the Internet of Things (IoT), cloud computing and 3D printing.

Swinburne University's program applies digital technologies across research, industry support and consulting, workplace training, courses and events. It includes training for VET students in these technologies and in the skills required to design and implement systems using such technologies. These skills are then rapidly transferred into companies through internships or graduate employment. This approach supports companies to develop and validate products, processes or business models. The program also provides options for PhD research projects and larger, multi-year, multi-partner industry engagement.[31]

Swinburne, in conjunction with industry partners, has also developed an Associate Degree of Applied Technologies that provides what is described as an Industry 4.0 Higher Apprenticeship. This two-year full-time course includes a choice of specialisation in advanced manufacturing, civil infrastructure or building information modelling. It is designed to develop graduates who are skilled in information technology, innovation and design thinking, project management, product lifecycles, teamwork and interpersonal skills.[32]

Because the space industry is very much at the cutting edge of new technologies, an initiative similar to Swinburne's Industry 4.0 program could make a valuable contribution to the space industry through various partnerships around projects, training and education. The Australian space sector would benefit greatly from many of the enhancements the fourth industrial revolution brings—particularly around automation, advanced manufacturing and 3D printing for efficient space product development facilities. A number of the space companies interviewed as part of this study discussed the role of such technologies in building a stronger future for space in Australia. This is explored further throughout this report.

3.2 Higher education and the space sector

There are several Australian universities teaching space-related courses. Some of these include:

- Bachelor of Space Science, RMIT
- Bachelor of Science (Space Sc & Astrophysics), University of Adelaide
- Bachelor of Science (Astronomical and Space Sciences), University of Southern Queensland
- Bachelor of Engineering (Aerospace Engineering) (Honours), University of New South Wales
- Graduate Certificate in Space Operations, University of New South Wales Canberra
- Graduate Certificate in Space Environment, Curtin University
- Master of Engineering (Aerospace), University of Adelaide
- Master of Science (Astronomy), Swinburne University
- Master of Engineering Science (Space Systems Engineering), University of New South Wales
- Master of Science in Astronomy and Astrophysics, Australian National University.

This list is a sample of courses available, noting that many of these are science and engineering degrees. This leaves a large gap for other skillsets and knowledge that the space industry currently requires and is likely to require in the future. Yet there are also a number of courses that might be considered useful for a space career because they touch upon skills and knowledge that are generally applicable to space, or are applicable to adjacent industries that contribute to or are benefitted by the space industry. These might include fields such as communications, law, strategic studies, business, marketing, information technology, security and other sciences. It could also include logistics and supply-chain management.

However, when it comes to applying existing Higher Education logistics knowledge within the space industry, industry participants responded with mixed views. One participant believed that the general logistics knowledge obtained from their degree provided a useful foundation for much of their work within their space company. However, another stated that the skills and knowledge needed for ST&L are not available within existing logistics training. One participant remarked:

> "I've done a Bachelor of Logistics and I can tell you a lot of the stuff that I'm encountering specifically with space, you don't get in the degree that I did.

Several participants were somewhat frustrated by the lack of educational support for the space sector:

> "Generally, everything that we've done so far, we've literally gone out and self-taught ourselves..

However, several other participants believed Higher Education was unnecessary for T&L in the space industry—it would create overqualified graduates, when what was actually required were more practical basic skills learnt through short VET courses and on-the-job training.

Yet another space company believed upskilling through Higher Education was important both for their staff and for their company. They had several staff who would work part-time while completing related university degrees.

Another participant was encouraged by new facilities being built within universities, as this laid a foundation for future opportunities within the space industry, but believed these were not being used to their full potential:

> "We're basically using [advanced manufacturing facilities] for university projects or very surface-level preliminary stuff, which is all important, but that's not the purpose it was built for.

Such statements indicate that the Higher Education sector has a long-term opportunity to tailor educational material and collaborative industry projects to better meet the needs of the space sector.

The *South Australian Space Industry Skills Demand Study* found that university-based space skills requirements are expected to increase by 2.4 times and that 28 new skills will be required to support growth in the industry. This is a 14% increase above the number of skills needed in 2023,[33] with industry demand expected to be similar across the nation. Higher learning that is specific to the space industry can greatly facilitate industry needs. A student who completes a VET diploma or certificate can build upon their hands-on experience with industry-relevant skills and knowledge through a pathway into a university degree. Such pathways could help reduce industry skills gaps while building an educated, professional workforce that can further drive growth and innovation for the sector.

3.3 Findings from interviews with Higher Education providers

This study conducted interviews with Australian Higher Education providers to understand the opportunities for Higher Education pathways between VET and universities, with particular consideration given to viability of these pathways for ST&L. The analysis and findings from these interviews are detailed here.

Articulation agreements

VET to university articulation agreements are formal arrangements between VET providers and universities that outline pathways for students to transition from VET qualifications to Higher Education programs. These agreements specify the credit (variously known as credit recognition, credit transfer, credit arrangements, advanced standing, exemptions, or indeed by other names) granted to students based on their prior learning and qualifications, facilitating seamless progression into related university courses. Articulation agreements aim to enhance educational pathways, reduce duplication of learning and support students in achieving higher qualifications more efficiently. They are designed to align qualifications across the AQF, ensuring that skills and knowledge gained in VET are appropriately valued and recognised within university programs.

The view of the education system

The education system in Australia is often viewed as two distinct sectors: VET and Higher Education. This perception shapes the nature of student pathways and the opportunities for credit transfer between the two systems. VET is generally associated with practical, skills-based training aimed at preparing students for specific industries and occupations, while Higher Education is perceived as academically oriented, focusing on theoretical knowledge

and research. This division reinforces a sense of disconnection, which can hinder the development of clear and consistent pathways for students transitioning between the sectors. As a result, credit recognition practices can vary significantly, often depending on individual institutional policies rather than cohesive national strategies. Bridging the gap between these two systems requires a cultural and structural shift to foster collaboration and mutual recognition of the value each system provides to the broader education and workforce landscape.

The AQF Qualifications Pathways Policy

The AQF Qualifications Pathways Policy (the Policy)[34] states at the following clause numbers:

> **2.1.8** Issuing organisations will systematically negotiate credit agreements with other issuing organisations for any AQF qualifications to maximise the credit available to eligible students for both entry into and credit towards AQF qualifications.

The Policy goes on to include:

> **2.1.9** Credit agreements negotiated between issuing organisations for credit for students towards AQF qualifications at any level, vertical or horizontal, will take into account the comparability and equivalence of the:
>
> - learning outcomes
> - volume of learning
> - program of study, including content, and
> - learning and assessment approaches.
>
> **2.1.10** Credit agreements negotiated between issuing organisations for credit for students towards higher level AQF qualifications in the same or a related discipline, having taken into account 2.1.9, should use the following as the basis of negotiations:
>
> - 50% credit for an Advanced Diploma or Associate Degree linked to a 3 year Bachelor Degree
> - 37.5% credit for an Advanced Diploma or Associate Degree linked to a 4 year Bachelor Degree
> - 33% credit for a Diploma linked to a 3 year Bachelor Degree
> - 25% credit for a Diploma linked to a 4 year Bachelor Degree.

There seems to be a varying understanding of the AQF among the university representatives interviewed. When asked how much credit a graduate with a VET advanced diploma would receive when enrolling in a related bachelor degree, one response was ‘none’, citing the lower AQF level of the VET qualification as being inappropriate. This perspective appears to conflict with the intent of the Policy.

Several T&L-related university courses are offered as postgraduate programs at the graduate certificate or graduate diploma level, both classified as AQF Level 8. This creates a noticeable gap between these courses and the highest VET T&L qualification, the advanced diploma, which is at AQF Level 6. The Policy, as outlined in clause 2.1.10, lacks specific guidance on pathway credit arrangements for AQF Level 8 qualifications, aside from provisions for four-year bachelor degrees. Interviewees identified this multiple AQF (6 to 8) gap as a key barrier to awarding credit to VET graduates seeking to enrol in postgraduate

courses. This disconnect highlights the need for clearer articulation and credit transfer frameworks within the AQF to bridge the divide between VET and Higher Education pathways at these levels.

The credit process

Several interviewees indicated that credit is awarded on a case-by-case basis, aligning with the Policy, clause 2.1.9. However, this approach, in isolation, seems to overlook the requirement to systematically establish credit agreements with other providers, as detailed in clause 2.1.8.

Articulation agreements were notably scarce among the universities interviewed. One interviewee mentioned they were aware of a single agreement but noted its limited success, as only a small number of students transitioned into the Higher Education course after completing their VET qualification. The two institutions involved in the agreement were located in different states, which may have contributed to the low uptake due to geographical distance, despite the university offering the transitioning course online.

In contrast, another interviewee highlighted the success of a large New South Wales public VET provider in establishing several articulation agreements with a university. These agreements worked well because the VET provider delivered the same course content across multiple campuses, providing greater consistency in student outcomes and predictability for the university. The size of a VET provider, in terms of both course offerings and student numbers, appears to be an advantage in forming such agreements. As one interviewee stated:

> "I mean, the university has always talked to the VET provider because they are big... They've got a lot of offerings. It makes sense to talk to them.

This raises questions about the challenges smaller VET providers might face in brokering similar agreements. With fewer course offerings and smaller student cohorts, smaller providers may struggle to provide the scale and consistency that universities value in articulation agreements. This disparity could limit the pathways available to students from smaller VET providers, further emphasising the need for strategic collaboration and support to foster broader access to Higher Education.

Other interviewees noted that articulation agreements are uncommon, citing a range of contributing factors. One key challenge is that these agreements are typically negotiated at a high level within universities, often involving senior decision-makers who may approach such arrangements cautiously. They may be hesitant due to concerns about maintaining academic standards, ensuring curricula align, and the perceived risks of granting credit for qualifications that might not fully meet the university's expectations. Additionally, negotiation between VET providers and universities can be complex and time-consuming, requiring a level of collaboration between these organisations that is strained by differing priorities, resources, and levels of commitment to the agreements.

University reputation was also identified as a barrier to the establishment of articulation agreements. Some university decision-makers may view such agreements as unnecessary, particularly if their courses are already oversubscribed and attract high numbers of applicants without the need for formalised pathways. Additionally, concerns about potential reputational risks can further

discourage agreements. Decision-makers may worry that aligning with certain VET providers could lead to complications if future issues arise, such as inconsistent student outcomes or negative perceptions of the partner institution. These factors contribute to a cautious approach, where universities prioritise protecting their prestige and autonomy over fostering broader access through formalised articulation agreements.

According to one interviewee, universities typically do not actively seek partnerships with VET providers. Instead, it is usually the VET providers that initiate the process, aiming to establish pathways to benefit their students and enhance the prestige of their institution. Having an articulation agreement with a well-regarded university not only provides students with valuable opportunities for progression but may also elevate the status of the VET provider by associating it with a reputable Higher Education institution. This dynamic reflects an imbalance in the perceived value of such agreements, with universities often adopting a more passive role while VET providers take the lead in pursuing collaboration.

Several interviewees suggested that articulation agreements could serve as effective feeder mechanisms for attracting more domestic students to Higher Education programs. With the Australian Government's policy decision to cap international student numbers (as outlined in the *Draft International Education and Skills Strategic Framework*),[35] such agreements may become increasingly important. For both VET providers and universities, articulation agreements and formalised student pathways offer a strategic means to bolster domestic student enrolments, helping to offset potential declines in international student numbers. This shift underscores the growing importance of collaboration between the sectors to maintain student pipelines and support the sustainability of both VET and Higher Education institutions in a changing policy and demographic landscape.

Another interviewee highlighted the inflexibility of training package structures as a significant issue when aligning VET courses with university programs for credit recognition. They explained that when additional skills are needed, the qualification packaging rules often prevent the selection of more units, limiting the ability to meet university course requirements. As the interviewee put it:

> "I just think the VET qualification structure needs to be a lot more carefully planned for that … So, there has to be a bit of flexibility with that, so universities and VET providers can negotiate and develop their courses to create a seamless pathway.

This apparent lack of flexibility in the VET qualification structure presents a barrier to creating more fluid and adaptable pathways between the sectors.

The financial implications of articulation agreements were discussed, with at least one interviewee acknowledging that granting student credit can lead to reduced tuition fees for the university. However, there is limited evidence to suggest that this is a significant factor in the broader reluctance to establish articulation agreements. Having noted this, usually where there is a negative financial implication there will be reluctance to pursue a particular strategy, so funding or other reforms could be considered to remove this barrier.

Other pathways

One interviewee said that their university is considering introducing a suite of short courses to be used as building blocks for credit towards post graduate courses. While this would be a worthwhile endeavour for some cohorts, it does not make use of the VET system or the AQF to guide credit arrangements.

Only one interviewee said they were considering the use of associate degrees linked to higher apprenticeships. However, they said that it would depend on industry requirements and no T&L-related higher apprenticeships were identified by interviewees.

Space Transport and Logistics

Courses specifically designed for the space industry are relatively rare, and courses focused on T&L within the space sector seem to be non-existent. However, several universities are offering programs in emerging technologies and other space-adjacent areas of knowledge, which can serve as precursors to space industry-related courses, helping to build foundational knowledge for students interested in pursuing careers in space.

Student transitional issues between VET and Higher Education

Interviewees were asked about the challenges VET graduates face when transitioning into university courses. Responses highlighted issues around assessment requirements. VET students often shift from a more practical, application-based assessment approach to a system that is more theory-driven and focused on written assignments.

Workload also appears to be a significant concern, with many students taking on four subjects concurrently. This heavy workload often leads to high attrition rates during the first few weeks of a new intake, as the demands of university study become more apparent.

Certain strategies to smooth the transition between the two education systems for students already exist but could be further enhanced by incorporating a transition unit into VET diploma and advanced diploma qualifications.

The introduction of the Australian Tertiary Education Commission (ATEC)

As part of the 2024-25 Budget, the Government has committed to establish an Australian Tertiary Education Commission (ATEC) as a steward of the tertiary education system, with the detail of the proposal to be developed in consultation with the sector.

The Australian Universities Accord Final Report made the finding that Australia's tertiary education system lacks the coordinated, future-focused and evidence-based decision-making capacity necessary for Australia's future success. It recommended the Australian Government establish an Australian Tertiary Education Commission (Recommendation 30) to take a new leadership and stewardship role.[36]

The Australian Tertiary Education Commission Implementation Consultation Paper outlines a number of its proposed responsibilities. One of these states:

> … targeted work on specific tertiary harmonisation projects would involve the VET sector. Over time, it is proposed the ATEC's initial, more moderate tertiary focus would extend to achieving broader reforms in the tertiary realm, bringing greater involvement from the VET sector, VET providers, relevant agencies, and state and territory governments. [37]

The paper goes on to say:

> …ATEC will lead and manage Australia's Higher Education system, including promoting a more harmonised tertiary education system by breaking down barriers between the Higher Education and VET sectors. [38]

The ATEC is also intended to:

> Foster greater tertiary alignment between the Higher Education and VET systems through driving collaboration with tertiary stakeholders to develop solutions to structural problems, such as credit recognition.[39]

and

> Establish a pricing framework for estimating the cost of delivering Higher Education and advising Government on the efficient prices paid for course-based and needs-based components. The Government will remain the final decision maker on pricing.[40]

Student pathways enhancement strategies

Based on the interviews conducted with Australian universities and subsequent analysis, this study proposes the following strategies to enhance student pathways between VET and Higher Education:

1. **Advocate for the following to be implemented by the Australian Government Department of Education:**

    a. Review and update of the AQF to specify the credit connections between AQF 6 and AQF 8 (in the same way as it currently specifies the connection between AQF 5 and AQF 7)

2. **Advocate for the following to be implemented via the ATEC:**

    a. Develop and roll out a training program to VET providers and universities to extol the positive reasons for students, and the Australian economy, for establishing articulation agreements. The upskilling should also cover the intent of the AQF and provider obligations.

    b. Develop positive funding arrangements which provide two-way funding weightings to VET providers and universities which demonstrably collaborate to determine course alignment, and therefore by extension it is assumed, develop meaningful articulation agreements aligned to the AQF Qualifications Pathways Policy

    c. Develop funding arrangements which do not disadvantage the 'transitioning in' institution for awarding credit

    d. An enforcement of the requirements of the AQF Qualifications Pathways Policy with a reverse onus of proof that VET providers and universities are undertaking best endeavours to comply with the stated AQF Qualifications Pathways Policy obligations. Negative funding arrangements where proof is not forthcoming could be a consequence.

3. **Apply the following changes to VET:**

    a. Develop a new unit of competency that is focussed on preparing students for the transition from VET to university. This unit should include topics such as, but not limited to, report writing, referencing, critical thinking concepts, differences between VET and university study, and strategies for managing multiple concurrent subjects and life. This unit should be delivered by a university academic in conjunction with a VET trainer/assessor and should be a named elective in all TLI qualifications at diploma and advanced diploma levels. Funding arrangements should be cognisant of the dual delivery/ assessment nature of this unit and compensate providers accordingly.

    b. Review T&L diploma and advanced diploma packaging rules to allow flexibility for VET providers to include additional units to these particular qualifications, if deemed appropriate, to better align with university courses for transitioning students. This should be on the proviso that there must be a formally ratified articulation agreement in place which demonstrably links any additional units, and students seeking to utilise the articulation arrangements are made aware of the additional unit requirements and fees at enrolment time. Additionally, non-transitioning students should not be required to undertake any additional units to be awarded the relevant AQF qualification.

4 Procurement and supply coordination

Context:

Procurement and supply coordination is an active yet new area of T&L for the space industry.

Gap:

Finding suitable suppliers and working effectively with them, as well as hiring skilled Transport and Logistics staff.

Solution:

Adjust select vocational training units to include ST&L contextual material and consultative processes with specialist manufacturers.

> "You do it yourself, like most of the space companies in Australia. You have one person doing everything in logistics and transport..
>
> – Interview participant

Procurement and supply coordination is an important component of logistics for the intake and production of any organisation. It includes activities such as procuring goods and services; coordinating the intake of supplies and raw materials; manufacturing and production; ensuring services and goods are delivered according to specifications; and managing staff, time and resources efficiently for such activities.

The relative proportions of involvement in procurement and supply coordination for space organisations interviewed is shown in Table 3. A lower number indicates less activity in that segment of the space value-chain; a higher number indicates greater activity in that segment.

Table 3. Relative proportions of the space value-chain segments involved in procurement and supply coordination

T&L area → / ↓ Space value-chain segment		A Procurement and supply coordination
1	Ground segment manufacturing and services	8
2	Space segment manufacturing and services	6
3	Space operations	11
4	Space applications	12
5	Space enablers and support services	6

Many of the space organisations interviewed were actively engaged in procurement and supply coordination. However, a few smaller organisations did not think of such activities as a logistics activity. For all organisations, practical knowledge around the methods and requirements for procurement and supply coordination was an important concern. Sourcing from Australian suppliers was also a repeated theme, although this was not always viable due to a developing national industry in contrast to more established and affordable products overseas.

Table 4. Summary of procurement and supply

Key skills or knowledge	Existing training	Training gaps
Analysis and selection of suppliers	*TLIR5014 – Manage suppliers* *TLIR5007 – Manage international purchasing* *BSBPRC403 – Conduct international procurement*	Space context, although it is not expected that there would be such a variance that would make these units inappropriate.
Working effectively with suppliers and stakeholders across industries	*TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* (from *TLI50119 – Diploma of International Freight Forwarding*)	Consultative processes with specialist manufacturers.
Hiring a skilled workforce for ST&L	*BSBHRM415 – Coordinate recruitment and onboarding*	Space context, although it is not expected that there would be such a variance that would make these units inappropriate

The interviews highlighted key skills and areas of knowledge relevant to procurement and supply coordination. New or emerging roles were not clearly identified due to the space industry being in a nascent stage of development. Interview data was analysed for matches within existing VET units of competency to identify skills or knowledge gaps. Based on industry demand for particular skills or knowledge, proposed solutions were developed. A summary of these findings is provided in Table 4. The proposed solutions should be read in the context of a moderate amount of the interviewees mentioning these needs.

Potential solutions
Include space industry contextual material within: ▪ *TLIR5014 – Manage suppliers* ▪ *TLIR5007 – Manage international purchasing* ▪ *BSBPRC403 – Conduct international procurement*
Add unit *TLI5064* to Group B: General elective units of *TLI50224 – Diploma of Logistics*. Augment the relevant companion volume implementation guide: Under the heading ‘Special freight transport services may include but are not limited to’ include: ▪ *transport of space vehicle components* Under the heading ‘Consultative processes may involve’ include: ▪ *specialist manufacturers (e.g. space equipment and components) and engineers for handling procedures.*
Include space contextual material within *BSBHRM415 – Coordinate recruitment and onboarding*

4.1 Analysis and selection of suppliers

A number of organisations highlighted the importance of selecting the right suppliers. Discernment when choosing suppliers, and the skillset to analyse suppliers and procurement options, were discussed as important aspects of logistics decisions with significant business consequences. This skillset was mentioned as not readily available through training.

This becomes even more challenging when choosing suppliers outside of Australia, especially when materials or items received fall under a restricted import category. Delivery time, cost and receiving undamaged goods were all important factors, similar to other industries. However, because the space industry often deals in dangerous goods, sensitive equipment and restricted or dual-use technologies (having both a civilian and military application), security and import/export regulations were essential concerns—with huge impacts upon supply chain processes and business operations if done improperly. Hence the importance of knowing how to choose the right suppliers, who know what they are doing when it comes to transporting materials or goods from an overseas country into Australia.

Several organisations mentioned the importance of building trusted relationships and working closely with their suppliers. Qualities they looked for in a supplier included integrity, attention to detail, value for money, lead times and a proven history.

One participant spoke of the 'space heritage' of equipment as an important factor in determining who to purchase from. If a company has been building space equipment for 40 years, then their equipment is more likely to have a proven heritage (or at least a clear track record to assess). Even if an item is 5 years old, that may be better than something brand new because the new item hasn't necessary been tested in space to the same extent and could therefore be less reliable and even more expensive. Discussion around such factors demonstrates the practical business acumen and engineering mindset needed to support sound decision-making in the industry.

Another participant discussed how their company weighed the pros and cons in importing ready-made overseas products versus sourcing raw materials and manufacturing the required product themselves. Overseas suppliers could indeed lead to higher costs, customs delays, and potential product damage during shipping, depending on the product required. In some cases, such as certain electronic devices, importing from overseas was the only option because these products were not available nationally.

Choosing the right suppliers is integral to an organisation's business decisions, and unique challenges in the space industry come with this. This study found a significant demand among space organisations for the right knowledge and skills required to choose the best suppliers.

While there are existing VET units that provide training relevant to the analysis and selection of suppliers—including *TLIR5014 – Manage suppliers, TLIR5007 – Manage international purchasing,* and *BSBPRC403 – Conduct international procurement*—these do not necessarily include contexts relevant to the space industry. A solution to better position these units to support ST&L would be to include contextual material within them.

4.2 Working effectively with suppliers and stakeholders across industries

Several participants highlighted that suppliers could often come from industries other than space, and that understanding how those industries operate and the standards they work within was an important area of knowledge. Building effective relationships with these suppliers was also a useful skill. One participant remarked:

> “Knowing how the businesses themselves will operate as suppliers to you, I think is something that's misunderstood by the [space] industry, especially in industries that have nothing to do with space but are still directly supplying them.

Participants discussed the need to understand large companies and industry primes in order to work well with them. These larger companies may operate within the space industry, but often not exclusively, and therefore they have a business model (as well as interests and culture) that can differ from organisations that are entirely space focused.

Larger companies typically have a well-established workforce, infrastructure, processes and commercial arrangements, which can place many requirements upon space companies, which can be challenging to meet, particularly in their start-up phase. Understanding these requirements and differences is something that smaller space companies need to know if they are to work effectively with these larger companies. This includes when procuring their goods and services, as well as supplying to them.

Participants mentioned the importance of having clearly defined terms upfront and understanding contracts and expectations when dealing with stakeholders and suppliers. One participant mentioned how they had assumed a prime company they were working with was going to manage the clearance of hardware in another country, while that prime had assumed the participant’s company was going to manage it. Due to this misunderstanding of terms, the hardware was left in holding for a considerable time.

Being able to clearly understand contractual arrangements in relation to procurement was considered an essential skill for logistics in the space industry. However, this is also the case for business in any industry. Nonetheless, specific changes to existing training could better support the space industry for effective work with suppliers and stakeholders across industries. The unit *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* (from *TLI50199 – Diploma of International Freight Forwarding*) could be added to Group B: General elective units of *TLI50224 – Diploma of Logistics*. The relevant companion volume implementation guide could then be augmented to include considerations of space transport and space manufacturers as listed in Table 4.

4.3 Hiring a skilled workforce for Space Transport and Logistics

Procurement of employees or contractors for core business, project delivery and specialised services is vital to the success of any organisation. Several interview participants discussed this topic.

One participant mentioned how they looked to adjacent industries to find the skillsets their company required. The example given was for someone who had experience in transporting sensitive medical equipment. This person could be hired and trained in the needs of their space company relatively quickly, so that their skill and experience could quickly adapt to moving sensitive space equipment.

Drawing upon the workforce from adjacent industries was a common topic among participants, as the space workforce is still very much being developed. One participant remarked that this required:

> "leaning in and looking at an adjacent industry and telling someone in that industry, "By the way, there's a space industry over here. You can come and work for us, and with all the skills and everything you already have, you can probably apply."

The relative newness of the Australian space industry brings a lack of clearly defined roles, standardised training and expected career paths. Interviews highlighted that this is particularly true for ST&L, where the workforce appears small and ad-hoc.

Even where a workforce was drawn from more experienced people overseas, those people with their specialised knowledge might arrive in Australia to find that the basic foundations of an industry were still being built, which could limit the applicability of their specialised skills. The industry is clearly still in its developmental phase. As one participant stated:

> "The space industry in Australia is quite young and immature compared to overseas. In the US, in the UK, there's the existing infrastructure [and] training. There is a body of knowledge there that we lack in Australia.

Participants were asked whether they viewed university degrees in T&L as a useful qualification for an employee to have. More often the response was that it was not such an important consideration, unless the company was operating at a larger scale. The smaller startup companies tended to hire people and train them on the job, and did not consider a bachelor degree as necessary; VET certificates or diplomas were usually considered more valuable because they were shorter and provided more readily implementable knowledge.

One participant stated that specialist knowledge in T&L was not something they looked for when hiring a temporary replacement. This perspective seemed to be shared across the industry. Specialists were engaged as a contracted service as needed—examples include customs experts and legal advisors.

Another participant said that they would look for someone to hire who had a qualification in T&L and then spend a day or two training them on the job in the specific activities for the company. That was considered sufficient to complete the required tasks effectively.

Participants described the workforce needed for ST&L as not requiring a high level of education. They did describe some of the more

difficult tasks, such as preparing documentation for transporting space equipment, understanding the complex and often changing regulatory environment, and knowing the right way to package, handle, store and transport items. Yet there was nothing substantial to indicate that a Higher Education degree was needed for the work being done—at least not at this point in a company's development, or not at the level they were looking to hire.

Another aspect of not looking for specially trained staff is that there is no formal training or qualifications currently in ST&L within Australia. While not a logistics concern, one participant mentioned that a staff member wanted to do further training in satellite launches and orbits, although there is no formal training available in this niche area. Space logistics training is even less accessible. This highlights how the 'end of the road' comes quickly for staff seeking to progress their career within ST&L, which hinders the establishment of a ST&L industry.

Overall, prior experience, whether in the space industry or related fields, was highly valued in hiring decisions. Most organisations interviewed were very pragmatic in their approach and hired people accordingly. However, this does not mean there was no interest in ST&L training *in the future*. As mentioned earlier, organisations stated that as they scaled their business, having more highly trained specialists would become increasingly important. Furthermore, many companies who pioneered the space industry in Australia had to learn ST&L by doing, by asking *TLIX0045 – Determine import/export prohibitions/ restrictions* who had done it before, and even sometimes by trial and error—there were no readily available guides or training packages. Participants from these companies often expressed how useful it would have been to have access to training that covered all those areas of ST&L that they had to work out for themselves.

The solution to challenges such as the lack of a skilled space workforce, reliance on adjacent industries, limited demand for in-house specialists, and the absence of formal training may come from the continued growth and development of the space industry itself. As the industry grows, this will bring more differentiated roles and specialist needs, including a greater number of niche roles in ST&L, from which demand for specialised training will increase. Regarding more generalist ST&L training, many participants recognised the need and value for this. Such training could provide a foothold to support the industry's development and assist new companies in establishing their ST&L workforce.

Recommended changes to the VET system to better support the hiring of a skilled workforce for ST&L would be to include contextual material relevant to the space industry for the unit *BSBHRM415 – Coordinate recruitment and onboarding.*

5 Inventory maintenance

Context:

Inventory maintenance has moderate relevance for the space industry. It is likely to be much more relevant as companies expand their activities.

Gap:

Maintaining inventories effectively, particularly for dangerous, sensitive or restricted goods. Ensuring efficiency of logistics operations at scale.

Solution:

Include contextual material within existing relevant VET units. Collaborate with and enhance existing industry 4.0 programs, to facilitate advanced manufacturing, automation and design thinking within the space industry.

Inventory maintenance includes activities and systems for organising, tracking and optimising an organisation's stock (raw materials, components, products etc.). Done well, such activities ensure stabilisation and efficiency across supply chains, which helps to reduce problems arising from delays to incoming stock and prevents excessive stockholdings—both of which can significantly affect a business financially.

Organised inventory is essential for smooth business operations, client and supplier experience, analytics and insights, cost savings and greater productivity. It becomes even more important as businesses scale their operations.

The relative proportions of involvement in inventory maintenance for interviewed space organisations is shown in Table 5.

Table 5. Relative proportions of the space value-chain segments involved in inventory maintenance

T&L area → / ↓ Space value-chain segment		B Inventory maintenance
1	Ground segment manufacturing and services	9
2	Space segment manufacturing and services	8
3	Space operations	9
4	Space applications	11
5	Space enablers and support services	4

Space-specific inventories often bring requirements beyond operational and financial efficiencies for an organisation, even though these facets of business are very important. Interviewed space organisations highlighted that their inventories often include dangerous, restricted and sensitive materials and equipment. Maintaining accurate records and tracking of such items becomes extremely important for an organisation's security, safety, governance and integrity. These considerations also extend to national security requirements.

Table 6. Summary of inventory maintenance

Key skills or knowledge	Existing training	Training gaps
Maintaining space-specific inventories	*TLIA5058 – Manage facility and inventory requirements*.	Space context
Automation and efficiency at scale	*TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding* (from the Diploma of International Freight Forwarding) *TLIL5026 – Manage export logistics* *TLIX0045 – Determine import/export prohibitions/restrictions* *TLIX0070 – Manage materiel logistics operations* Swinburne University's Industry 4.0 project – Associate Degree of Applied Technologies	Automation and space context

The interviews highlighted key skills and areas of knowledge relevant to inventory maintenance. New or emerging roles were not clearly identified due to the space industry being in a nascent stage of development. Interview data was analysed for matches within existing VET units of competency to identify skills or knowledge gaps. Based on industry demand for particular skills or knowledge, proposed solutions were developed. A summary of these findings is provided in Table 6. The proposed solutions should be read in the context of a moderate amount of the interviewees mentioning these needs.

Potential solutions
Include contextual material within *TLIA5058 – Manage facility and inventory requirements*. Augment the relevant TLI companion volume implementation guide: After the heading 'The workplace environment may involve: large, medium and small companies', add: *including within the Australian space industry.*
Add units *TLIL5062*, *TLIX0045* and *TLIX0070* to the Group B: General elective units for *TLI50224 – Diploma of Logistics*. Augment the relevant TLI companion volume implementation guide: For unit *TLIL5062*, under the heading 'Sources of information required to perform international freight forwarding functions may include', add: *Defence and Strategic Goods List* For unit *TLIL5026*, under the heading 'Work may be undertaken: in various work environments in the sections of the warehousing, storage, transport and distribution industries involved in export logistics', add: *including within the space industry* Under the heading 'Consignments may be:' add: *Sensitive components or large oversized sections relating to the space industry.* For unit *TLIX0070*, after the unit application statement sentence '… but may be applicable to individuals in broader logistics roles', add: *including the space industry*. Encourage collaboration with existing industry 4.0 programs to facilitate advanced manufacturing, automation and design thinking within the space industry—for example: Swinburne University's Industry 4.0 project – Associate Degree of Applied Technologies

5.1 Maintaining space-specific inventories

Most organisations interviewed did not have large or complex inventories needing management, and in many cases there was nothing particularly distinct about their inventories compared to other similar industries. Several organisations stated that as their operations grew, they expected the need to focus on inventory management would increase. A few organisations worked with third-party partners who stored and managed their inventory.

One factor that makes space inventories different is that space organisations often include dangerous goods, restricted items, and physically sensitive technologies. Security, safety and regulatory requirements around such items increases the importance of properly documenting and tracking such inventory. The more restricted an item, the greater the consequences of mismanaging such items as inventory. The same applies for dangerous goods.

Chemically hazardous items such as fuels and explosives were commonly mentioned, and biologically hazardous items (for example, bacteria for zero-gravity research) were occasionally mentioned. These bring additional considerations for their handling, storage and transportation, which will be discussed in the following sections.

Interviewed organisations mentioned how, as a result of working with dangerous or restricted materials, space equipment or components can cause unexpected delays at customs due to the regulatory restrictions around such items. Delays can have compounding repercussions down the supply chain, causing additional costs and delays, which can be costly or may lead to operational failure. Tracking such items as part of the supply chain is essential, as is developing contingency plans. Startup organisations, in particular, highlighted such challenges, as did organisations not initially familiar with the regulatory requirements around these items or materials.

Several organisations spoke of the steep learning curve they undertook to fully understand these regulatory requirements prior to operating with such materials. These organisations developed their knowledge primarily by informal discussions with others in the industry, engaging with consultants, and in some cases learning by doing. Access to training material that is orientated to the space industry which instructs in compliance and best practices for inventory maintenance was largely absent. As one participant stated:

> “Having more understanding of how you could manage inventory, internally, it would probably be quite useful.

Among organisations interviewed, there was moderate demand for inventory manager roles. Having staff who are trained to understanding the complexities, compliance requirements and unique problems that may arise in managing space-specific inventories can contribute to better inventory management practices among Australian space organisations.

Recommended changes to the VET system to better support maintaining space-specific inventories would be to augment the relevant TLI companion volume implementation guide for the unit *TLIA5058 – Manage facility and inventory requirements* to include space industry context, as indicated in Table 6.

5.2 Automation and efficiency at scale

Australian space companies want to be successful. They want to grow and deliver high quality goods and services, to build the industry and the nation toward greater success. This was a common thread among those interviewed.

With the industry in its early stages, many organisations are startups that do not yet have well-defined processes for their T&L operations. With a lack of available training on T&L for space companies, most have needed to learn as they go. This has resulted in largely organic growth across an industry that lacks the level of structure and systemisation needed for operating at larger scales.

As the global space sector grows, these smaller companies will need to adopt more efficient and coordinated systems and processes if they are to maintain their position in the industry. With increased international competition surrounding—and entering—a smaller Australian industry in its early days, this need for efficiency becomes essential if the Australian space industry is going to remain a player on the world stage.

Companies operating through large quantities of products or mass-market service delivery models can gain a lot by improving their efficiency as they scale. This helps keep costs and prices down and shortens timespans across the supply chain. This was something that interested many of the participants that were interviewed.

However, some companies deal with bespoke equipment, as singular items or in small quantities, that is typically very expensive. Being designed specifically for a single customer, the demand is low and the cost when something goes wrong is high. In these business models, scaling through automated mass production is not likely to be a suitable approach. While efficiency remains important, profit margins are higher on individual items, making quality the primary focus for profitability. Nonetheless, other aspects of the business can still be automated.

Automation is already well established in many supply chains across industries, both globally and in Australia. Automation is one of the main technologies linked to what is commonly known as the fourth industrial revolution, or Industry 4.0.

One participant believed automation was an important step for the future expansion of the industry:

> It's going to become similar to how SpaceX is landing rockets and reusing them. I think there may be a substantial amount of automation and supply chain integration: autonomous packing of payloads, autonomous launch and refuel, [that] sort of thing. And I think that level of automation means that the launch cadence will increase drastically. So that's going to be a major thing.

The participant described how Australia risks falling behind global advances if we are not able to keep pace with these developments. They mentioned the risk to Australia's commerce and reputation. For the space industry, they highlighted the importance of examining how other industries are developing efficient, automated systems. They also believed there was a strong future for Australian space technology and services to contribute to regular companies in other industries.

Other participants supported this wider approach. They spoke of how the Australian space industry is currently somewhat insular. Expanding the market by developing useful goods and services for new markets—adjacent industries, other industries, regular companies—can lead to greater demand, thereby enhancing the capacity to scale. Adding automation and efficiency practices to this can support supply chain networks and vertical integration while greatly accelerating the overall sector. This can lead to more launches, which brings greater publicity and attracts greater interest.

Commercial success reinvested into the development of highly efficient automated systems that meet the wider needs of national and global industries can drive the Australian space industry forward.

Efficient operations, including automation, to scale a business require increased sales efforts to build demand among customers. This in turn requires additional staff. Many companies mentioned how they currently do not presently have need for extra staff to operate T&L within their business. This suggests the industry is not in a particularly expansive phase.

However, if the industry is to continue, it will inevitably enter new growth phases. As a future focused industry that thrives upon and contributes greatly to technological advances and provides valuable services to many adjacent industries, the space industry does not appear to be going away. This highlights the need to think long-term, which several participants emphasised. More efficient supply chains and automated systems can build a stronger foundation upon which the Australian space industry can develop for decades, even centuries, to come. Workforce requirements will grow, increasing training demand, particularly in relation to systematic processes for T&L.

While such training does exist for general industry (for example, Swinburne University's Industry 4.0 program, discussed in Section 3.1, 'An overview of Higher Education pathways'), no such training is targeted at the space sector.

Developing training material for supply chain and systems efficiency and automation that targets (markets to) the space sector would provide a key for accelerating the growth of the Australian space industry. This could include not only some space-focused advertising to attract interested students into this program, but also include contextualised space learning material (examples, case studies and activities), perhaps short courses as components of such training, and perhaps also apprenticeship programs with interested space companies.

Specific recommendations to existing VET units to facilitate automation and efficiency at scale for the space industry are listed in Table 6. These include adding new electives to *TLI50224 – Diploma of Logistics* and augmenting the relevant TLI companion volume implementation guide to include logistics context for the space industry, consideration for the Defence and Strategic Goods List, and context for sensitive components and large oversized sections relating to the space industry. An additional recommendation is to encourage collaboration between the space industry and existing industry 4.0 programs, to facilitate advanced manufacturing, automation and design thinking within the space industry—for example: Swinburne University's Industry 4.0 project and their Associate Degree of Applied Technologies.

6 Warehouse management

Context:

Many space companies are not yet operating at a scale that requires warehousing. Companies are looking to a future where facilities support advanced manufacturing and logistics automation.

Gap:

Space products often involve dangerous goods and sensitive or restricted technologies. These require special handling, storage, packaging and transporting, including the use of cleanrooms. Relevant training for the space industry is lacking in these areas.

Solution:

Add existing VET units on packaging as electives to logistics qualifications. Develop new units appropriate to the space industry for handling sensitive technologies, working within cleanrooms, warehousing and developing advanced facilities.

> “The majority of my role is working with Safe Work SA to obtain all the explosive licenses required, including the classification of explosives, because you can't bring an explosive into South Australia until it's been classified.
>
> – Interview participant

Warehouse management typically involves activities such as packaging, handling and storage of inventory; ordering and receiving stock; fulfilling orders; maintenance of the warehouse space; and overseeing labour.

The relative proportions of involvement in warehouse management for interviewed space organisations is shown in Table 7.

Table 7. Relative proportions of the space value-chain segments involved in warehouse management

T&L area → / ↓ Space value-chain segment	C Warehouse management
1 Ground segment manufacturing and services	7
2 Space segment manufacturing and services	5
3 Space operations	5
4 Space applications	5
5 Space enablers and support services	3

The activity among participants in warehouse management was low. Many of the organisations interviewed did not use warehouses. Some had minimal storage needs, while others operated in a way that did not require any storage space. A few had established warehouses. Other organisations mentioned that they would like to expand into warehouse space in the future as they scale their production and distribution. In many cases, the storage and handling of dangerous goods and sensitive parts and equipment was a major element of warehousing.

The interviews highlighted key skills and areas of knowledge relevant to warehouse management. New or emerging roles were not clearly identified due to the space industry being in a nascent stage of development. Interview data was analysed for matches within existing VET units of competency to identify skills or knowledge gaps. Based on industry demand for particular skills or knowledge, proposed solutions were developed. A summary of these findings is provided in Table 8. The potential solutions recommended should be read in the context of fewer interviewees highlighting these needs.

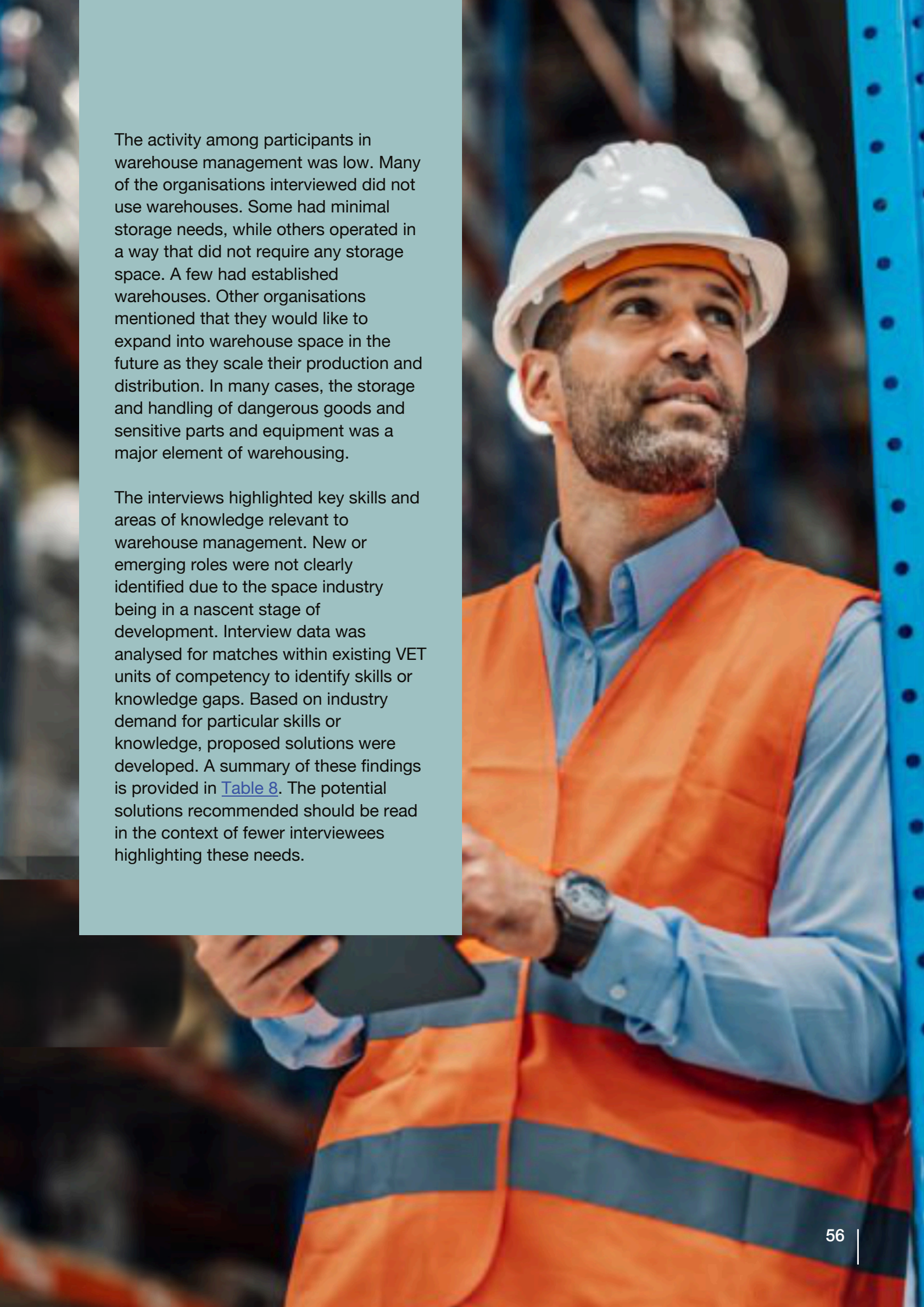


Table 8. Summary of warehouse management findings

Key skills or knowledge	Existing training	Training gaps
Handling, packaging and storing dangerous goods	*TLIA5029 – Plan and manage storage of dangerous goods and hazardous substances* *DEFEXO001 – Work safely with explosive ordnance* *ICPPTD302 – Set up and produce 3D prints*	Packaging
Handling, packaging and storing sensitive parts and equipment	No relevant units identified	Handling, packaging and storing sensitive parts and equipment
Working within cleanrooms	No relevant units identified	Working with cleanrooms within the space industry
Warehousing and advanced facilities	*TLIA5058 – Manage facility and inventory requirements* would be appropriate for space enterprises planning to develop storage facilities.	Processes linked to appropriately warehousing space items

Potential solutions
For *TLIA5029 – Plan and manage storage of dangerous goods and hazardous substances*, review of the number of enrolments there has been for this unit. If the numbers are low, suggest removing the unit's reference to bulk handling as this is unlikely to be suitable for space context. This unit should be added to the general elective units in the *TLI50422 – Diploma of Materiel Logistics*. Add *DEFEXO001 – Work safely with explosive ordnance* to the Group B: General elective units for *TLI50224 – Diploma of Logistics*. Add *ICPPTD302 – Set up and produce 3D prints* to the Group B: General elective units for *TLI50224 – Diploma of Logistics*, to allow for 3D printing of packaging for space items. This unit currently only appears within AQF level 3 qualifications, so this may not be possible.
Develop a purpose written unit to cover these requirements for ST&L.
Develop a purpose written unit to cover these requirements for ST&L.
Develop a purpose written unit to cover these requirements for ST&L. Market this training as part of a career in the space industry. Include course material relevant to warehousing for the space industry in existing programs in advanced manufacturing, automation and infrastructure that combine universities, VET and industry.

6.1 Handling, packaging and storing dangerous goods

A number of organisations mentioned that they work with dangerous goods. This included mainly fuels (solid propellants, liquid fuels and gases), however some participants mentioned large batteries, one mentioned epoxies and another mentioned biological material. There was no mention of radioactive material.

Knowledge of how to handle, package and store such materials is not a unique requirement to the space industry. However, this study indicated that working with dangerous goods is a skill that is in demand within the space industry. A single dangerous material might have many uses across a range of industries, such that training in how to handle and store that material may not be unique to space. Nonetheless, understanding how to handle, package and store dangerous goods is a useful skill for ST&L.

Transporting dangerous goods was often outsourced to a third-party transport company. This makes sense for companies whose area of expertise in not in such transportation. Engaging with a trusted, well-established supplier for these services can reduce (for a price) the complications around import/export regulations, insurance, and safety.

However, other companies mentioned that they would have found it so much easier in the beginning of their business if they had access to a simple, up-to-date source of information on how to handle dangerous cargo, how to package it, store it, put it onto a truck, a ship, an aircraft, what the regulations are around this for particular materials, and so on. This applies to those companies who did some (or all) of the handling requirements themselves. Several other participants spoke of how useful similar information would be (this is discussed further in Section 7.3, 'Informative resources on Transport and Logistics and Australian regulations'). They mentioned that this could be tailored to the space industry, as an online resource (such as a website), a short training course, or some kind of advisory service.

Participants discussed the importance of having competent and knowledgeable staff to handle, package and store dangerous goods. The potential costs—impacting safety, infrastructure, business, and legal compliance—are too high to risk having untrained personnel. Many of these skills are transferable across various industries, making them not unique to the space sector.

However, to support the space industry in warehousing skills related to dangerous goods, there is value in making some specific changes to existing training. The unit *DEFEXO001 – Work safely with explosive ordnance* should be added as an elective unit for *TLI50224 – Diploma of Logistics*. Changes should also be made to *TLIA5029 – Plan and manage storage of dangerous goods and hazardous substances* to make it more suitable for a space context, and this unit should also be added to the general elective units in the *TLI50422 – Diploma of Materiel Logistics*. *ICPPTD302 – Set up and produce 3D prints* should be added as an elective unit for *TLI50224 – Diploma of Logistics*, to allow for 3D printing of packaging for space items. These changes are detailed in Table 8.

Additionally, marketing relevant training to the space sector, and to students interested in such careers, could attract people interested in a career in space to gain a space warehousing skillset, which the industry has indicated is useful.

6.2 Handling, packaging and storing sensitive parts and equipment

Similar to dangerous goods, many space companies discussed how their work involves handling, packaging and storing of sensitive parts and equipment. While some participants used the term ‘sensitive’ as a synonym for ‘restricted’ items—meaning defence-export-controlled technologies—in this study ‘sensitive’ refers to items and technologies that are easily damaged due to movement, vibrations, temperature and other environmental factors, including humidity, dust, pollution, or other substances. Items may be fragile or very small. They can include high-quality lenses, electronic components, and other highly calibrated equipment.

Most companies working with sensitive items tended to deal with single pieces of equipment or small sets of items, rather than large quantities of mass-produced products. Such items needed extra attention in their handling, packaging and storing.

Participants mentioned how some items needed to be carefully moved and suitably packed for transportation. This might require custom designed boxes to handle shock or temperature changes during transport. One participant spoke of how they needed a custom aluminium box to be designed for a spacecraft they were transporting first nationally, then internationally.

Items could require certain temperature or humidity ranges during storage. Participants expressed how upskilling in this area of knowledge would be useful for their staff. The right packaging considerations and environmental controls are essential for sensitive items, and failure to understand and apply these typically means damage to often-expensive items.

One participant said about sensitive components:

> “If you don't know how to pack them, you can actually damage them without even knowing that you're damaging them and usually it's orbitally expensive. You know, for the space industry, there's an extra two zeros … and we've had it before where it's arrived at the other end and it's broken.

Companies mentioned the importance of inspecting incoming items for damage. Inspection includes specific requirements around packing and unpacking items. It could require detailed technical testing. In some cases, extra sensitive equipment required the use of cleanrooms (see Section 6.3, ‘Working within cleanrooms’). One participant also mentioned that they use 3D printing to create customised packaging to protect sensitive space equipment.

One participant mentioned how some airlines would simply ignore temperature sensitivity requirements. Where an item was required to be stored in a climate-controlled environment, this would occur only some of the time. Other participants warned of being very careful when dealing with less-developed countries regarding storage, packaging and handling. And another participant highlighted the importance of considering how the road conditions differ in outback Australia, and packaging for dust and temperature extremes. The requirements for sensitive items makes choosing the right transportation routes and suppliers very important, and this tends to increase packaging, storage and transportation costs.

Although common to the space industry, the requirements around sensitive items are not particularly unique to space; similar needs are found in other industries—typically those involving highly sophisticated technology, such medicine, mining, scientific research, or defence.

However, no relevant VET units on handling, packaging and storing sensitive parts and equipment were identified. This training gap could be supported by the development of a purpose-written logistics training unit to cover these requirements within the space industry. Participants mentioned that they would find training material on handling sensitive goods for the space industry very useful.

6.3 Working within cleanrooms

Many companies spoke of the importance of understanding how to work within cleanrooms. A cleanroom is a sealed environment designed to minimise airborne particulates (microscopic atmospheric solid or liquid matter). Cleanrooms are environmentally controlled and cleansed to maintain very low levels of contamination, including dust, airborne organisms and vaporised particles. Temperature, humidity and static electricity are closely controlled within cleanrooms.

As a National Aeronautics and Space Administration (NASA) article mentions, 'almost all those involved in space travel have one thing in common: a cleanroom' and 'even small particles are capable of endangering missions. Smeared optics, dirty solder joints, unclean bearings are weak points that must be prevented'. [41]

Understanding how to setup, maintain, and work within cleanrooms was considered an important skillset for the space industry, primarily for the purpose of handling electronic components and sensitive equipment. This included knowledge of how to receive components and equipment, unpack and pack them, and assemble and test items. Participants spoke of knowing how to apply appropriate environmental controls (temperature, humidity etc.) and correctly use personal protective equipment (PPE) within cleanrooms.

Certain items would require a complex cleaning process following shipping, before being brought into a cleanroom. Manufacturing could also occur within cleanrooms, using special cranes designed for these environments. Products were tested and then packed in cleanrooms, before being shipped in a protected state to their location. These very technical procedures are an essential step in a logistics supply chain. If not applied correctly, items may be damaged leading to problems and failures down the line, at a large cost to a company's finances and reputation.

Cleanrooms are very important for the space industry. While also found in other industries, one can imagine the role of cleanrooms in the not-too-distant future, if humans ever build a base on the Moon or Mars, for example. Yet even today, such an environment is essential for any spacecraft and for ground operations. Having technicians and other staff trained in the various aspects of a cleanroom was a common requirement among those interviewed. Cleanroom knowledge and skills are therefore in demand for the space industry.

Still, no relevant VET units on working within cleanrooms were identified. This training gap could be supported by the development of a purpose-written logistics training unit to cover these requirements within the space industry.

6.4 Warehousing and advanced facilities

Companies talked about the advanced facilities we have in Australia and whether or not these are being put to effective use.

One example given was around cryogenics facilities. Cryogenics studies how materials behave at very low temperatures (less than -153°C). Space equipment is typically exposed to such temperatures. Outer space can have temperatures as low as -270°C, and some of the outer planets (Uranus, Neptune, Pluto) also experience cryogenic temperatures (Jupiter does not quite meet this threshold, and Saturn comes close). Craters near the Moon's poles can reach as low as -246°C and Mercury, although nearest to the sun, can reach as low as -180°C at night. [42, 43]

Cryogenics facilities are important for storing and working with particular materials (such as liquid hydrogen, methane and oxygen) and for testing how space equipment behaves under extremely low temperatures. Such facilities are very useful for researching and developing space equipment.

One participant expressed their concern that Australia has the facilities for more advanced space activities (such as cryogenics) but not the knowledge or willingness to actually use them to advance the space industry. They mentioned that Australia invests funds in establishing manufacturing facilities but is yet to develop a workforce with the knowledge or skills needed to use these facilities to our full advantage. The result is that space companies tend to work with experts outside of Australia. Likewise, overseas companies are less willing to come to Australia to do such work. The participant said they knew of one expert who visited Australia to speak with those working at such facilities only to find such facilities were being underutilised.

While local universities often have long waiting-lists and are costly, individuals seeking to learn advanced manufacturing, testing and integration for space projects can get certified qualifications cheaper and faster overseas. The participant's concern was that:

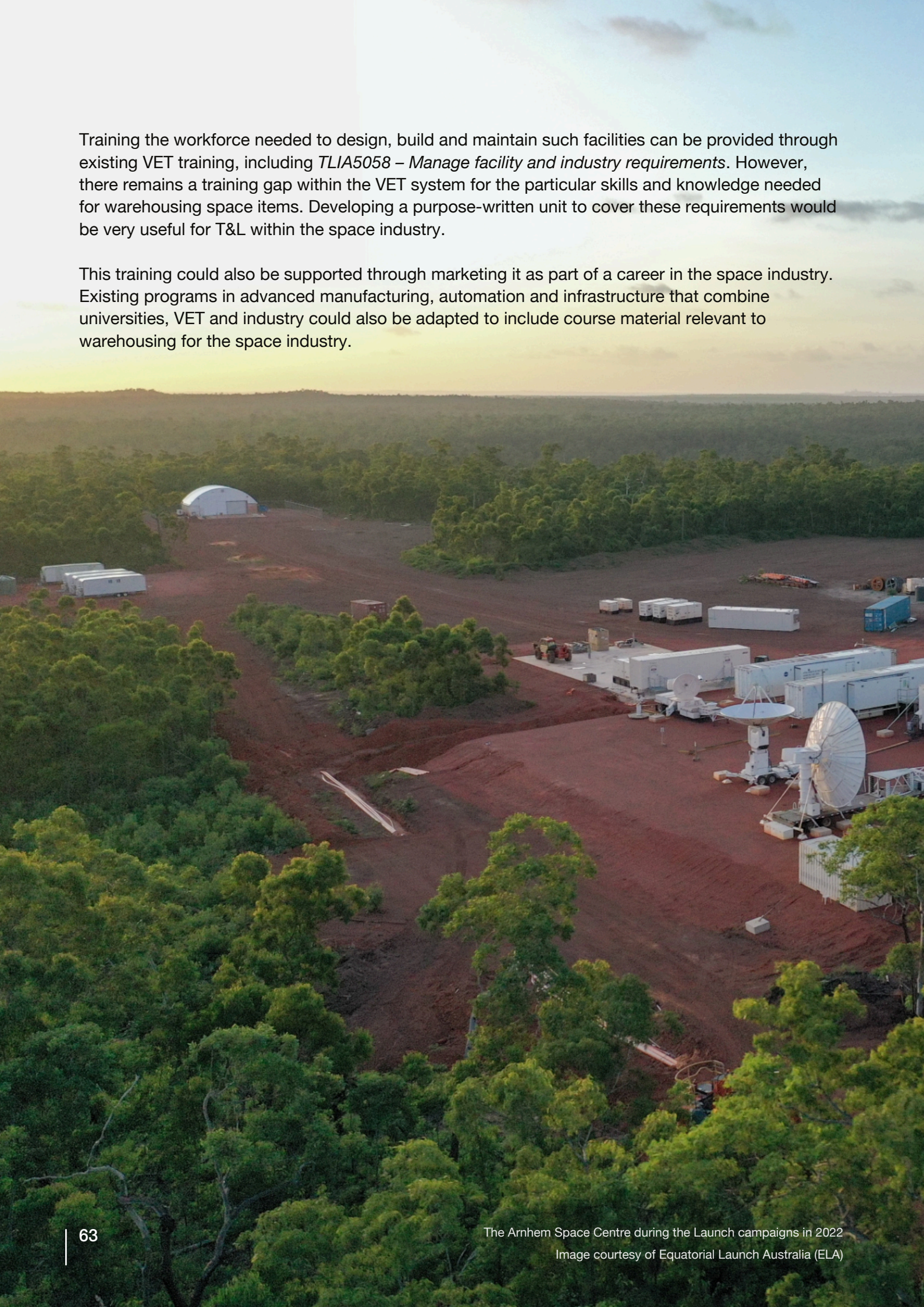
> "[There] probably just needs to be a lot more skin in the game for all the relevant stakeholders. Otherwise, we could have a space industry in name and the players within here [Australia] are just going outside [overseas] to get stuff done.

This critical view of the Australian space sector provides insight into what is needed to advance the space industry. Having impressive facilities for research and development without the skilled, knowledgeable workforce required to work within them to advance the industry will only result in Australia falling behind other countries.

While there is a distinction between warehouses and advanced facilities, there is also much crossover. Storage facilities are an integral part of T&L needs and would benefit from cooperative relationships with higher research and development of space technologies. Space-related research projects and advanced manufacturing facilities require infrastructure, including warehouses, designed to specific technical standards. They also require staff with the skills and knowledge to operate and maintain such facilities. These requirements are integral to the long-term growth of Australia's space industry and provide a focus point for universities, the VET sector, and industry to collaborate.

Training the workforce needed to design, build and maintain such facilities can be provided through existing VET training, including *TLIA5058 – Manage facility and industry requirements*. However, there remains a training gap within the VET system for the particular skills and knowledge needed for warehousing space items. Developing a purpose-written unit to cover these requirements would be very useful for T&L within the space industry.

This training could also be supported through marketing it as part of a career in the space industry. Existing programs in advanced manufacturing, automation and infrastructure that combine universities, VET and industry could also be adapted to include course material relevant to warehousing for the space industry.



The Arnhem Space Centre during the Launch campaigns in 2022
Image courtesy of Equatorial Launch Australia (ELA)

7 Transportation

Image courtesy of Southern Launch.

Context:

Transportation is the most active area of logistics for the space industry and is what is most commonly thought of by the term *logistics*.

Gap:

Understanding the requirements and regulations around imports and exports of space items is a huge challenge for industry.

Solution:

A wide range of changes to VET units and logistics courses can facilitate training in support of space transportation, including import/export regulations, customs, physical transportation requirements, and physical and cyber security.

> "We as a business are going to see quite rapid increase in exports. It's fundamentally a core part of our business.
>
> – Interview participant

Transportation involves the movement of raw materials, parts, equipment and products. Such movement can be local, national or global and can proceed by land, air, or sea—or even by space, as the industry develops. Transportation is an essential aspect of any supply chain and an important requirement for linking organisations and expanding trade.

The relative proportions of involvement in transportation for interviewed space organisations is shown in Table 9.

Table 9. Relative proportions of the space value-chain segments involved in transportation

T&L area → / ↓ Space value-chain segment	D Transportation
1 Ground segment manufacturing and services	10
2 Space segment manufacturing and services	9
3 Space operations	12
4 Space applications	14
5 Space enablers and support services	8

Among all organisations interviewed, transportation was the most prominent area of logistics, both in terms of their operational needs and in what they commonly understood logistics to mean. It was also the most challenging, as will become apparent from the findings discussed in this section. The greatest challenges involved the difficulty in understanding import and export regulations, navigating customs and, to a lesser degree, the logistics of moving large products, sensitive equipment or dangerous goods.

Image courtesy of Southern Launch.

The interviews highlighted key skills and areas of knowledge relevant to transportation. New or emerging roles were not clearly identified due to the space industry being in a nascent stage of development. Interview data was analysed for matches within existing VET units of competency to identify skills or knowledge gaps. Based on industry demand for particular skills or knowledge, proposed solutions were developed. A summary of these findings is provided in Table 10. The proposed solutions should be read in the context of more interviewees mentioning these needs.

Table 10. Summary of transportation findings

Key skills or knowledge	Existing training	Training gaps
Import/export regulations for space items	*TLIX0045 – Determine import/export prohibitions/restrictions* *TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding* *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo*	Space context Exporting to five-eyes countries International Traffic in Arms Regulations Legal matters relating to importing space products
Customs brokers and knowledge of international customs requirements	*TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo*	Working with customs brokers

Potential solutions

TLIX0045 – Determine import/export prohibitions/restrictions currently appears in *TLI50822 – Diploma of Customs Broking*. Add it to the Group B: General elective units for *TLI50224 – Diploma of Logistics*.

Augment the relevant companion volume implementation guide. Under the heading 'Information on relevant aspects of permit requirements may include:' add:

- *Defence and Strategic Goods List*

TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding currently appears in *TLI50119 – Diploma of International Freight Forwarding*. Add it to the Group B: General elective units for *TLI50224 – Diploma of Logistics*.

Augment the relevant companion volume implementation guide. Under the heading 'Applicable regulations and legislation may include:' add:

- *Australian dangerous goods code*

TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo currently appears in *TLI50119 – Diploma of International Freight Forwarding*. Add it to the Group B: General elective units for *TLI50224 – Diploma of Logistics*.

Augment the relevant companion volume implementation guide:

Under the heading 'Special freight transport services may include but are not limited to:' add:

- *transport of space industry equipment, components and propellants*

Under the heading 'Consultative processes may involve:' add

Specialist manufacturers (e.g. space equipment and components) and engineers for handling procedures

TLIL5064 currently appears in *TLI50119 – Diploma of International Freight Forwarding*. Add it to Group B: General elective units for *TLI50224 – Diploma of Logistics*.

Augment the relevant companion volume implementation guide. Under the heading 'Consultative processes may involve:' add

Customs brokers

Key skills or knowledge	Existing training	Training gaps
Informative resources on Transport and Logistics and Australian regulations	*TLIO5006 – Plan and manage security procedures for transferring and transporting dangerous goods* *TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding* *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* *TLIA5029 – Plan and manage storage of dangerous goods and hazardous substances* *TLIX0045 – Determine import/export prohibitions/restrictions*	A single unit of competency which draws together all legislation and regulations relevant to ST&L

Potential solutions

TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding currently appears in *TLI50119 – Diploma of International Freight Forwarding.*

Add it to the Group B: General elective units for *TLI50224 – Diploma of Logistics*.

Augment the relevant companion volume implementation guide.
Under the heading 'Applicable regulations and legislation may include:' add:

Australian dangerous goods code

TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo from *TLI50119 – Diploma of International Freight Forwarding*. Add it to Group B: General elective units for *TLI50224 – Diploma of Logistics*

For *TLIA5029 - Plan and manage storage of dangerous goods and hazardous substances*, review the number of enrolments there has been for this unit. If numbers are low, suggest removing references to bulk handling as this is unlikely to be suitable for the space industry. This unit should be added to the general elective units in the *TLI50422 - Diploma of Materiel Logistics*.

TLIX0045 – Determine import/export prohibitions/restrictions currently appears in *TLI50822 – Diploma of Customs Broking*. Add it to the Group B: General elective units for *TLI50224 – Diploma of Logistics*.

Augment the relevant companion volume implementation guide. Under the heading 'Information on relevant aspects of permit requirements may include:' add:

Defence and Strategic Goods List

There does not appear to be a unit of competency that focuses purely on transport regulations for the space industry. Prepare a new unit to cover Australian (state and national) and international legislation, including but not limited to Incoterms, importing/exporting rocket propellants, electromagnetic spectrum rights, International Traffic in Arms Regulations, Export Administration Regulations, the Defence and Strategic Goods List, and the *Space (Launches and Returns) Act 2018* and additional relevant Australian standards.

Key skills or knowledge	Existing training	Training gaps
Physical transportation requirements for space equipment	*TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* *TLIX0070 – Manage materiel logistics operations* *TLIL5026 – Manage export logistics*	Accessing secure facilities Transporting biological material Insurance requirements
Transportation security	*BSBXCS402 – Promote workplace cyber security awareness and best practices* *TLIO5006 – Plan and manage security procedures for transferring and transporting dangerous goods*	Space Transport and Logistics context

Potential solutions

TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo is from *TLI50119 – Diploma of International Freight Forwarding*. Add it to Group B: General elective units for *TLI50224 – Diploma of Logistics*.

Augment the relevant companion volume implementation guide. Under the heading 'Special freight transport services may include but are not limited to:' add:

- *transport of space industry equipment, components and materials*
- *transport of specialist space industry technology including lenses, electronics, and other environmentally sensitive components*
- *transport of biological material for the space industry*

Under the heading 'Communications systems may involve:' add *GPS tracking*

To 'Knowledge Evidence', add *Procedures and documentation for accessing secure facilities*

For *TLIL5026 – Manage export logistics*, augment the relevant TLI companion volume implementation guide to include:

Under the heading 'Work may be undertaken: in various work environments in the sections of the warehousing, storage, transport and distribution industries involved in export logistics' add

including within the space industry

Under the heading 'Consignments may be:' add

Sensitive components or large oversized sections relating to the space industry

Recommend developing a new unit to fully cover space industry logistics insurance.

BSBXCS402 – Promote workplace cyber security awareness and best practices should be added to Group B: General elective units for *TLI50224 – Diploma of Logistics*.

For *TLIO5006 – Plan and manage security procedures for transferring and transporting dangerous goods*, after the unit application statement sentence '… but may be applicable to individuals in broader logistics roles', add:

including the space industry.

Add *TLIO5006* to the Group B: General elective units for *TLI50224 – Diploma of Logistics*.

7.1 Import/export regulations for space items

Almost every company that was interviewed mentioned the need to understand the regulations and controls around transporting space equipment and related components. This is not because space equipment is a regulated industry in itself, but because such items often fall into categories that are already regulated, whether dangerous goods, explosives, defence equipment (including dual-use technologies), biological materials, and so on.

For Australia, some space items are regulated under the Defence and Strategic Goods List, an Australian legislative instrument that applies to certain categories of goods, technologies and software exported from Australia.[44] Some of these categories include space launch vehicles and other space items, hence its applicability to the space industry.

Only one participant mentioned the Defence and Strategic Goods List, while the vast majority of participants repeatedly mentioned United States regulations, specifically the International Traffic-in-Arms Regulations (ITAR) and Export Administration Regulations (EAR). Whether this shows a lack of awareness of Australian export regulations compared to United States regulations, or that the former simply was not mentioned, is not certain—the one participant aware of this seemed to think more awareness was required. They also believed there was a lot of future potential for a workforce with knowledge of these Australian regulations to better support the space industry.

Image courtesy of Southern Launch.

Nonetheless, both United States and Australian regulations need to be considered when space items are exported from the United States (under ITAR and EAR) and imported into Australia (under the Defence and Strategic Goods List).

The United States applies ITAR and EAR to control information and items related to military technologies and services. Many participants emphasised how it was essential for space companies to understand these regulations when working with the United States (and its people and technology), since rockets and launch vehicles are classified under the same category as missiles, bombs and mines.[45]

Failure to be well versed in ITAR and EAR, which often require specialised legal expertise, could lead to mistakes being made unknowingly—the consequences of which could include huge financial penalties, enforced compliance measures and exclusion from future exports. Some participants were aware these regulations were changing (these changes came on October 23, 2024, and were the most significant change for space-related items since 2014).

Many participants also spoke of exporting to or importing from the United Kingdom or Europe, including Denmark, Germany, France, Sweden, the Netherlands, Italy, Spain and Romania. Some spoke of exporting to or importing from South America, New Zealand, India, Taiwan, Kenya, Singapore, United Arab Emirates, China and Hong Kong. International trade is a large and important aspect of business for Australian space companies, hence the importance of understanding the necessary regulations. One participant said that Singapore had clearly outlined requirements. However, most participants also expressed their frustration at how difficult it was to navigate overseas transportation requirements.

Many factors make transporting space equipment very complex. Different countries tended to have different regulations, standards, associated processes, taxes and other requirements. This means that companies exporting equipment to multiple locations need to understand multiple sets of regulations and requirements. There was little indication of international consistency. Understanding the local language and culture of different countries was also considered a useful area of knowledge when exporting or importing products.

Interviewees spoke of the complexities of exporting equipment to a location that required two stopovers. They spoke of the time-limits placed on items in transit before taxes were applied—for a $20 million rocket, a 5% or 10% tax can be costly. Being well-organised and having the right documentation, to avoid delays, was an important factor. Insurance was mentioned as another essential requirement; thankfully this can be more easily applied internationally. Participants also sought clear information on whether Goods and Services Tax (GST) or other overseas taxes applied to an imported item. A number of participants presented a mix of concerns and knowledge gaps.

The newness of the Australian space industry reveals a lack of consistent knowledge in domestic and international import/export regulations. Companies attempting to navigate this regulatory environment have relied largely upon learning on the job, asking others who have transported space equipment before, specialist consultants, and trial and error.

In seeking to understand how to import rockets, one participant spoke of how they had to:

> Develop relationships with Australian Border Force and Austrade and just working with the government officials as to how this happens and how we do this.

Their somewhat frustrated conclusion was that training on how to important rockets 'just doesn't exist'.

Another participant remarked about how they learnt what they needed to know at an event:

> So basically there's a bunch of space companies that are there and you'd end up in the same tea room as somebody else from another company and you say, oh, how did you go about that

The near-total absence of formal training in import/export regulations for transporting space equipment was the most strongly indicated need among the companies interviewed. Of all the organisations interviewed, the only participant who seemed to have a clear understanding of this process from the onset of their business was one who had a strong background in logistics from the Department of Defence. His view demonstrated confidence in the logistics requirements for his job:

> To me, there's absolutely nothing special about space logistics. Because at the end of the day, it's a hardware. You understand where it's got export controls, you can understand classification.

However, for most other participants, the logistics training they had done did not fully cover the needs of their role. They often struggled to find accessible, reliable information and training needed for the space industry.

Having such training available would greatly help Australian space companies to reduce the time (and cost) spent doing the groundwork themselves to try to understand such a complex set of disparate requirements. It would increase compliance with both Australian and foreign/international laws, prevent costly mistakes and mitigate risks. Such training would contribute to the foundations for a consistent, lawful Australian space transport industry.

Regulations change frequently, meaning any such training would require regular updates. Developing course material would require the appropriate legal, customs and industry input. Such material would be a highly valuable contribution, furthering the success of the Australian space industry.

This study therefore recommends the development of training material on import/export regulations for space items, covering both Australia and other countries, based on changes listed in Table 10. These include changes to *TLI50224 – Diploma of Logistics:*

- Add *TLIX0045 – Determine import/export prohibitions/restrictions* as an elective unit and include context for the Defence and Strategic Goods List.
- Add *TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding* as an elective unit and include context for the Australian dangerous goods code.

- Add *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* as an elective unit and include context for the transport of space industry equipment, components and propellants, and context for specialist manufacturers (e.g. space equipment and components) and engineers for handling procedures.

7.2 Customs brokers and knowledge of international customs requirements

The need to work with customs agencies and customs brokers was mentioned by a number of the interviewed organisations as an area of specialised knowledge. While essentially an element of import/export regulations, which has been already discussed earlier, customs brokers and knowledge of customs was specifically discussed of as part of the transportation process, therefore additional detail is included here. Participants commonly mentioned requirements such as preparing the correct paperwork, understanding customs processes, and understanding how other countries operate, both officially and in practice.

Getting products through customs quickly was a concern among participants. Delays could mean a complete halt to a company's supply chain, particularly for smaller companies that worked with single or small numbers of expensive and sophisticated technology. Timing in transportation can be essential to meet schedules and there is often a degree of uncertainty, particularly for overseas customs. Geopolitical uncertainty can compound this further.

In shipping products to a customer, one participant described the importance of:

> "Knowing how long it is going to take, because otherwise you're going to promise a customer, yes, you're going to have it on the 19th of October. [But] where is it? It's [stuck at] customs because I didn't set it in the right box frame or whatever. I did not meet customs regulations of that particular country. So then your customer is frustrated.

This and other very specific customs requirements could make the difference between success and failure for a business.

Rather than handling customs needs themselves, smaller organisations mentioned that they worked with external customs brokers—although this comes at a cost, it allowed them to bypass a lot of difficulties in this area. These organisations might have a logistics officer who would liaise with these brokers. Custom brokers can work with a number of clients across several industries. The demand for such a role is likely to increase with the growth of the space industry. One organisation made customs the responsibility of their customer, with the idea being that a customer would have a better understanding of the customs requirements in their own country.

Navigating the complexities of customs is an integral aspect of transportation for space companies. It requires a degree of expertise and is essential for business success. Some space companies have developed knowledge in this area, although this process was challenging.

Having the knowledge of international customs requirements can facilitate smooth international distribution of space products. Training people in this knowledge can enhance business for Australian space companies, and as the industry develops, the demand for more customs experts within the space industry will increase.

A specific recommendation to support the space industry in knowledge of customs and working with customs brokers, as listed in Table 10, is to add the unit *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* as an elective unit to *TLI50224 – Diploma of Logistics* and augment the relevant companion volume implementation guide under the heading 'Consultative processes may involve' to include customs brokers.

7.3 Informative resources on Transport and Logistics and Australian regulations

Several organisations mentioned how useful it would be for them to have access to a single-source, easily understandable, practical resource on Australian regulations specifically written for ST&L. Participants suggested this could include information on who to contact within government for official information on T&L requirements, which international bodies to contact, outlines of the international trade agreements with allied nations, and practical guidance on shipping and transportation within Australia. It could also include guidance on insurance for space equipment and cyber and physical security for space technologies.

As one participant stated, it was very difficult to find the right information for space transportation and customs requirements:

> "We have burned ourselves so many times, you know, where do you find it? You see in some cases, what happens is there is no set guidelines.

When transporting space equipment, participants stressed how the ever-changing regulatory landscape was a challenge to keep up with. An information resource that kept up to date with changing regulatory requirements could greatly assist the industry.

Participants said this information could be either on a website or in a training course. They stated that the current lack of accessible information made it extremely difficult for many space organisations to understand what was required from both state/territory and federal governments in relation to T&L. This meant organisations spent a lot of time just trying to grapple with these requirements, in some cases costing their business also in resources, finances or reputation due to lacking the knowledge to properly navigate the complex regulatory environment.

One participant, like many others, expressed how exporting space equipment was a major challenge:

> "Since starting to export satellites for launch and other things, it's a whole can of worms. It is a lot of information to absorb.

The information is present, but not well organised or refined into accessible resources, according to participants. Information for T&L applicable to the space industry is absent from VET and university courses. One participant spoke of how they had completed some logistics units within their Bachelor of Logistics degree and had not found these particularly useful for the work they were currently doing, which involved importing space technologies and navigating customs regulations in Australia:

> Again, what I recall learning in the logistics units within my degree was more just around Incoterms and cross-docking. It wasn't around what you might face with treaties, regulations, biosecurity, customs, dangerous goods or anything that isn't just general freight.

The participant demonstrated an appetite for learning material, however, that would cover the skills and knowledge needed to better support their role:

> From understanding the shipping logistics internationally coming in around biosecurity and customs and the likes of that, if there was a course or a reference site or something I could go to for that, I would happily attend that.

Some participants suggested the Australian Space Agency should provide this information:

> So within the Agency … there could be one person who we could go to and say, right, this is our problem, we've got to export it to—pick a country that's slightly dodgy—is it something we can do?.

One participant highlighted how the Australian Space Agency was providing training resources, but not for T&L:

> Even our own industry representatives, the Australian Space Agency … I've gone through their website to try and find whether there are training resources. There's plenty of them, but they're mostly for engineers. They're mostly for people who build rockets, people who put fuel in rockets, people who build anything rocket related.

These examples highlight the demand for ST&L information resources. Given the importance of understanding import and export regulations and other T&L requirements, and the consequences for space businesses in not understanding them, having a single, accessible source of easy-to-apply, up-to-date resources on ST&L regulations and other practical information would be very useful for the Australian space industry.

Training for a similar purpose would also be highly useful. While the space industry often shares points of commonality with other industries, training material that could group all these needs into a single course or a series of units (perhaps as electives within a more general logistics course) would be extremely valuable for the Australian space industry. It would provide new companies with the knowledge and certainty to move forward in their businesses. It would allow established companies to hire graduates of such training material, knowing they are well versed in the fundamentals needed for ST&L, and it would help bring consistency and efficiency across the industry, allowing space companies to accelerate their operations.

Specific VET recommendations to support the Australian space industry in accessing informative resources on Transport and Logistics are detailed in Table 10. These include adding electives and relevant context to *TLI50224 – Diploma of Logistics* as follows:

- Add *TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding* currently as an elective and include context for the Australian dangerous goods code.

- Add *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* as an elective.

- Add *TLIX0045 – Determine import/ export prohibitions/restrictions* as an elective and include context for the Defence and Strategic Goods List.

For *TLIA5029 - Plan and manage storage of dangerous goods and hazardous substances*, this study recommends a review the number of enrolments there has been for this unit. If numbers are low, remove references to bulk handling as this is unlikely to be suitable for the space industry. This unit should be added to the general elective units in the *TLI50422 - Diploma of Materiel Logistics*.

Additionally, there does not appear to be a unit of competency that focuses purely on transport regulations for the space industry. This study strongly recommends preparing a new unit to cover Australian (state and national) and international legislation, including but not limited to Incoterms, importing/exporting rocket propellants, electromagnetic spectrum rights, International Traffic in Arms Regulations, Export Administration Regulations, the Defence and Strategic Goods List, the *Space (Launches and Returns) Act 2018* and any additional relevant Australian standards.

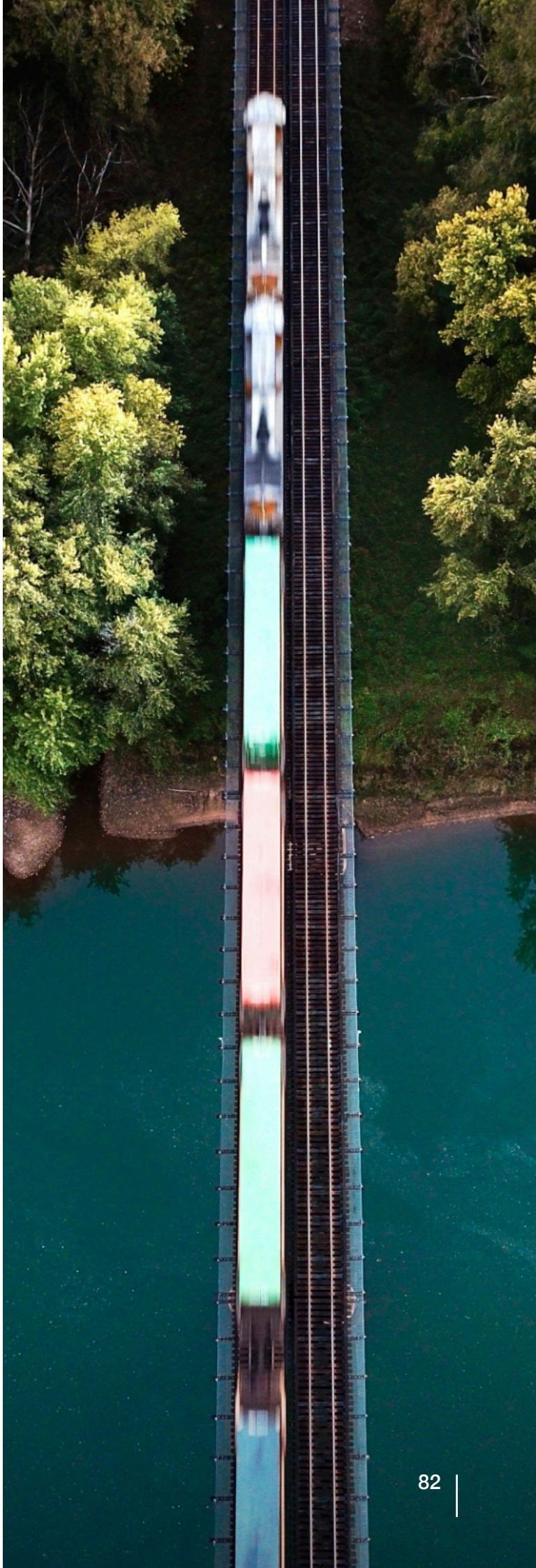


Photo by Sid Suratia on Unsplash

7.4 Physical transportation requirements for space equipment

Notwithstanding some unique circumstances, many of the physical transportation challenges faced by space companies are similar to those faced by adjacent industries, such as mining, defence, aviation, agriculture or medicine. Transported space items may be Oversize Overmass (OSOM); dangerous, restricted or sensitive; or simply awkward to package and move. Items could require certain types of equipment or vehicles to move, which may include specific vehicle types for transportation by road, rail, sea or air.

Participants spoke of how every point of the transportation route required forward consideration. The packaging an item was sent in needed to be suitable across multiple routes and checkpoints. Packaging needed to consider vibrations, movement, shock, temperatures and environmental factors, weight loads, GPS tracking equipment, and other factors.

Photo by Jacques Bobb on Unsplash

Companies spoke about needing to move large equipment, including OSOM items, and some believed the demand for moving larger items was going to increase in the coming years.

One participant mentioned how they needed to transport items in containers larger than the standard 20-foot containers. They also needed to consider different requirements for transportation not only internationally, but across different states within Australia. As with the previous section on available information for ST&L, this participant had trouble finding the relevant information for transporting such large items. They observed the general lack of structured procedures for transportation across the space industry:

> "I feel like everyone is just sorting it out by themselves, by the contact and the someone who knows someone that knows someone, and there is no core body of [knowledge], like structured guidelines, you know, about how to do that.

As with many other tasks within ST&L, people often learnt how to transport items on the job, simply because the right training, expertise or relevant information was difficult to find. As one participant said:

> "People can understand the regulations, but can they physically do it? That's the other part. On the job. You'd be surprised how many people just do on the job learning, training, and just get things done on the job.

Other challenges companies faced included transporting space equipment by road to remote locations within Australia, such as launch sites. The equipment could be very large. Road conditions may not be ideal and could include dust, vibrations and high temperatures. Packing was a primary consideration, to ensure safety and avoid damage to equipment. Most companies that were interviewed relied upon third-party transportation companies for their remote transportation needs.

Business decisions were another element of transportation. A participant discussed their considerations around whether or not to transport propulsion systems fully fuelled—a decision affecting the physical transportation needs, but also the customer's needs at the other end. They mentioned how this process required more specialised knowledge to do it safely. This example highlights the crossover between physical transportation and more complex business decisions. It shows that while space companies need people who understand how to properly transport space items, including dangerous goods or restricted or sensitive equipment, they also need people who understand the commercial, security and legal implications.

This highlights the different types of skill and knowledge required for space transportation. Of the participants interviewed, some performed primarily physical tasks, inspecting and testing equipment, packaging and moving items, operating forklifts or cranes, driving vehicles, maintaining inventories and warehouses, and so on. Other people worked within knowledge roles, determining transportation routes, ascertaining requirements, liaising with customs, speaking with customers, calculating costs and timing, making complex business decisions, and developing innovative solutions to logistical challenges. Some people covered both the physical and knowledge requirements—this

was particularly prevalent among senior staff within smaller companies, due to the industry being somewhat new and undifferentiated.

The skillsets and knowledge required to meet the challenges for space transportation are largely similar to those required for transportation in other industries. While training in the fundamentals of T&L is available, it is not necessarily packaged for the space industry. Specific recommendations to change VET units and courses are detailed in Table 10. They include:

- Adding *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* as an elective unit for *TLI50224 – Diploma of Logistics,* and including context for transport of space industry equipment, components and materials; transport of specialist space industry technology, including lenses, electronics and other environmentally sensitive components; transport of biological material for the space industry; GPS tracking of transported items; and procedures and documentation for accessing secure facilities.
- *For TLIL5026 – Manage export logistics,* adding context for exporting in the space industry in work environments involving warehousing, storage, transport and distribution, and for consignments that may include sensitive components or large oversized sections relating to the space industry.
- Developing a new unit to fully cover insurance for space industry logistics.

Furthermore, marketing such learning material for careers in the space industry would attract interested people to gain the fundamental skills and knowledge needed to support transportation for the space industry, while also gaining a broader skillset for general T&L in other industries.

7.5 Transportation security

In a world of cloud computing, artificial intelligence and augmented reality, amid geopolitical uncertainty cyber security is one of the most rapidly growing markets. Cyber security is very important for the space industry, particularly because the industry deals with restricted and dual-use technologies. For similar reasons, physical security is essential. The cost of not knowing what's required for cyber and physical security around such items (and related intellectual property) can be very costly to a company and potentially dangerous for national security.

There are several areas to consider with regard to transportation and cyber and physical security, depending on how a space company operates.

The first area is where a space company has some crossover with the defence industry. Companies transporting Defence restricted items and technologies are required to adhere to Defence security protocols. Information systems linked to such activities are treated similarly.

A second area is the security concerns around Australian critical infrastructure, under the *Security of Critical Infrastructure Act 2018*.[46] While at present there are no critical infrastructure assets for space technologies listed under this Act, the transportation industry has a range of obligations which space companies need to understand when they are transporting items.[47] This area could become a higher priority for the space industry due to the recent Technology Safeguards Agreement (TSA) entering into force on 23 July 2024. The TSA allows United States space technology (such as rockets and satellites) to be launched from Australia, which could increase the space-related footprint for critical infrastructure within Australia.[48]

A third area, which is relevant to any company, is the fundamental cyber security a company has around its data systems and networks and the physical security of its premises and transported items. These are necessary to protect a space company from cyber and physical security breaches. Even where transported items are not restricted, the cost of security breaches can be crippling to business operations.

One participant remarked:

> "Australia needs to get really good at logistics and more so international specialty logistics with high security.

Generally, security during transportation was a recurring topic. Participants believed this would become increasingly important into the future. One company stated that they had their own security team; another mentioned that security clearances were required for staff working on projects connected to Defence. Security was also mentioned as a consideration for T&L documentation.

Surprisingly, only a few participants mentioned cyber security. One had completed a short course on the topic; another mentioned how they expected emerging roles in cyber security within the space sector. But the topic was absent from most discussions, which suggests in the present global climate a much greater need for awareness and conversation around cyber security for T&L within the space industry.

Only one participant spoke of it at length, emphasising how important it was for the industry to learn more about this area:

> "Data security expertise is going to be very, very useful because of supply chain attacks.

The participant continued, explaining how a physical breach can lead to a cyber incident:

> "I've seen the majority of cyber incidents occurring when something is being sent from one place to another … it's in the middle that you'll end up with some sort of security issue that will arise from people having physical access.

Another participant also highlighted this risk:

> "When it comes to Transport and Logistics operations, we're going to need people that are more like security professionals that are really tracking where the items are going, that the item is reaching point A to B in a timely manner and safely, and who is it reaching in between, especially when you send things overseas.
>
> For example, just to make sure that if you send a part that's going to go on a satellite that no one has actually opened it, changed something and then put it back.

A company's computer systems that manage their transportation activities can also be disrupted. A participant spoke of how cyber security was vital for:

> "Sensitive equipment or computing or even when it comes to the establishment of your data networks that are essential for maintaining your transportation and logistics networks. They are big, big targets.

Space T&L is unlikely to become a successful industry without proper consideration given to its cyber and physical security needs. Physical security roles tend to be flexible with regard to the industry. And while general training and career paths for cyber security are becoming increasingly widespread, so is the demand among all industries. Within the space sector, specialised cyber security roles are beginning to appear, but much less apparent for ST&L, which is a much more niche area.

Nonetheless, since there appears to be a lack of discussion around cyber security, and this is an essential need for a developing yet vulnerable space industry, there is value in marketing existing cyber security training to those interested in a career in space. Tailoring existing training material to include relevant contextual material for ST&L could also raise awareness of this need and career pathway.

Specific recommendations for the VET system to address some of the particularities of cyber and physical security for space transport include:

- Adding *BSBXCS402 – Promote workplace cyber security awareness and best practices* as an elective unit for *TLI50224 – Diploma of Logistics.*
- Adding *TLIO5006 – Plan and manage security procedures for transferring and transporting dangerous goods* as an elective unit for *TLI50224 – Diploma of Logistics* and including context in the unit's application statement for logistics roles in the space industry.

SpIRIT satellite being boxed up to leave Adelaide for launch integration and launch provider (SpaceX)
Image courtesy of Inovor Technologies

8 Returns, repairs and recycling

Context:

Returns, repairs and recycling have a relatively low volume of activity within the space industry, due to the nature of space product development and supply chains.

Gap:

Commercial and security constraints often make returns, repairs and recycling a costly endeavour. There is very little training available to guide best practices in this area of logistics.

Solution:

This study proposes developing a VET unit specifically for returns, repairs and recycling of space equipment, components and related materials.

Returns, repairs and recycling—also referred to as reverse logistics—combines the requirements around product returns, repairing faulty parts or products, asset recovery, maximising efficiency in material and by-product usage, preventing waste and environmental protection.

The relative proportions of involvement in returns, repairs and recycling for interviewed space organisations is shown in Table 11.

Table 11. Relative proportions of the space value-chain segments involved in returns, repairs and recycling

T&L area → / ↓ Space value-chain segment	E Returns, repairs and recycling
1 Ground segment manufacturing and services	6
2 Space segment manufacturing and services	7
3 Space operations	7
4 Space applications	9
5 Space enablers and support services	4

Returns, repairs and recycling was the second least mentioned area of logistics among those companies interviewed. Nonetheless it is an essential aspect of the logistics supply chain. When poorly managed it has the potential to create a great amount of inefficiency, loss of revenue, wastage and harm to the environment.

The reason this area of logistics was less mentioned may be due to the developing state of the Australian space industry, where the current focus of organisations is on getting started, raising funds, designing and building

products and getting these to customers. The space industry can also tend towards a long timeframe for the product development cycle. One participant remarked on the phases and timing of their activity:

> "So we're not importing anything, we're not shipping anything, we're doing absolutely nothing for like 12 months. Then all the things will be arriving. There'll be three months where 100 things are going to be turning up, and then there'll be a period where it's all about the whole spacecraft logistics, so as a company about our size, we go through these cycles and phases.

Space technologies can take years to develop and eventually sell, meaning many newer companies may not be in stage of development where reverse logistics is a primary concern. This does not, however, diminish the importance of this area of logistics.

Another reason for this area being less mentioned may be due to many companies working with small quantities of highly specialised and tailored products, rather than mass-produced products developed in large quantities. The result is fewer items to return, repair and recycle. In any case, returns, repairs and recycling are likely to become increasingly important as the industry matures.

The interviews highlighted key skills and areas of knowledge relevant to returns, repairs and recycling. New or emerging roles were not clearly identified due to the space industry being in a nascent stage of development. Interview data was analysed for matches within existing VET units of competency to identify skills or knowledge gaps. Based on industry demand for particular skills or knowledge, proposed solutions were developed. A summary of these findings is provided in Table 12. The potential solutions recommended should be read in the context of fewer interviewees highlighting these needs.

Table 12. Summary of returns, repairs and recycling findings

Key skills or knowledge	Existing training	Training gaps	Potential solutions
Efficient supply chain processes for reverse logistics	No relevant units identified	Managing returns and repairs of space items for overseas trade	Develop a new unit which covers returns, repairs and recycling of space equipment, components and related materials
Policies and documentation for returns, repairs and recycling	No relevant units identified	Repair and maintain satellite antennas Documentation for returns and testing (satellite equipment) Recycling space products	Develop a new unit which covers returns, repairs and recycling of space equipment, components and related materials

8.1 Efficient supply chain processes for reverse logistics

Some organisations mentioned the importance of developing efficient supply chains for their business, which included considerations for the proper handling of the reverse logistics phase of a supply chain. This was particularly a concern as they scale their operations.

Some of the main concerns around repairs, returns and recycling were loss of revenue from damaged or faulty items, protocols for conducting repairs, minimising waste and appropriate waste-product disposal, and inefficiencies when reverse logistics processes are scaled.

Participants spoke of how return freight costs were sometimes more expensive than the parts themselves, hence the question arose as to whether the return was worthwhile. Questions of asset recovery are also a factor here. One participant weighed up the value in returning an item where its transportation would cost more than the item itself, versus the implications of abandoning an asset. Another mentioned the engineering lessons learnt and the economic efficiency of repairs versus replacements to customers:

> "A part of this is driven from engineering and wanting to understand what maybe went wrong so we can improve on it. But in terms of the pure economic cost of repairing goods, sometimes we don't. We typically do not actually get into repairing something and reshipping it. We typically go for a replacement.

Returns and repairs were also a long process that may involve several stages of transportation to the right facility where the item could eventually be repaired, before being transported back to the customer again. As another participant remarked:

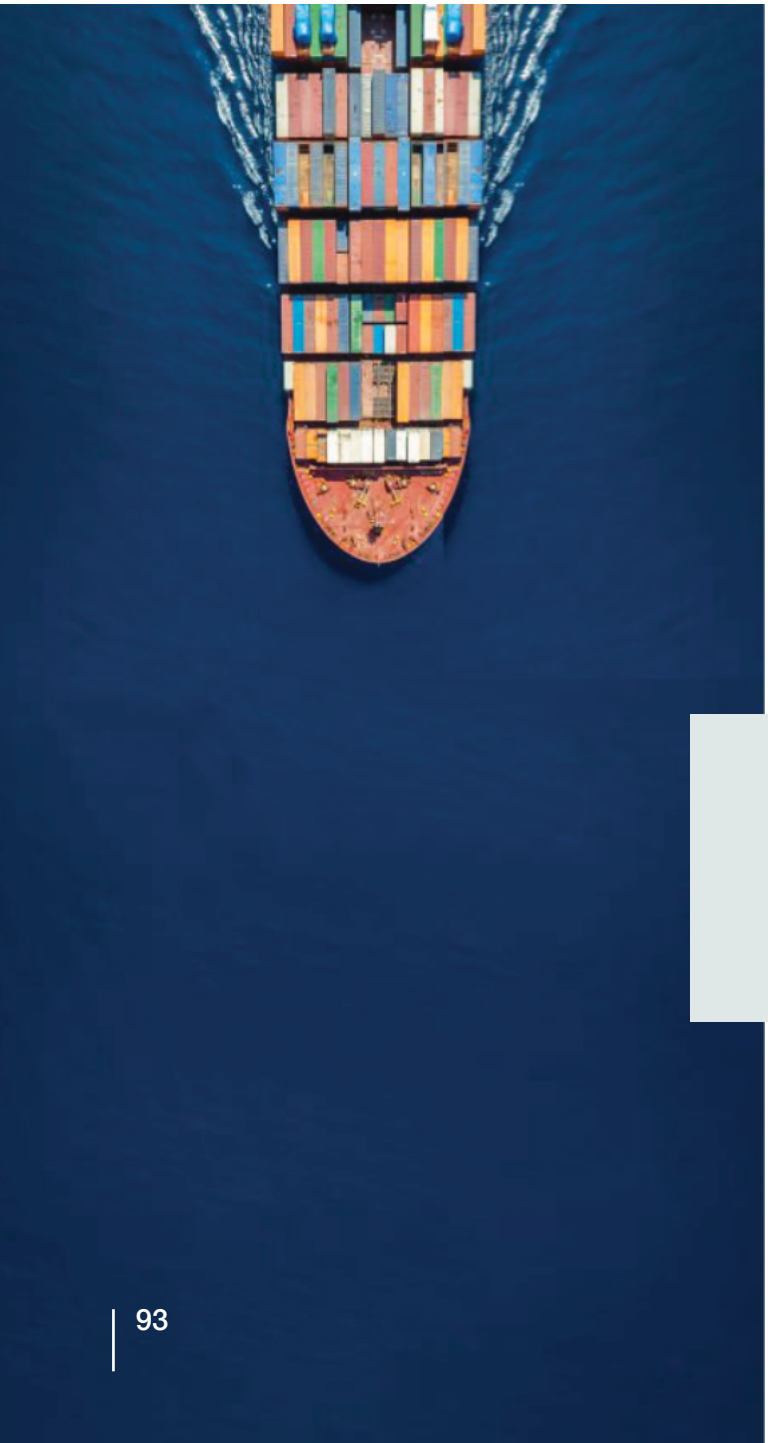
> "The vast majority of our returns for repairs are returned to our factory or resource management office. If something fails and we don't repair it ourselves, we arrange for that to be shipped back to the manufacturer or a repair agency that can do the work. And that thing gets repaired and sent back. It's a long, drawn-out process.

The requirements are more stringent for Defence restricted space items, which need special licences, depending on the import and export requirements, and could not simply be abandoned. Restricted items typically need to be returned to the provider or appropriately destroyed.[49] For repairs, restricted items would typically need specific licences for pre-approved products going to pre-approved repair destinations.[50] Inventory management and secure transportation are also essential in this process. By law, national security requirements cannot be compromised, meaning that a business may need to make adjustments in other areas for commercial efficiency and cost reduction, in order to accommodate the extra complexities and costs that come with maintaining security requirements.

Participants were hopeful that recycling would become a more prominent aspect of the space supply chain and expected this to occur in the future. However, like many other areas of ST&L, there are regulatory and logistical complications that make it difficult.

The logistical, commercial and security challenges of returns, repairs and recycling for the space industry are upheld by a lack of accessible training for the space industry in this specific area of logistics. Units or short courses that focus exclusively on reverse logistics in the space industry could be quite useful to better orientate company staff to the realities of this area.

As detailed in Table 12, this study recommends developing a new unit for the VET system that covers returns, repairs and recycling of space equipment, components and related materials.



8.2 Policies and documentation for returns, repairs and recycling

Participants also mentioned the importance of having clear company policies and correct documentation for returns, repairs and recycling.

Space products that companies built were often highly sensitive, therefore easily damaged, and required great care in storing, packaging and transporting. Ensuring that a company's repair policies accounted for this commercial risk was essential from a business perspective. Many space items also included dangerous materials (typically chemical hazards and sometimes biological hazards), which meant their recycling or disposal is strictly regulated. Companies required the appropriate policy and procedures in place to ensure such materials were safely handled.

Insurance considerations for returns and repairs was another factor, especially where sensitive equipment or dangerous goods were involved. Companies needed to consider insurance both in relation to customers and suppliers. One participant expressed the difficulty they faced when seeking to understand space-related insurance requirements, asking rhetorically:

> "What insurance do you need for a rocket that may fall off the side of a boat in the middle of the Pacific Ocean?

While this may seem an outlandish example, given the investment of time and resources into such equipment, all such possibilities needed to be considered.

Having clear documentation and well-written policy added to a space company's integrity and effectiveness, while helping to manage and mitigate risks. One participant spoke of their clear stance on how they deal with returns and recycling:

> "We actively encourage our host departments to leave the recycling with us. So we take the mission equipment for them. We always ask them if we can get rid of that stuff locally through e-waste.

Without the proper documentation, aligned to both company policy and national (and international) regulations, space companies can stray into unclear territory and become lost when things go wrong. As one participant stated:

> "The client's frustrated because he's not getting the item that he needed, or it's broken and all of that. Why? Because there was a process that was not followed because there was no regulations around it. There was no guidelines. And so there was a mistake being made. But if you have a guideline, then you minimise mistakes as well. And you then become more successful.

Such experiences among industry highlight the importance of properly preparing and understanding company policy, government policy, international regulations and related documentation needs for reverse logistics. However, like many other areas of logistics, there is no training specific to the space industry. A short course or a customised unit that groups together the knowledge and skills needed to prepare space reverse logistics policy and documentation would be very beneficial for the industry. It would not only prevent costly mistakes but could also support sustainable and efficient business processes across the industry.

9 Recommendations

Image courtesy of Southern Launch.

Recommendation 1

Implement the proposed changes to Vocational Education and Training

This study recommends a series of changes that can be applied to VET material in order to better support the skills needs of the Australian space industry.

The potential solutions developed through this study are discussed in Sections 4–8. These solutions cover a variety of recommended changes to existing VET material and in some cases the development of new training material.

These solutions are summarised in the following pages, having been prioritised and grouped as high, moderate and low demand, based on the level of discussion on the topic and the importance given to it by participants.

Full details of each proposed solution are available in the corresponding table for each T&L area:

Procurement and supply coordination	Table 4
Inventory maintenance	Table 6
Warehouse management	Table 8
Transportation	Table 10
Returns, repairs and recycling	Table 12

Actions

High demand

1. **Transportation.** To facilitate knowledge of the import and export regulations, apply the following changes to *TLI50224 – Diploma of Logistics*:

    a. Add *TLIX0045 – Determine import/export prohibitions/restrictions* as an elective unit and include context for the Defence and Strategic Goods List.

    b. Add *TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding* as an elective unit and include context for the Australian dangerous goods code.

    c. Add T*LIL5064 – Manage international special freight transport services including dangerous good*s and special cargo as an elective unit and include context for the transport of space industry equipment, components and propellants, and context for specialist manufacturers (e.g. space equipment and components) and engineers for handling procedures.

2. **Transportation.** To support the Australian space industry in accessing informative resources on Transport and Logistics:

    a. Add *TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding* currently as an elective to *TLI50224 – Diploma of Logistic*s and include context for the Australian dangerous goods code.

    b. Add *TLIL5064 – Manage international special freight transport services including dangerous goods* and special cargo as an elective to *TLI50224 – Diploma of Logistics*.

    c. Add *TLIX0045 – Determine import/export prohibitions/restrictions* as an elective to *TLI50224 – Diploma of Logistics* and include context for the Defence and Strategic Goods List.

    d. For *TLIA5029 - Plan and manage storage of dangerous goods and hazardous substances*, this study recommends a review the number of enrolments there has been for this unit. If numbers are low, remove references to bulk handling as this is unlikely to be suitable for the space industry. This unit should be added to the general elective units in the *TLI50422 - Diploma of Materiel Logistics.*

    e. Prepare a new unit to cover Australian (state and national) and international legislation, including but not limited to Incoterms, importing/exporting rocket propellants, electromagnetic spectrum rights,

International Traffic in Arms Regulations, Export Administration Regulations, the Defence and Strategic Goods List, *the Space (Launches and Returns) Act 2018* and any additional relevant Australian standards.

3. **Warehouse management.** To support the space industry in warehousing skills related to dangerous goods, the unit *DEFEXO001 – Work safely with explosive* ordnance should be added as an elective unit for *TLI50224 – Diploma of Logistics*. Changes should also be made to *TLIA5029 – Plan and manage storage of dangerous goods and hazardous substances* to make it more suitable for a space context, and this unit should also be added to the general elective units in the *TLI50422 – Diploma of Materiel Logistics*. *ICPPTD302 – Set up and produce 3D prints* should be added as an elective unit for *TLI50224 – Diploma of Logistics*, to allow for 3D printing of packaging for space items. These changes are detailed in Table 8.

4. **Warehouse management.** To support the space industry to setup, work within and maintain cleanrooms, develop a purpose-written logistics training unit to cover these skills for the space industry.

5. **Transportation.** To assist the space industry in meeting its physical transportation requirements:

   a. Add *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* as an elective unit for *TLI50224 – Diploma of Logistics,* and include context for transport of space industry equipment, components and materials; transport of specialist space industry technology, including lenses, electronics and other environmentally sensitive components; transport of biological material for the space industry; GPS tracking of transported items; and procedures and documentation for accessing secure facilities.

   b. For *TLIL5026 – Manage export logistics*, add context for exporting in the space industry in work environments involving warehousing, storage, transport and distribution, and for consignments that may include sensitive components or large oversized sections relating to the space industry.

   c. Develop a new unit to fully cover insurance for space industry logistics.

   d. Market this learning material for careers in the space industry to attract interested people who can gain the fundamental skills and knowledge needed to support transportation for the space industry, while also gaining a broader skillset for general T&L in other industries.

Moderate demand

6. **Procurement and supply coordination.** To support the space industry in the analysis and selection of suppliers, include space contextual material within the units *TLIR5014 – Manage suppliers, TLIR5007 – Manage international purchasing,* and *BSBPRC403 – Conduct international procurement.*

7. **Procurement and supply coordination**. To support effective work with suppliers and stakeholders across other industries, add the unit *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* (from *TLI50199 – Diploma of International Freight Forwarding*) as an elective unit to *TLI50224 – Diploma of Logistics*. The relevant companion volume implementation guide could then be augmented to include considerations of space transport and space manufacturers as listed in Table 4.

8. **Transportation.** To support the space industry in knowledge of customs and working with customs brokers, as listed in Table 10, add the unit *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo* as an elective unit to *TLI50224 – Diploma of Logistics* and augment the relevant companion volume implementation guide under the heading 'Consultative processes may involve' to include customs brokers.

9. **Inventory maintenance.** To support maintaining space-specific inventories, augment the relevant TLI companion volume implementation guide for the unit *TLIA5058 – Manage facility and inventory requirements* to include space industry context, as indicated in Table 6.

10. **Transportation.** To address the need for cyber and physical security in space transportation:

    a. Add *BSBXCS402 – Promote workplace cyber security awareness and best practices* as an elective unit for *TLI50224 – Diploma of Logistics.*

    b. Add *TLIO5006 – Plan and manage security procedures for transferring and transporting dangerous goods* as an elective unit for *TLI50224 – Diploma of Logistics* and include context in the unit's application statement for logistics roles in the space industry.

Low demand

11. **Warehouse management.** To support the space industry skills need for handling, packaging and storing sensitive parts and equipment, develop a purpose-written logistics training unit to cover these requirements within the space industry.

12. **Procurement and supply coordination.** To support the hiring of a skilled workforce for ST&L, include contextual material relevant to the space industry for the unit *BSBHRM415 – Coordinate recruitment and onboarding.*

13. **Returns, repairs and recycling.** To improve the space industry's capacity to return, repair and recycle space equipment, components and related materials, including the development of appropriate policy and other documentation, develop a new unit that covers these topics.

14. **Warehouse management.** Training the workforce needed to design, build and maintain space warehousing facilities can be provided through existing VET training, including *TLIA5058 – Manage facility and industry requirements*. However, there remains a training gap within the VET system for the particular skills and knowledge needed for warehousing space items. Developing a purpose-written unit to cover these requirements would be very useful for T&L within the space industry. These training changes could also be supported through marketing associated courses as part of a career in the space industry.

15. **Inventory maintenance.** To facilitate automation and efficiency at scale for the space industry, applying the recommended changes listed in Table 6. These include adding new electives to *TLI50224 – Diploma of Logistics* and augmenting the relevant TLI companion volume implementation guide to include logistics context for the space industry, consideration for the Defence and Strategic Goods List, and context for sensitive components and large oversized sections relating to the space industry. An additional recommendation is to encourage collaboration between the space industry and existing industry 4.0 programs, to facilitate advanced manufacturing, automation and design thinking within the space industry—for example: Swinburne University's Industry 4.0 project and their Associate Degree of Applied Technologies.

16. **Warehouse management.** To promote the development of advanced warehousing facilities, existing programs in advanced manufacturing, automation and infrastructure that combine universities, VET and industry could be adapted to include course material relevant to warehousing for the space industry.

Goal

The goal of this recommendation is to make specific changes within VET courses and units to better support the skills gaps within Transport and Logistics for the Australian space industry.

Recommendation 2

Develop a Space Transport and Logistics skill set

This study recommends the development of an ST&L skill set to group together in-demand skills and knowledge.

A skill set is a single unit of competency or combination of units of competency from one or more training packages that link to a licence or regulatory requirement, or defined industry need. [51] This study recommends the development of an ST&L skill set because this will provide a framework for industry to group the skills and knowledge that have been identified through this study as in demand. An ST&L skill set will provide the Australian space industry with a relatively rapid option to upskill their T&L workforce.

Action

Develop a ST&L skill set that includes the following units:

- *TLIA5029 – Plan and manage storage of dangerous goods and hazardous substances*
- *TLIA5058 – Manage facility and inventory requirements*
- *TLIL5062 – Apply knowledge of logistics, storage and distribution to international freight forwarding*
- *TLIL5064 – Manage international special freight transport services including dangerous goods and special cargo*
- *TLIX0045 – Determine import/export prohibitions/restrictions.*

Goal

Provide the space industry with a near-term solution that packages a range of required T&L skills and knowledge which have been identified by multiple space industry participants.

Recommendation 3

Develop a purpose written space AQF qualification

Develop a new qualification for the space industry.

The creation of a space-focused AQF qualification will encourage training providers to tailor their courses specifically to the space industry. This qualification should incorporate new space-oriented units, some of which are outlined in Table 8, Table 10 and Table 12, and represents a longer-term development initiative.

Further research will be required to determine the greatest priority in terms of AQF level for the proposed qualification, however an AQF 5 level should be considered as it aligns well with the functional level of many of the industry participants interviewed. It is anticipated that once training options for managers are established, demand for lower-level space-related qualifications, such as AQF level 3 and 4, will increase.

Actions

Developing a purpose written space AQF qualification will involve several key steps:

1. **Industry consultation.**
    a. Undertake further research to determine the appropriate AQF level for the qualification.
    b. Undertake industry consultation to refine the content of the proposed new units, including those outlined in Table 8, Table 10 and Table 12.
2. **Development and endorsement.** Develop and receive endorsement for the proposed new units.
3. **Further industry consultation.** Engage in further industry consultation to determine the packaging rules and the composition of core and elective units for the new qualification.
4. **Endorsement.** Seek endorsement of the new qualification.
5. **Information sessions.** Develop materials for information sessions and engage training providers and space industry personnel.

Goal

To provide an AQF qualification that provides industry upskilling specifically to the space industry.

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Recommendation 4

Implement the student pathways enhancement strategies to facilitate vocational pathways to Higher Education

The student pathway enhancement strategies detailed in Section 3.3 outline a range of measures to facilitate greater and more consistent pathways for VET graduates transitioning to the Higher Education sector.

Having clearly defined ST&L VET options that include pathways leading into Higher Education would provide a solid step for students and career-transitioners seeking to enter the industry. Space T&L Higher Education would also contribute to the development of highly trained space professionals, to facilitate maturation of the national industry.

Collaboration with the Australian Government Department of Education and the Australian Tertiary Education Commission (ATEC) will be crucial for advancing the student pathway enhancement strategies.

Actions

Activities associated with this initiative will include:

1. **Advocate for the following to be implemented by the Australian Government Department of Education:**

    a. Review and update of the AQF to specify the credit connections between AQF 6 and AQF 8 (in the same way as it currently specifies the connection between AQF 5 and AQF 7)

2. **Advocate for the following to be implemented via the ATEC:**

    a. Develop and roll out a training program to VET providers and universities to extol the positive reasons for students, and the Australian economy, for establishing articulation agreements. The upskilling should also cover the intent of the AQF and provider obligations.

    b. Develop positive funding arrangements which provide two-way funding weightings to VET providers and universities which demonstrably collaborate to determine course alignment, and, therefore by extension it is assumed, develop meaningful articulation agreements aligned to the AQF Qualifications Pathways Policy.

c. Develop funding arrangements which do not disadvantage the 'transitioning in' institution for awarding credit.

d. An enforcement of the requirements of the AQF Qualifications Pathways Policy with a reverse onus of proof that VET providers and universities are undertaking best endeavours to comply with the stated AQF Qualifications Pathways Policy obligations. Negative funding arrangements where proof is not forthcoming could be a consequence.

3. **Apply the following changes to VET material:**

   a. Develop a new unit of competency that is focussed on preparing students for the transition from VET to university. This unit should include topics such as, but not limited to, report writing, referencing, critical thinking concepts, differences between VET and university study, and strategies for managing multiple concurrent subjects and life. This unit should be delivered by a university academic in conjunction with a VET trainer/assessor and should be a named elective in all TLI qualifications at diploma and advanced diploma levels. Funding arrangements should be cognisant of the dual delivery/ assessment nature of this unit and compensate providers accordingly.

   b. Review T&L diploma and advanced diploma packaging rules to allow flexibility for VET providers to include additional units to these particular qualifications, if deemed appropriate, to better align with university courses for transitioning students. This should be on the proviso that there must be a formally ratified articulation agreement in place which demonstrably links any additional units, and students seeking to utilise the articulation arrangements are made aware of the additional unit requirements and fees at enrolment time. Additionally, non-transitioning students should not be required to undertake any additional units to be awarded the relevant AQF qualification.

Goal

To introduce a series of initiatives aimed at enhancing and broadening pathway opportunities for VET graduates transitioning into Higher Education.

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