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Benchmarking Australia and New Zealand Aviation Academic Research Output between 2017 and 2021

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The purpose of this study was to achieve a better understanding of the boundaries of the aviation education discipline and academic composition as well as patterns of research output in tertiary aviation education in Australia and New Zealand. This study developed a framework to identify aviation academics in Australia and New Zealand and operationalized a definition for aviation research. Based on these boundaries, a database of aviation academics and associated peer-reviewed research publications over a 5-year period between 2017 and 2021. From the database, this study was able to identify staffing profiles of aviation academics as well as patterns of research output at different levels of seniority to include the ratio of research publications that were considered aviation and non-aviation. Additionally, based on the relevant research area represented by journals of publication, aviation research disciplines were inductively developed. The study found that research outputs increase across levels until Level E, at which publications drop sharply, and that non-aviation research output was present at all levels but notably higher at Level C and Level D. It also found a research output profile for each level for both aviation and non-aviation research that can support performance benchmarking. In addition, the study identified seven aviation research disciplines based on the research area of periodicals in which aviation research was published. Lastly, the study highlighted the significant challenge of distinguishing aviation research and identifying aviation academics as well as limitations for external quantifying aviation research performance.

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Introduction

The body of academic research that supports the aviation industry as a component of greater STEM research is growing in importance and impact (Li et al., 2020). However, in the academic community, aviation researchers, as well as practitioners who identify as researchers in aviation, lack clear definitions; applied research in aviation is prevalent throughout a wide range of disciplines, including psychology, law, education, communication, and organizational management (Dunn et al., 2022; Lee et al., 2017; Wu and So, 2018). But while Australia and New Zealand have a mature system of categorizing research fields and disciplines, there is no category for comprehensively addressing aviation research that reflects the community of practice. This is problematic in two ways: first, for assessing the research output of academics with regard to a defined professional standard (for professional development purposes). It also creates difficulty in tracking the discipline-level capability of a university's research team, as research may be classified under a related discipline individually. This presents challenges for both individual academics and academic institutions alike; accurate evaluation of research output in context is useful for performance tracking and strategic decision-making (Broome and Swanepoel, 2020; Donkin et al., 2020). The purpose of this research is to achieve a better understanding of the boundaries of the aviation education discipline and academic composition, as well as research output in tertiary aviation education in Australia. It operationalizes a definition for aviation research and seeks to develop a standard profile of performance for academics that is based on aviation research output as well as identify patterns of publication for aviation research and key journals. A better understanding of what constitutes aviation research, typical profiles of publication performance at different levels of seniority, and where aviation research is being published will not only help academics self-evaluate and set goals for their professional development but also provide more clarity for universities seeking to ensure staff research is appropriately captured.

Literature Review

The Australian and New Zealand Standard Research Classification (ANZSRC) provides for a system of categorization against which academic research can be assessed. It utilizes three different approaches to understanding what kind of research is being produced: activity-based, discipline-based, and impact-based (Bureau of Australian Statistics, 2020a).

The ANZSRC Type of Activity classification organizes research "…according to the type of research effort, namely, pure basic research, strategic basic research, applied research, and experimental development" (Bureau of Australian Statistics, 2020b, Explanatory Note 2). This classification does not consider the discipline of research involved, simply how the activity might be considered from a methodological perspective.

The other two ANZSRC classification systems do consider the relevant discipline. The Field of Research (FoR) classification system is specifically discipline-based. It seeks to organize research around "common knowledge domains," and a FoR code is intended to "describe the nature of the research being performed and reflects the area of knowledge discovery" (Bureau of Australian Statistics, 2020c, Explanatory Note 2). This system utilizes a numeric code to identify related research at three levels: division, group, and field. Divisions have two-digit codes and are further specified into groups by adding two additional digits. Groups are further specified into fields by adding two more digits, creating a six-digit field code. If two fields fall under the same group and division, this will be reflected by both fields having the same first four digits. Whereas if two fields fall under the same division but fall into different groups, only the first two digits of their codes would match. Divisions include broad areas of research, including health sciences, law and legal studies, and education. There is also a division of Engineering, under which sits the group of Aerospace Engineering, within which there are eight fields: aerospace materials; aerospace structures; aircraft performance and flight control systems; avionics; flight dynamics; hypersonic propulsion and hypersonic aerothermodynamics; satellite, space vehicle and missile design and testing; and aerospace engineering not elsewhere classified. In this classification system, there is no distinction between aviation and aerospace, and aviation is not addressed as a division, group, or field.

In the ANZSRC Socio-Economic Objectives (SEO) classification system, research is organized based on the outcome or area of impact of the research. It uses the same nomenclature of division, group, and field as the FoR classification system. However, the category titles are different. In this system, there is a division of transport that is grouped into aerospace transport, environmentally sustainable transport activities, ground transport, water transport, and other transport. The aerospace transport grouping is described as "…R&D directed toward improving the efficiency, safety, and utility of international and domestic air transport for passengers, freight, and livestock" (Bureau of Australian Statistics, 2020d, Table 4). It includes fields of air freight, air passenger transport, air safety and air traffic management, air terminal infrastructure and management, autonomous air vehicles, space transport, and aerospace transport not elsewhere classified.

While the ANZSRC provides a framework for assessing areas and significance of research impact, measuring individual academic performance is complex, as well as establishing in-field profiles of performance. Research has indicated a need to better understand research productivity at the discipline level. Broome and Gray (2017) explored how occupational therapy academics produce research and contribute to their field across various levels of seniority to develop profiles of performance. The resulting profile suggested benchmarks in the areas of publications, citations, and co-authorship. The researchers outlined implications for both academics and universities; for individuals, benchmarking can be useful for self-evaluation career planning. For universities, benchmarking "can be used to guide appointment levels during recruitment, academic promotion opportunities, and professional development discussions" (Broome and Gray, 2017, p. 405).

Similar benchmarking exercises have been completed in other disciplines and are not a new endeavor. The exercise of benchmarking research output and patterns of publication was conducted by Howard et al. (1987) with the aim of assessing institutional research quality. In

Australia, Broome and Swanepoel (2019) conducted a similar study in the area of dietetics academics to benchmark research output. Donkin et al. (2020) explored research track records with regard to academic levels in the area of medical science. Echoing the sentiment of Broome and Gray (2017) and Broome and Swanepoel (2019), Donkin et al. (2020) identified a need to establish field-based standards for the assessment of research productivity, noting:

> University-wide expectations of research performance are often applied to promotion without considering intricacies and variances between disciplines. For example, for academics publishing high-quality research of value to society in less populous fields (e.g., medical education), it may be prudent to accept lower citation rates when judging against benchmarks. (p. 7)

Subsequently, these studies have been able to benchmark productivity with their respective disciplines, including but not limited to the number of publications by appointment level as well as profiles of academic output using different metrics such as h-index, citations, and coauthors.

Other studies have explored research breadth, productivity, and targeted journals in STEM. Li et al. (2020) conducted a systematic review of STEM-designated research between 2000 and 2018 with the aim of exploring how to quantify STEM research outputs and identify patterns of publication. Similarly, Li et al. (2019) analyzed the first five years of publication of the International Journal of STEM Education to explore demographic factors of publication and access, as well as publication trends within the discipline.

While there is a precedent for discipline-level benchmarking of academic performance in well-defined disciplines, the field of aviation has the added challenge of needing to identify the boundaries of the discipline. This is not unique to aviation; studies that have attempted to quantify research outputs, disciplines, and publication patterns have grappled with the methodological challenge of defining/operationalizing a working definition for the field. In many cases, research has relied on either author self-identification or keywords in article titles to determine their inclusion as data, such as Li et al. (2020) and Mizell and Brown (2016). As to this problem with the STEM field, Li et al. (2020) note, “A review of research development in a field is relatively straightforward when the field is mature, and its scope can be well defined” (p. 2), and “Multiple perspectives about the meaning of STEM education adds further complexity to determining the extent to which scholarly activity can be categorized as STEM education” (p. 2). These parallel challenges in STEM highlight this difficulty in the field of aviation.

To better understand the scope and publication patterns of aviation academics throughout Australia, this study poses the following research questions:

> Research Question 1: What is the staffing profile of academics at tertiary aviation education institutions in Australia and New Zealand?
>
> Research Question 2: What are the patterns of research output of aviation academics in Australia and New Zealand?

RQ2a. What is the volume of output at various levels of organizational seniority?
RQ2b. Which journals are targeted for aviation academic-generated research?
RQ2c. Which research disciplines in aviation are represented by publication patterns?

Methodology

Aviation Academic Research Output Database

For this study, a database was developed of publicly accessible staff and research outputs of universities that have tertiary aviation education programs in Australia and New Zealand that are distinct from engineering disciplines (e.g., Aerospace Engineering). This was done by identifying relevant universities with aviation degrees at the bachelor level or higher using a general search engine. Full-time academics that teach and/or conduct research in the context of these programs were identified using that university's aviation contacts page or, if none, searching that university's name and aviation as keywords. Honorary, emeritus and adjunct academics were excluded.

Each academic in the database was cross-referenced with Scopus and Web of Science to establish their profile of publications between January 2017 and December 2021 (a five-year window). Each piece of research was categorized as being aviation-related or non-aviation-related. For the purpose of this study, the definition of aviation research was operationalized to include any research that supports the development, operations, and management of global civil aviation, excluding research that was reasonably considered part of an engineering discipline. For each piece of aviation research, the journal of publication was recorded, as well as its associated discipline areas identified through Scopus/SJR Scimago Journal and Country Rank.

Method

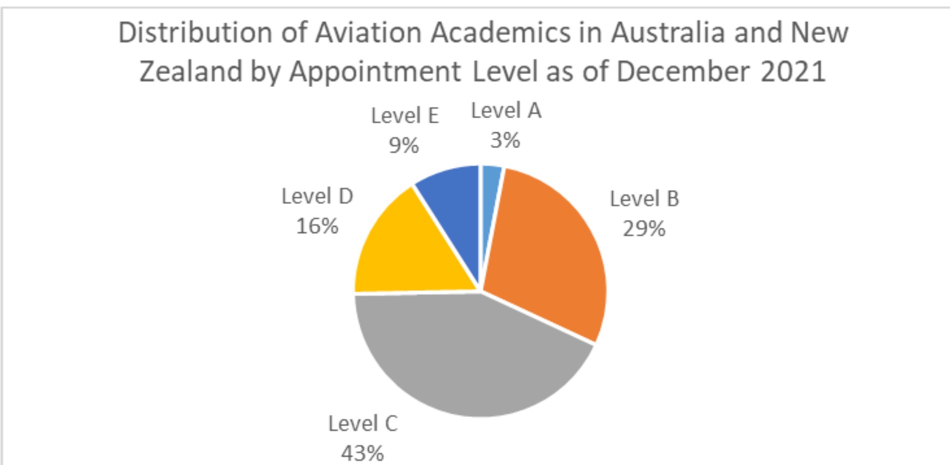
To answer RQ1 regarding staffing profiles of aviation academics, descriptive statistics were generated to understand the distribution of academics by seniority as well as their composition of teaching and research duties. To establish patterns of aviation and non-aviation research outputs, publications were first identified as being aviation or non-aviation publications per the operationalized definition of aviation research used for the study.

RQ2 investigated aviation research output from three aspects: number of publications by seniority level (RQ2a), which journals were targeted for publication across aviation academics (RQ2b), and what aviation research disciplines are represented by publications (RQ2c). For RQ2a, descriptive statistics were used to describe aviation research output from academics organized by academic seniority. For RQ2b regarding the journals targeted by aviation academics, journals (as well as book chapters) were ranked according to their unique publications from the data set; where multiple researchers had collaborated on a single journal article, it was only included once. Additionally, the H-index of the periodicals was obtained to explore any relationship between journal quality and volume of output. To answer RQ2c regarding the research disciplines represented, the relevant research area of each aviation publication was established by cross-referencing the publication with the discipline areas of that particular journal as defined by Scopus. Where multiple research areas were associated with a journal, the most relevant area was selected to represent the publication; to ensure reliability, this was established by both researchers. Those areas were then consolidated into like-categories to establish research disciplines within aviation.

Results

RQ1 addressed identifying aviation academics in Australia and New Zealand in terms of appointment level and discipline areas of their aviation publications. It explored the staffing profile of academics at tertiary aviation education institutions in Australia and New Zealand. The database identified 56 academics across nine universities in Australia and New Zealand, distributed across standard academic levels A-E as of December 2021, as shown in Figure 1. Senior Lecturers (Level C academics) represented 43% of the population. Associate Lecturers, Lecturers, Associate Professors, and Professors, respectively, comprised 3%, 29%, 16%, and 9% of the population.

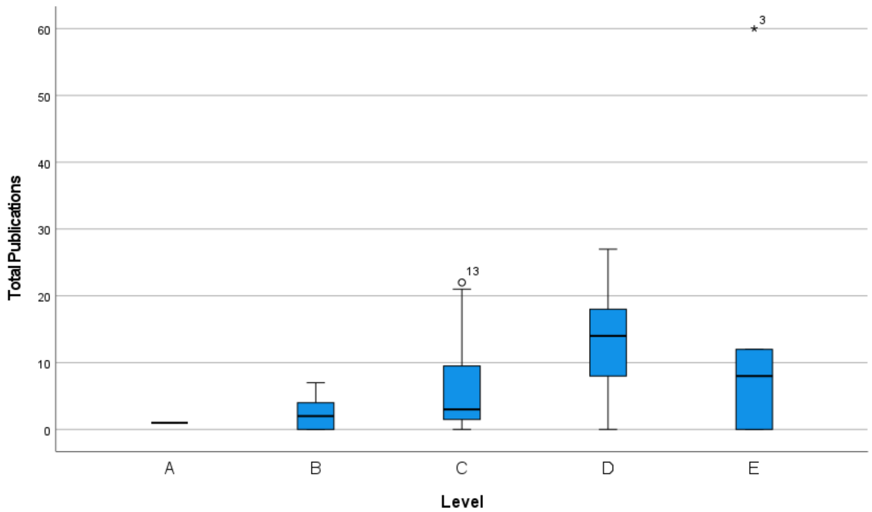
Figure 1
Distribution of Aviation Academics in Australia and New Zealand by Appointment Level as of December 2021



Regarding teaching and research duties among the 56 academics, on average, 43 (77%) were identified to have teaching and research roles, while 10 academics (18%) were identified as teaching only. The remaining three (almost 5%) were identified to hold only an administrative or leadership role as well as a teaching and research role.

RQ2 addressed patterns of research output of aviation academics in Australia and New Zealand, with RQ2a exploring research output as a function of academic level. Of the academics whose role included research, Figure 2 presents boxplots of the breakdown of total research output between 2017 and 2021 at each level.

Figure 2
Boxplots of the total research output of Australia and New Zealand aviation academics between 2017 and 2021



For the Level E group (full professor academics), one potential outlier was identified; one academic's publication record was more than three times the interquartile range above quartile three for total research. Considering the potential for influence affecting the interpretability of results for this category, the results below present both the original Level E data as well as Level E adjusted data that exclude the outlier.

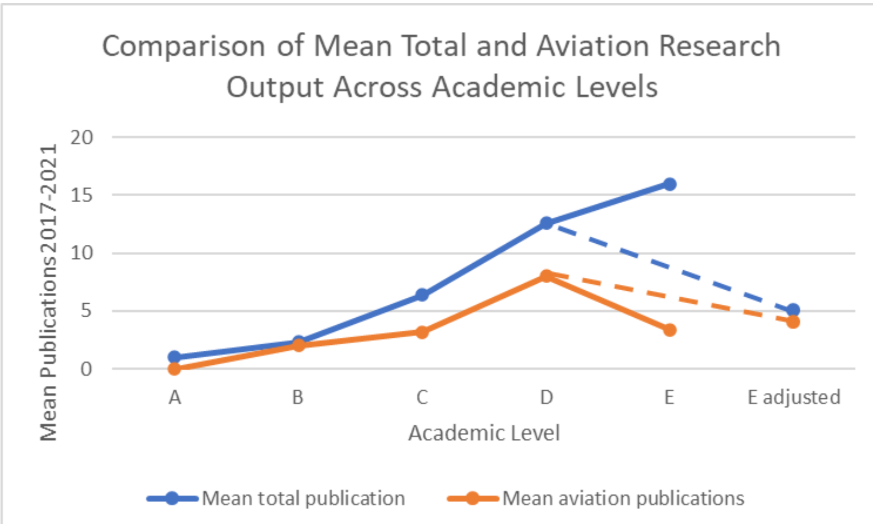
Corresponding to Figure 2, Table 1 shows the means and standard deviation of total research output as well as aviation research output by Australia and New Zealand aviation academics between 2017 and 2022.

Table 1
Descriptive statistics for all research output by level between 2017 and 2021.

Level	N	Mean Total Research	Total Research Std Deviation	Mean Aviation Research	Mean Aviation Research Std Deviation
A	1	1	-	0	-
B	12	2.33	2.309	2	2.174
C	20	6.4	6.847	3.2	3.847
D	9	12.56	8.974	8	8.322
E	5	16	25.14	3.4	4.219
E adjusted	4	5	6	4	4.169

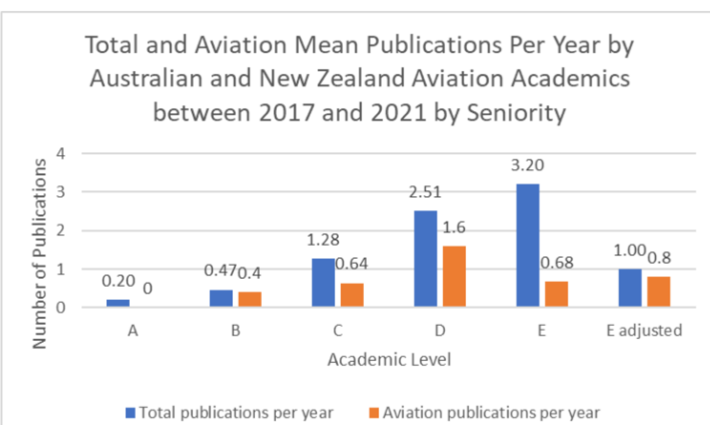
Further to this, a comparison of mean total research output over the five-year window and mean aviation research output is shown in Figure 3. This provides an indication of the percentage of research outputs at each level that were determined to be aviation research outputs. For Levels A-E (including E adjusted), the percentages of total research that were aviation research over the interval of 2017-2021 were found to be 0%, 85.7%, 50%, 63.7%, 20.2%, and 80%, respectively.

Figure 3
Comparison of mean total research output and mean aviation research output across academic levels.



Additionally, the mean number of publications per year over the five-year window of 2017-2021 is displayed in Figure 4. This provides an indication of the average annual research productivity for an aviation academic whose role encompasses research. Figure 4 distinguishes between total research outputs and aviation research outputs.

Figure 4
Total and aviation mean publications per year by Australia and New Zealand aviation academics over 2017-2021.



RQ2b explored journals that were targeted for publication by aviation academics between 2017 and 2021. During this interval, aviation academics across Australia and New Zealand published 326 journal articles and books/book chapters, of which 156 were aviation-related based on the operationalized definition of aviation research used for the purpose of this study. Among the 156 publications, 148 of them were published in 68 academic journals, while eight outputs were books/book chapters. The most frequently targeted journal of publication was found to be the Journal of Air Transport Management, in which 25 unique research outputs were identified. Table 2 exhibits journals of publication for aviation academics' research outputs, where there were at least three unique publications between 2017 and 2021. Those 13 journals accounted for 79 publications, representing 53.4% (79 out of 148) of the research outputs of aviation academics. Not listed in Table 2 were the 16 journals that had two unique publications and the remaining 39 journals that had a single unique publication. In addition, Table 2 lists the impact factors (H-Index) of the journals, which ranged from 2 (Air and Space Law) to 199 (Tourism Management).

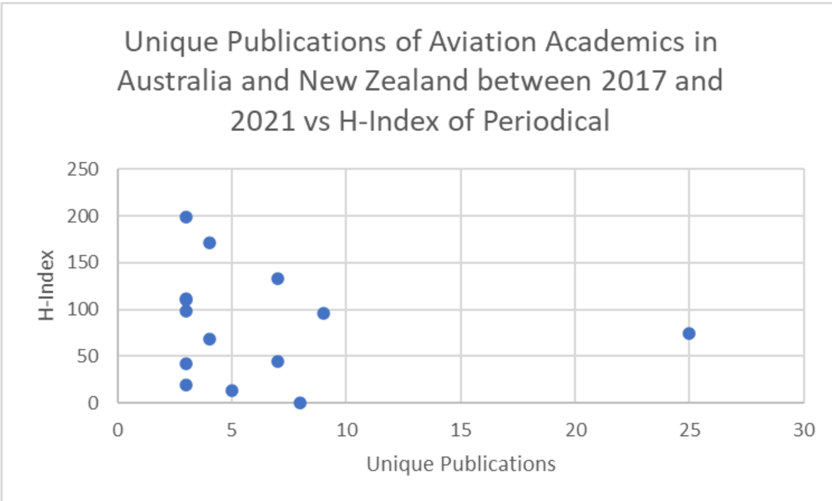
Table 2

Journals with greater than three unique publications by aviation academics in Australia and New Zealand between 2017-2021.

Name of Journal	Unique Publications	H-Index (SJR)	CiteScore (Scopus)
Journal of Air Transport Management	25	75	10.2
Transport Policy	9	96	10.7
Book or Book chapter	8	N/A	N/A
International Journal of Aerospace Psychology	7	44	1.8
Transportation Research Part A: Policy and Practice	7	133	12.4
Aviation	5	13	2.4
Aerospace Medicine and Human Performance	4	69	1.1
Annals of Tourism Research	4	171	15.9
Aerospace	3	19	3.0
Applied Ergonomics	3	98	6.9
Safety Science	3	111	12.4
Tourism Management	3	199	22.9
Transportation Planning and Technology	3	42	3.6
Transportation Research Part E: Logistics and Transportation Review	3	110	14.7

Additionally, Figure 5 explores the relationship between the volume of unique output and the H-index of the set of periodicals in Table 2.

Figure 5
Unique publications of aviation academics in Australia and New Zealand between 2017 and 2021.



The observed correlation between the number of unique publications and the H-Index was found to be -.107, corresponding to p=.728. Considering the Journal of Air Transport Management as a potential outlier, the correlation between the unique publications and H-Index for all publications excluding it was found to be -.082, corresponding to p=.801.

RQ2c sought to identify the research disciplines represented by the pattern of research publications by aviation academics between 2017-2021. To address RQ2c, the 148 aviation research outputs were cross-referenced with the research area of their journal of publication. As a result, 26 unique research areas were identified, as shown in Table 3. To identify research disciplines, those 26 research areas were amalgamated into like-categories. This process yielded seven research disciplines: Engineering, Human Factors, Safety, Management, Tourism, Transportation, and Other.

Table 3
Disciplines associated with research areas corresponding to Australia and New Zealand aviation publications between 2017 and 2021.

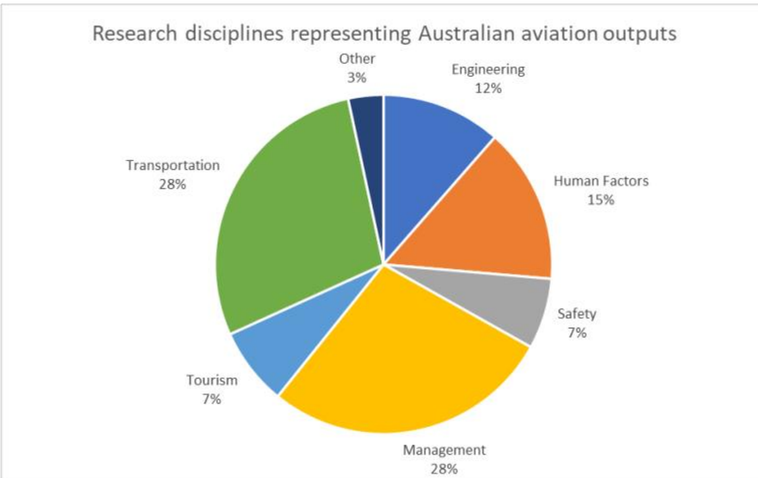
Discipline	Research Area	Frequency
Engineering	Aerospace Engineering	12
	Civil and Structural Engineering	1
	Mechanical Engineering	2
	Materials Science	2
	Total	17
Human Factors	Human Factors and Ergonomics	7
	Human-Computer Interaction	2
	Public health and Occupational health	4
	Applied Psychology	7
	Experimental and Cognitive psychology	2
	Total	22
Safety	Safety Research	7
	Safety Risk Reliability and Quality	3
	Total	10
Management	Strategy and Management	30
	Management	2
	Management, Monitoring, Policy, and Law	2
	Law	1
	Business, Management, and Accounting	1
	Management Science and Operations Research	1
	Marketing	1
	Information Systems and Management	3
	Total	41
Tourism	Tourism, Leisure and Hospitality Management	11
	Total	11
Transportation	Transportation	40
	Operations Research Transportation	2
	Total	42
Other	Social Sciences	1
	Urban Studies	1
	Emergency Medicine	1
	Education	2
	Total	5

Figure 5 shows the percentage of each of the seven identified research disciplines relative to the totality of aviation research. With 28.4% (42/148), Transportation was found to be the largest discipline represented. Following closely was Management, which represented business-related areas such as strategic planning and decision-making in aviation, representing 27.7%

(41/148) of the total publications. Third was Human Factors, which represented 14.9% of outputs. Ranked fourth was the category of Engineering, which, despite the removal of non-aviation research, represented 11.5% of the outputs. The categories of Tourism, Safety, and Other represented 7.4%, 6.8%, and 3.4% respectively, as shown in Figure 5.

Figure 5

Research disciplines representing Australia and New Zealand aviation outputs between 2017 and 2021



Discussion

The research was found to be a required component of the vast majority (77%) of aviation academic positions in Australia and New Zealand. From a professional development perspective, this suggests that the research output is, in some capacity, part of the expectation of productivity and career progression. Though inadvertent exclusion of academics by the methodology was possible based on the search criteria, the Aviation Academic Research Output Database compiled for this study provided some insight into the profile and productivity of aviation academics in New Zealand and Australia. Further to this, it is important to note the limitations of the Aviation Academic Research Output Database, namely that it only explored a specific 5-year window. It is possible that there have been changes to seniority level or position description by staff members within this window, and it is possible that confounding events (such as the COVID-19 pandemic) disrupted research patterns. As such, the academic level of a staff member was recorded based on their status in December of 2021; for example, a Lecturer (Level B academic) who was promoted to Senior Lecturer (Level C academic) in 2018 would be included in the database as Level C. Further research could seek to approach quantifying research output by longitudinally assessing academics and averaging their research output at each level, which may provide additional insights.

From a productivity perspective, average total research outputs per year were observed to range from .2 (Level A) to 2.51 (Level D, excluding the Level E outlier). These numbers include research that was not considered aviation-related; looking at only aviation research yields outputs ranging from zero (Level A) to 1.6 (Level D). Looking at the boxplots in Figure 2, it is important to note that at nearly all levels, for both total research and aviation research, zero was within one standard deviation of the mean.

The implication of zero being within the standard deviation of the mean research output, as well as the presence of academics at all levels that did not publish any research outputs between 2017 and 2021, is suggestive of career progression without (or with minimal) research engagement. Further research should investigate this possibility; there may be a disparity between published position descriptions and operational expectations by universities. If universities value operational contribution differently from how positions are described for employment and promotion purposes, they should explore better aligning the two. It is also important to note that this study did not account for research impact or research quality. These may vary between or within academics and may play a role in career progression. Additionally, given the complexity of even defining aviation research, there may be other ways of evaluating research engagement that was not captured in the scope of this study (e.g., student supervision, non-peer-reviewed publications, industry collaboration, funding, etc.).

Within the scope of this study, research outputs appear to increase steadily across levels up to Level C/Level D and drop considerably at Level E. Future research should address why Level E research output (especially aviation outputs) is comparatively low. Factors that may help to explain this reduction might include a reduction of motivation to advance (as Level E is the highest academic rank) or the expectation of administrative and management duties at that level. The outlier identified in the Level E group of academics presents an interesting situation in that it represented a high level of research output that did not meet the criteria for aviation research for this study. Considering the low number of Level E aviation academics in Australia and New Zealand with comparatively low and/or inconsistent research output, there may not be a clear understanding of the university expectations of career advancement of aviation academics and the role of research in this progression. As such, further research may consider investigating the research performance/research career progression of Level E academics at the individual level to account for unique experiences. Future research can also address whether this phenomenon is consistent with other academic fields that incorporate significant technical training, licensure, and administrative oversight.

Further to this, regarding the ratio of aviation and non-aviation research, this study found that non-aviation outputs appear to be present consistently across levels and are the largest ratio of total publications at Level C and Level D. While this finding is consistent with the observation of multidisciplinary research across STEM by Li et al. (2020), future research should seek to unpack this phenomenon among aviation researchers. While interdisciplinary research might be valued, there may be elements of pressure or the need to conform to institutionally set academic promotion research output standards. If the pursuit of interdisciplinary research is not organic in nature for aviation researchers, this endeavor may be a distraction from engaging in more impactful research.

Regarding the journals targeted by aviation researchers in Australia and New Zealand between 2017 and 2021, the Journal of Air Transport Management was the dominant destination for aviation research. Beyond that, there appeared to be diversity in publication destinations, including book chapters/books, which were found to be the third most popular research output. While this study did not explore the decision-making behind publication destinations or whether there were failed attempts at publication prior to acceptance, it did observe no correlation between publication frequency and H-Index. The apparent absence of a relationship between journal popularity and publication frequency of aviation research is noteworthy.

An exploration of the emergent research disciplines based on the journal topic areas from aviation publications yielded noteworthy results. This study defined aviation research as “any research that supports the development, operations, and management of global civil aviation, excluding research that was reasonably considered part of an engineering discipline.” Despite the specific exclusion of engineering-related research from this definition, engineering was still found to be an emergent discipline based on patterns of publication (with 17% of aviation research aligning to engineering areas). Further to this, the most dominant disciplines were found to be Transportation (28.4%) and Management (27.7%). While management was associated with a variety of business-related areas, what actually constitutes “transportation” remains elusive. For transportation to be a genuine discipline, its definition must be distinct from the definition of aviation research operationalized by this study as well as the other observed disciplines.

Regarding the other observed disciplines, there were some noteworthy findings. Tourism, which was distinct from the management topics as it tended to relate to human behavior patterns, may indeed have some overlap and could possibly be amalgamated into the management discipline. Safety and Human Factors appeared to be reasonably well-defined disciplines based on the associated research areas. However, there were two particularly remarkable findings associated with RQ2c. First, there were only two unique outputs associated with education. Considering academic work in the field of education itself and the magnitude of aviation training in this context, the near absence of scholarship in teaching and learning research is noteworthy. Along these lines, the other remarkable finding was that there was no observed discipline that captured aviation professional performance (pilot, mechanic, management, and other personnel) in either an operational or training environment. Research has been conducted in these areas. However, it is either not in a great enough volume over 2017-2021 to be captured by this study or is associated with inconsistent patterns of publication and is distributed across other disciplines. It is simply possible that the Scopus framework lacks the ability to distinguish this, similar to the challenges faced by the ANZSRC with its research classification frameworks. These findings are consistent with the challenges of defining the field identified by Li et al. (2019) and Mizell and Brown (2016).

Conclusions

This study sought to operationalize a definition for aviation academics and aviation research to better understand patterns of research outputs, including productivity and representative research areas and disciplines. Findings from this study suggest that, on average, productivity across academic levels increases but drops sharply at Level E, with non-aviation research contributing to total research output at all levels. For benchmarking purposes, average total research outputs per year based on a 5-year window of observation were found to be .2, .47, 1.28, 2.51, 3.20, and 1.0 for aviation academics at Level A, Level B, Level C, Level D, and Level E, respectively.

There remains confusion about the boundaries of aviation research as well as how aviation academics are identified. This presented significant limitations for this study and should be the subject of further research. The apparent disconnect between how research is positioned for publication, how aviation research contributes to the career progression of aviation academics, and how external entities (such as universities) quantify and make sense of aviation research appears to be an ongoing struggle.

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