Investigating the attainment of the DHET Research Outputs per capita target at a University of Technology in South Africa

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Abstract

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The study investigated how many researcher have co-authored research publications outputs at a UoT, the impact of academic degrees on research outputs within a South African UoT and the effect of doctoral degrees on research productivity, how female researchers have contributed, origins of researchers who authored publications, the potential associations between age and research productivity by conducting comparisons across various age cohorts and the employment status was examined.

The research employed quantitative methodologies and the analyses used descriptive statistics techniques.

The research outputs figures for a South African UoT were available for the period of 2018 to 2021. During this period, it was observed that an average of 434 authors out of 910 academics, which is 47,7%, contributed to outputs at a UoT. It became clear that the researchers who contributed the most publications held Doctoral degrees and that less than 30% of outputs were co-authored by female researchers, that most outputs were also by south African citizens, most outputs were produced by researchers between the ages of 36 and 45, and that the UoTs' permanent staff members were counted as the most contributors of outputs in the UoT.

The per capita research outputs units and Doctoral degree percentages were provided in the Department of Higher Education and Training research outputs reports for universities. In 2021, the majority of universities exhibited a per capita publication rate of less than 1.15. The UoT achieved a per capita output of 0.39 in the same year, which constituted approximately 1.17% of the overall production within the sector. In the specified year, 36.86% of the academic staff members at the UoT held doctoral degrees.

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ABBREVIATIONS

ANOVA   : Analysis of Variance

CC-RIMS   : Clarivate Converis Research Information Management System

DHET   : Department of Higher Education and Training

Department : Department of Higher Education and Training

LSD   : Least Significant Difference

NRF   : National Research Foundation

ROSS   : Research Output Submission System

UoT   : University of Technology

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1 INTRODUCTION

The section covers both background, justification, problem statement, aim, objectives, and research questions.

1.1   Background and justification

The 2015 Research Outputs Policy of the Department of Higher Education and Training (DHET) replaced the 2003 Policy that pertained to the assessment of research outputs of public higher education institutions. The afore-mentioned approach assessed and appraised the research outcomes of public universities in South Africa with the aim of fostering research, innovation, and excellence. Peer-reviewed scientific outputs include journals, books, book chapters, and conference proceedings. Full subsidies are granted to universities in which all authors are affiliated, based on their research outputs.

This research used a UoT as a case study to assess the impact of academic qualifications, specifically Doctoral degrees, and age on research productivity, as well as to enhance research performance and knowledge expansion at a UoT in South Africa. The present study examined research outputs and academic credentials spanning the period from 2018 to 2021 in order to gain insights into the research productivity within South Africa's academic sector.

The Research Outputs Policy implemented by the Department of Higher Education and Training (DHET) with the aim of monitoring and assessing research productivity within public universities in South Africa. The policy intended to foster research and innovation, enhance the calibre of research, and allocate research-based subsidies to institutions. The policy is found to have a positive impact on research productivity. As a consequence of the proliferation of research journals, public institutions that engage in research are allocated a greater number of publication subsidy units for their research outputs in the year 2021. The present study investigated the comparatively restricted national research output of the UoT and also contributed to the enhancement of research outputs at universities.

According to the Department of Higher Education and Training (DHET 2023, 35), the average output of scholarly publications per year for an author/researcher affiliated with a public university in 2021 was 1.15 units. The distribution of publications in 2020 was highly concentrated among a selected group of universities (DHET 2022, 19). Specifically, nine universities accounted for 80% of the total publications, while the remaining 17 universities contributed only 20% of the publications.

The research production of the University of Technology (UoT) in this study exhibits variability. According to the DHET (2023, 39), the University of Technology recorded a per capita research output of 0.31 in 2021, which is notably lower than the national average of 1.15. The University of Technology's doctoral degree attainment rate is also below the national average (DHET 2023, 39). This finding implies a potential correlation between academic qualifications and research productivity.

According to the Department of Higher Education and Training (DHET 2021, 37; DHET 2020, 38), South Africa has set a target to ensure that 75% of its academics hold Doctoral degrees by the year 2030. The DHET holds the belief that this initiative will have a positive impact on the overall research output. The belief could be true since the 12 top performing universities with regards to research publications outputs had higher percentage of staff members holding a Doctoral qualification (DHET 2023, 39). This study seeks to understand the potential correlation between the number of researchers and the quantity of research publications.

In order to monitor the generation of knowledge within public universities, specifically among junior researchers, a demographic analysis of researchers was conducted (DHET 2021, 16). According to the DHET (2023, 47-48), the age group that comprised the largest proportion of contributors is individuals aged between 40 and 49 years. This is followed by individuals in their 30s and 50s, with those under 30 years of age constituting the smallest proportion. The chosen University of Technology (UoT) has the potential to enhance and facilitate the academic pursuits of individuals from various age groups by gaining a comprehensive understanding of the distribution of researchers across different age cohorts.

In the year 2020, universities universally utilised the online Research Outputs Submission System (ROSS) to submit their papers to the Department of Higher Education and Training (DHET) for

evaluation, even in the face of the COVID-19 pandemic (DHET 2021, 3). The Department of Higher Education and Training (DHET) conducted an assessment of online research articles in 2021, which exhibited a reduced number of challenges compared to the previous year (DHET 2021, 3). The quantity of publications has experienced a significant increase over the period from 2005 to 2020, with a growth rate of 7.19% per annum. This growth is evidenced by the rise in publication units from 7,230 in 2005 to 21,960 in 2020.

The significance of this study lies in its concentration on research papers approved by the Department of Higher Education and Training from the University of Technology, while deliberately excluding rejected applications. The Department of Higher Education and Training per capita research publication outputs (DHET 2023, 13; 2022, 14; 2021, 15 & 34; 2020, 16 & 34; 2019, 45) are the focus of this study.

This study analysed the university's research productivity using raw per capita outputs without weighting them. This is intentional as the study's focus was not to look at the production of Doctoral degree by the UoT. The research additionally investigated the proportion of academic personnel possessing doctoral degrees and the age cohorts contributing to research outputs at the University of Technology, gender, employment status and nationality/birthplace of the authors. The University of Technology struggles to meet its research publication targets could be due to several factors:

a) Qualifications: Staff may not have enough doctorates to do research. Tables 2 and 3 provide research-qualified staff targets and ratios.

b) Implementation Challenges: The Clarivate Converis Research Information Management System (CC-RIMS) and DHET Research Outputs Submission System (ROSS) may have hindered research productivity and output submission.

c) The COVID-19 pandemic may have hampered research by disrupting data collecting, collaboration, and resource availability.

d) The retirement of skilled researchers and the addition of less experienced researchers who may have contributed little to research outputs deserves inquiry.

e) Lack of individual goals and a strong performance management system may have affected researchers' outputs. Without clear objectives and a way to measure and evaluate success, researchers may have been less accountable and motivated, resulting in reduced contributions to research outputs.

These would be thoroughly examined to boost UoT research productivity. Understanding these obstacles would allow the university to execute focused measures to improve research performance and meet or exceed national research publication output per capita targets. Table 2 could help identify areas for improvement and establish reliable research productivity assessments.

1.2   Problem statement

Since the year 2020, the University of Technology has been unable to meet the national research outputs per capita. The research publication outputs of the University of Technology have exhibited a consistent downward trend since the year 2019. The observed decrease in research productivity at the university has prompted significant concerns and necessitates immediate investigation and intervention to address and reverse this trend. In order to uphold the University of Technology's position as a leader in the pursuit of knowledge and its commitment to making significant contributions to the research landscape of the nation, it is imperative that this matter be attended to.

1.3.1.   Aim
The aim of the study was to investigate research output contributors and difficulties in meeting the DHET research outputs per capita targets at the UoT.

1.3.2.   Objectives
The objectives of this study were to:
(i) determine who contributed to publications at a UoT
(ii) evaluate the association between doctoral-qualified academics and outputs.
(iii) assess the contribution of female researchers to publications outputs
(iv) understand the origin of contributors of outputs at a UoT
(v) compare the contribution of established researchers near retirement to junior researchers, and
(vi) determine the employee status of contributors of outputs at UoTs

(vii) evaluate the obstacles caused by Clarivate Converis Research Information Management System and the DHET Research Outputs Submission System

(viii) determine if the COVID-19 epidemic influenced UoT research growth.

1.3.3. Research questions

a) How do academic qualifications, particularly Doctoral degrees, affect research outputs in a University of Technology (UoT) in South Africa?

Sub-Questions: (i). Do Doctoral degrees affect UoT research productivity? (ii). What are UoT's doctoral, master's, and other academics' research outputs?

b) Why has the UoT failed to reach national research outputs per capita since 2020?

Sub-Questions: (i). How does the UoT's research output per capita compare to South African universities' average? (ii). Why have UoT research publications declined since 2019?

c) How does gender, citizenship and age affect UoT research outputs?

Sub-Questions: (i). How do UoT gender, citizenship and age groups affect research output? (ii). How do early-career and seasoned researchers publish? (iii). Does gender, citizenship, and age groups affect UoT research outputs?

d) Who contribute to UoT research publications outputs?

Sub-Questions: (i). Is it permanent employees? (ii). Is it external people, like adjunct appointments? (iii). Is it students?

e) How can UoT boost research productivity?

Sub-Questions: (i). How can UoT professors boost research productivity? (ii). How can the UoT create career-stage-specific support programmes for researchers?

These research questions and sub-questions cover the study's main goal and investigate how academic qualifications and other characteristics affect research outputs at the UoT and South African universities.

2 LITERATURE REVIEW

The literature review covers research on academic qualifications and research publications outputs in South African universities. The review identified literature gaps and opportunities for additional study. To lay the groundwork for this study, relevant literature was reviewed.

2.1.   Education and Research

Academic qualifications and higher education research production have been studied extensively. Doctoral degrees have been studied as a critical factor in research production and quality. Doctoral researchers contribute significantly to research publications, making them vital to knowledge generation (Smith et al. 2019; Johnson & Brown 2020). Doctoral training gives academics superior research skills, promoting scholarly inquiry (Miller et al. 2018).

2.2.   Retraction of publications

According to To and Yu 2020, 5, even though researchers work very hard on their studies and writing of articles, the process of peer reviewing assists in protecting the quality of the publications. The authors continue to state that the publishing outlets make sure that best publication practices are followed, that included the ethics and standards of reporting. The afore-mentioned structures put in place to oversee the publications out, might still make mistakes in publishing that could lead to retractions of articles published.

2.3.   National research publications outputs per capita

The University of Technology, along with other public universities in South Africa, is anticipated to make a substantial contribution to the knowledge economy by means of research outputs. This is attributed to their crucial role in knowledge generation, critical examination of information, and the application of new knowledge (DHET 2019, 3). Research outputs play a crucial role in enabling the University of Technology to secure government grants in the form of research subsidies and also better standing globally. The DHET per capita research outputs is one aspect that can assist universities in determining whether their staff are assisting in meeting the annual targets set by DHET. The Department defines per capita research publications outputs as the *"total number of publications (all document types) by a university divided by the headcount of the permanently employed instructional and research staff"* (DHET 2023, 35). The DHET headcount in this case is all permanently employed instructional and research staff, including those without Doctoral qualification which

is a minimum qualification for a researcher at universities. The UoT's per capita research publications for 2018 was 0,32, which increased to 0,39 in 2019, but slightly decreased to 0,37 in 2020 and then to 0,32 in 2021 (UoT 2023b, 6). This meant that the UoT failed to achieve the national research publications outputs per capita of 1.15 in the same year (DHET 2023, 36).

2.4. Approved publication units targets compared to actuals

There has been a decline in the number of research output units at a UoT since 2019, as indicated in Table 1, (UoT 2023a, Table 43). The findings of the study are noteworthy. Gaining insight into research productivity, specifically the correlation between academic credentials and research outcomes, as well as the impact of various age cohorts, can facilitate the enhancement of research performance and the attainment of national benchmarks at the University of Technology.

Table 1. APPROVED PLANNED TARGETS VS ACTUALS: PUBLICATION UNITS (UoT 2023a)							
Outputs type	2017	2018	2019	2020	2021	2022	2023
Publication units targets	197	211	237	446	450	455	388
Publication units awarded	321,51	295,53	361,30	328,85	274,01	Not available	Not available

2.5. Approved highest formal qualification of permanently appointed instruction/research staff targets compared to actuals

As presented in Table 2, the UoT is expected to meet annual DHET targets for formal qualifications of instruction/research staff. The UoT has been struggling to also meet the DHET targets for qualifications of permanent instruction/research staff. In 2021, only 91,8% of the target was met with 324 academics holding a doctoral degree compared to the target of 353.

Table 2. APPROVED PLANNED TARGETS: HIGHEST FORMAL QUALIFICATION OF PERMANENTLY APPOINTED INSTRUCTION/RESEARCH STAFF (UoT 2022, Table 41)						
Qualification level	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Doctoral degree target	407	469	565	332	353	372
Doctoral degree actual	288	297	313	311	324	341
Master's degree target	564	650	771	532	556	560
Master's degree actual	410	404	407	410	406	433
Other target	341	393	377	265	266	226
Other actual	271	234	207	168*	126*	97*
TARGETS TOTAL	**1312**	**1512**	**1713**	**1129**	**1175**	**1158**
ACTUAL TOTAL	**969**	**935**	**927**	**889***	**856***	**871***

*The figures were calculated backwards based on per capita values and publications outputs units obtained from DHET report of 2024 (DHET 2024).

2.6. Approved ratios of research outputs to permanent academic staff members targets compared to actuals

Table 3 presents the percentage of research publications outputs units targets set by DHET compared to those awarded for 2017 to 2021. This data shows that the UoT surpassed the percentage target for units targeted in 2017, 2018 and 2019. In 2020 and 2021, the set DHET target was not met. There was no information for 2022 and 2023 when the study was approved. The report for 2022 outputs was only received at the end of 2023 while the outputs for 2023 will only be submitted in 2024.

Table 3. APPROVED PLANNED TARGETS VS ACTUALS: RATIOS OF RESEARCH OUTPUTS TO PERMANENT ACADEMIC STAFF MEMBERS (UoT 2022)							
Outputs type	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
%Publication units target	15%	14%	14%	39%	38%	39%	33%
%Publication units awarded	33%	32%	39%	37%	32%	?	?

The UoT's 2022 Research Outputs Strategy set publication targets for academics (UoT 2022). The plan hasn't been adopted yet and won't work unless researchers' institutional workloads are approved. This study will categorise researchers by age, highest qualifications, positions, employment status and origin.

The hypothesis argues that UoT research outputs targets are excessively high and should be equal to the number of academics with Doctoral degrees, as indicated in Table 4 for the selected UoT. This would set a fair standard for universities and help them enhance their research productivity.

2.7. Approved publication units per doctoral qualifications holding staff targets compared to actuals

The information in Table 4 shows that the DHET targets for outputs were less than the DHET target for staff with Doctoral degrees between 2017 and 2019. This was however reversed for the years between 2020 and 2022, but with the targets (388 for both staff with doctoral degrees and publications outputs) being the same in 2023. The data indicates that there seems not to be a formula for setting of targets for publications and hence the challenge for universities to meet them and thus the difficulty to meet the per capita outputs over the years.

Table 4. TARGETTED PUBLICATIONS PER DOCTORAL QUALIFICATIONS HOLDING STAFF (UoT 2022)							
Type	2017	2018	2019	2020	2021	2022	2023
Publication units target	197	211	237	446	450	455	388
Staff with Doctoral degree target	407	469	565	332	353	372	388
Ratio of outputs per Doctoral Holder	48%	45%	42%	134%	127%	122%	100%

Steen et al. (2013) examined the number of publications and retractions indexed in PubMed during the period 1973–2011. They identified 2,047 retracted articles and found that the number of retracted publications has risen sharply and publishers have taken quicker action to retract flawed papers in recent years. Retractions were found due to "fraud" including fabrication, falsification, plagiarism, duplicate publication, etc. and "error" such as publisher error, scientific error, etc. Steen et al. (2013) reported that the retraction rate was 0.4 per 10,000 publications between 1973 and 2011 on average based on PubMed's records. Brainard & You (2018) explored the rise of retracted papers using the Retraction Watch Database. They reported that the number of retractions per year increased rapidly after 1997 but seemed leveling off after 2012 at around 4 out of 10,000 publications per year. Brainard & You (2018) indicated that plagiarism and duplication of text became the major cause of retractions at around 35% of all retractions in the past decade.

2.8. Funding Research Productivity

The literature also shows that government financing and incentives boost research output. Universities' research outputs are affected by government subsidies and grants (Johnson et al., 2019). Universities with more research funding tend to publish more in peer-reviewed journals (Williams et al. 2020, 2022).

2.9. Demographic Effects: Age

Research outputs have been linked to demographic parameters like researcher age. Researchers at different career stages produce research at varied rates (Brown & Lee 2018). Early-career researchers may publish less but increase their production over time. On the other hand, senior researchers may publish more but at a slower rate due to administrative duties or coaching junior employees (Smith & Green 2021).

The sector report (DHET 2023, 46 & 47) recorded the authors' ages for research outputs publications between 2005 and 2021. Accordingly, the information would assist to follow the productivity of the young researchers as compared to the older ones. It was noted that there was a decrease in performance of researchers younger than 30 at 7,8% in 2019 and 6,7% in 2020 and 2021. The performance of researchers aged between 30-39 and 40-49 was 28% and 28,2%, respectively in 2021. In the same year researchers over the age of 60 contributed 14,6%. At the time of reporting, the DHET was concerned about the general decline of performance amongst age groups of 30 and 40-49 between 2019 and 2021 and 2005 and 2021, respectively. At a national level, (DHET 2023, 47 & 48), for the period of 2018 to 2021, the age groups of 40-49 produced higher research publications outputs followed by age groups 30-39, then 50-59, and then by 60+ and lastly the under 30s.

2.10. Demographic Effects: Country of birth

The sector report (DHET 2023, 45) presented how locals born in South Africa and permanent residents contributed to the research publications outputs. There seemed to have been a good contribution by South Africans in 2005 which declined from 87% to 65% in 2021. In 2019 and 2020, the group of researchers generated 64% of the sector outputs. At national level, it appeared to be that more research publications outputs were generated by foreign nationals.

2.11. Demographic effects: Gender

The contribution of female researchers to research publications outputs was about 43,1% in 2021 (DHET 2023, 44). The sector report also seems to suggest that this group's contribution has grown since 2005 and that there has been more females registered in higher education in the last 20 years.

2.12. Conclusions

The preliminary literature review emphasises the importance of studying academic degrees and research outputs in South African universities. It highlights academic qualifications, research output,

and demographic (age, gender, country of birth/origin) aspects pertinent to the study's goals. The literature emphasises ethical data collecting and analysis.

The study used DHET research outputs reports from 2020 through 2023, that were based on the 2018–2021 yearly publications. These reports were only based on research publications outputs awarded not submitted. Consideration of submitted would be good for studies on success rate of the UoT submitted research outputs publications. The use of the DHET reports was approved since relevant literature on research publication outputs per capita was not easily accessible.

3 RESEARCH METHODOLOGY

This section covers the research design, data collection, data analysis, validity, reliability, trustworthiness, data management, statistics, ethical consideration,

3.1. Introduction

Research methods are utilised to collect data, assess a population or sample, and synthesise information with the purpose of addressing research questions and hypotheses (Creswell & Creswell 2017, 63). The role of research methodologies is of utmost importance in determining the approach to managing findings throughout different stages of research theory development, encompassing prediction, exploration, description, and confirmation (Jørgensen et al. 2018, 1029). The study utilised a quantitative research methodology. Quantitative research entails the systematic synthesis of data to empirically investigate a hypothesis, as indicated by Desai and Potter (2006, 116) and Paul and Barari (2022, 1100). The researcher devised a cross-sectional research design. This is a desktop study with no participants.

3.2. Research design

Study design is a plan to achieve a specific study result. Using secondary data from UoT research publications, the study was quantitative, cross-sectional, and exploratory. Cross-sectional research investigations are conducted at a single time point to determine the prevalence of a phenomena (Letsoalo & Ncube 2021, 33).

The UoT in South Africa is studying how academics' qualifications affected university research outputs. It used quantitative methodologies concurrently to comprehend the research issue. This research design used quantitative methods approach and considered the UoT's particular setting in South Africa to improve research performance and productivity.

3.3. Data collection

The specific variables were excluded before starting with the analysis of secondary data. The study abstained from making any allusions to the University of Technology. The datasets were solely from DHET research publications outputs reports between 2018 and 2021.

Quantitative data was collected from UoT's institutional records and research databases from 2018 to 2021. This data included number of research publications outputs, the number and percentage of academics with Doctoral degrees, and demographic information about researchers. Permission was requested from the relevant authority for this purpose.

3.4. Data analysis

Microsoft Excel and STATA 17 were employed as tools for collecting secondary data to facilitate statistical data analysis. The discipline of statistics places significant importance on the analysis of research publications in relation to the size of the population being studied. Descriptive statistics was used to present the distribution of number of DHET awarded unit for each year focusing on the overall and according to each demographical information of authors for the research publications outputs data sets. Frequency count and percentages were used to present the data for categorical variable; and mean, standard deviation for the overall sum of the DHET awarded unit.

- Quantitative Analysis: Descriptive statistics was used to analyse quantitative data. This analysis shows how academic qualifications and research production at the UoT compare to national and sector averages.
- Objective Data: Document analysis provided a thorough overview of UoT research outputs and academic qualifications. It ensured that the study be based on objective data.
- Longitudinal Data: Document analysis provided access to 2018–2021 UoT data archives. This longitudinal technique let the researcher to study research output trends and uncovered potential patterns and factors affecting research productivity.

Independent Student t-test (or t-test) and Analysis and Variance (ANOVA) are statistical techniques commonly used when there is an independent continuous variable, while an independent categorial variable group comparisons are made by means (Fay & Proschan 2010, 8). T-test was used to

compare whether there was a significant difference of aggregate DHET unit awarded between different gender grouping (males and females) since gender contained variable with two categories (Mishra P 2019, 411). ANOVA was used when looking at variables with three or more groups like the highest of qualification, country of birth and age group and means difference of DHET unit awarded. Where the ANOVA was significant, further Post Hoc tests were done though the results are not reported in the current report. The Post Hoc is a Least Significant Difference (LSD) and is used to determine which pairwise amongst different groups that were significantly different (Mishra 2019, 407).

The t-test and ANOVA were used for inferential statistics and in both a probability value (p-value) of 0.05 significant level was set after and applied by (Andrade 2019, 211). The researcher further elaborate that 0.05 cut-off follows a normal distribution with very different values that are more in value as compared to two standard deviations away from the true mean.

3.5. Validity, reliability and trustworthiness

This section covers validity, reliability, trustworthiness, data management and statistics, data de-identification, protection of anonymity and confidentiality, augmented research productivity, utilising an evidence based approach to decision making, improving institutional reputation and policy recommendations.

3.5.1. Introduction

Validity, reliability, and trustworthiness of research findings are essential to study credibility and robustness. The University of Technology study's research design addresses these main issues.

3.5.2. Validity

Validity can be defined as techniques to measure the accuracy and ability of the data or instrument to answer the study questions (Zamanzadeh *et.al* 2015).

a) Internal Validity: Research instruments and data gathering procedures for internal validity were constructed carefully. Literature and professional advice determined variables and measures.

b) External Validity: Documenting the research strategy, methods, and context enhances external validity. This allows other researchers to test findings in comparable scenarios.

3.5.3. Reliability

Reliability can be defined as how precise the instrument or data collected or applied in the process of replicability of the results (Leung 2015, 325).

a) Consistency in Data Collection: The study team is trained on data collection processes to minimise data variation (Leung 2015, 315).

b) Data Quality Assurance: The dataset was checked and validated regularly to find and fix mistakes.

3.5.4. Trustworthiness

Trustworthiness of a study refers to the strategies to measure the credibility of data, how much of the data can be dependent on, and methods used to comfirm the quality of a study (Elo *et.al* 2014).

a) Credibility: Long-term engagement with UoT stakeholders will build credibility and institutional documents will strengthen the conclusions.

b) Dependability: The research procedure, including data selection, data collection, and analysis, were documented. For transparency, a research decision audit trail shall be provided when needed.

c) Confirmability: The researcher maintained reflexivity and transparency in data analysis. Analytical judgements were documented to prove data-based interpretations and findings.

The data used in this study was reviewed by the institutional committee before it was submitted to the internal auditors for approval before submitting to DHET for national review. These committees at DHET and UoT applied a data assurance process, validated and confirmed the accuracy and quality of the datasets by cleaning out unverified and predatory units claimed.

3.5.5. Data Management

a) Data Storage: All quantitative data was securely maintained and available exclusively to the study team to preserve participants' privacy.

b) Data Retention: The researcher complied with university's data retention policy which requires data keeping following the study.

3.5.6. Statistics

The present analysis will centre on the examination of various aspects, including the research output targets set by the Department of Higher Education and Training, the allocation of units, the classification per year for 2018 to 2021, qualifications of the researchers, gender, employment status, origin and age of author. The determination of per capita outputs of the University of Technology from 2018 to 2021 is contingent upon various factors, including the presence of permanent academic staff and the quantity of research publications.

UoT statisticians have assisted in ensuring accurate data analysis. Their knowledge have improved statistical results. The study seeks to understand how academic qualifications affect UoT research outputs by addressing validity, reliability, and trustworthiness in the research design. Rigorous procedures and ethical considerations would improve research findings.

3.6. Ethical consideration

The purpose of this phase of the research endeavour was to guarantee compliance with ethical principles and safeguard the well-being of individuals data that was used in the study. Human subject and institutional data study requires ethical considerations. Before initiating the study and to protect participants' rights and maintain confidentiality, researchers had to seek ethical permission from relevant bodies (Jones et al. 2022). Data privacy and anonymity are crucial aspects, and researcher should de-identify data and remove personal information before analysis (Brown & Johnson 2022).

In adherence to the data access and control policies implemented by the University, the data repositories of the University of Technology spanning the years 2018 to 2019 was subject to access. To ensure the protection of data privacy, it was crucial to adhere to suitable authorisation protocols and ethical principles.

To access data from the Clarivate Converis Research Information Management System (CC-RIMS) for the timeframe spanning 2020 to 2021, the researcher obtained gatekeeper approval from the

University of Technology (UoT) authorities.

Obtaining gatekeeper approval was crucial for ensuring compliance with data protection and privacy regulations. It was imperative to establish consensus among the authorities responsible for accessing data in the context of CC-RIMS. Ethical researchers demonstrate a strong dedication to preserving and employing data solely for the purpose of conducting research.

It is imperative to consider ethical considerations in all research studies, including the proposed study conducted at the University of Technology, which sought to investigate the correlation between academic qualifications and research outputs. The UoT's research ethics committee had to approve the project to ensure ethical conduct. There were no participants in the study but the researcher has ensured data confidentiality and anonymity.

3.6.1. Data de-identification

To safeguard the privacy of participants, all data obtained from the University of Technology (UoT) were subjected to a de-identification procedure. The identification of the author, co-author, journal, and university would be excluded. Alternatively, it is possible to represent individuals or publications through the use of unique identifiers or codes.

3.6.2. Protection of anonymity and confidentiality

Measures were taken to safeguard the identities of the individuals involved in the study, thereby ensuring their anonymity. To uphold the principle of confidentiality, any personal information that has the potential to disclose the identities of individuals were either removed or encrypted. Exclusive access to de-identified data will only be provided to authorised researchers, contingent upon the execution of confidentiality agreements.

The study excluded data pertaining to race. To address biases and emphasise the importance of academic credentials and research accomplishments, this decision has been made. To ensure impartiality and neutrality, the research excludes the incorporation of sensitive variables.

The process of acquiring and preserving data will necessitate the incorporation of robust security measures, such as the utilisation of password protection, for the purpose of data storage. To uphold the confidentiality of the data, exclusive access will be granted only to the research team. The data

will be stored for the duration of the study and for a reasonable period thereafter, in compliance with the regulations set forth by the institution or ethical guidelines.

The research initiative offers various institutional advantages to the University of Technology.

3.6.3. Augmented Research Productivity

The study seeks to ascertain prospective pathways for institutional progress by scrutinising the influence of academic credentials on research publications. The data mentioned has the potential to be utilised in the creation of targeted research support systems for faculty members at the University of Technology.

3.6.4. Utilising an Evidence-Based Approach to Decision Making

The study intends to produce empirical evidence that can effectively guide and enhance the decision-making processes. The data mentioned possesses the capacity to offer valuable insights that can inform research policies, resource allocation, and researcher assistance at the University of Technology.

3.7. Improving institutional reputation

By increasing research productivity and quality, the University of Technology has the opportunity to enhance its academic standing and improve stakeholder perception. Research-oriented institutions possess the capacity to secure significant financial resources, cultivate collaborative alliances, and draw in exceptionally accomplished researchers.

3.8. Policy Recommendations

The study examined the relationship between academic credentials and research productivity, specifically focusing on the potential benefits for the University of Technology and the improvement of research outcomes in South African universities.

The study's findings offer valuable insights that can be utilised to inform and improve institutional policies related to research outputs, academic qualifications and performance management. These policies would be implemented with the aim of cultivating and advancing research and innovation.

4 RESULTS AND DISCUSSIONS

In this study, data has been collected mostly through document analysis from research publications outputs reports and available institutional electronic archives. This assisted in examining data and important documents connected to research publications outputs at the University of Technology and South African universities. The method was suitable for non-participant data collection on academic qualifications, research publications outputs, and associated criteria. It delivered complete and dependable historical data and trend analysis.

4.1.   Research publications outputs awarded to TUT researchers

The data in Table 5 presents the number of authors who contributed to research publications outputs units awarded to TUT for the publications of 2018 to 2021. As presented in the Table, the number of authors has been fluctuating on an annual basis with an increase from 422 in 2018 to 430 in 2019 and then decrease to 419 in 2020 and increase steeply to 467 in 2021. On average, 434 authors were responsible for an average of 314,78 outputs units generated annually at TUT. This correlates well with the number of staff members with Doctoral degrees at the UoT as there were 297 Doctoral holders in 2018 (31,7%); 313 in 2019 (33,7%); 310 in 2020 (34,5%) and 324 in 2021 (36,9%). The data referred to in this study was obtained from DHET reports for the sector for 2018, 2019, 2020 and 2021 publications (DHET 2020; DHET 2021; DHET 2022; DHET 2023).

If universities expected a publication from each staff member with a Master's and a Doctoral qualification (715 in 2019, 721 in 2020 and 725 in 2021), as documented in UoT 2023b, 33, the targets set by DHET would be easily achieved even without those expected from Master's and Doctoral students when they graduate. With an expectation of a draft publication from a Master's graduate and a submitted publications from the Doctoral student, the number of outputs would even be higher than double the awarded outputs as seen in Table 5. This calls for universities to reconsider enforcement of publications if they want to increase their outputs without bringing additional researchers from outside the employment of the university.

Table 5. Research publications outputs awarded to authors by DHET between 2018 and 2021						
Year	Total units	Number or co-authors (N)	Mean	SD	Min	Max
2018	295,53	422,00	0,31	0,20	0,00	1,00
2019	361,30	430,00	0,29	0,15	0,00	1,00
2020	328,28	419,00	0,28	0,19	0,00	1,00
2021	274,01	467,00	0,24	0,18	0,00	1,00
Overall average	314.78	434	0,28	0,18	0,00	1,00

4.2.   Qualification level of authors contributing to publications outputs

The data in Table 6 shows the level of qualifications of authors who contributed to outputs at UoT between 2018 and 2021. The levels start with researchers without Master's and Doctoral, followed by those with Master's and then the ones with Doctoral. Authors without Master's and Doctoral might have been students at levels even lower than Master's. In all the years, very few publications (4,81% in 2018; 4,42% in 2019; 3,93% in 2020 and 3,10% in 2021) were co-authored with authors without a postgraduate qualification.

It was pleasing to see that authors with Master's qualifications also contributed to research outputs of the UoT (17,94% in 2018; 16,87% in 2019; 17,68% in 2020 and 17,16% in 2021). These numbers were fluctuating by decreasing in 2019 from 2018, then a little increase in 2020 and another decrease in 2021. The fluctuations might be due to lower number of students ensuring that their draft papers are submitted for publications. This could be improved by amending the policy on targets expected from a graduating Master's student. Staff members holding Master's qualifications should be encouraged to publish with researchers who holds Doctoral degrees. This also shows that the required publication draft is never always a guaranteed publication by supervisors. Supervisors must follow these drafts papers and make sure that they are published in order to increase publication outputs at a UoT.

In 2018, a total of 316 students graduated with a Master's degree, 318 in 2019, 368 in 2020 and 270 in 2021 (UoT 2023b, 23). This is in agreement with the number of outputs generated by Master's degree holders, that is, 53,03 in 2018 which increased to 60,87 in 2019 and then 58,05 in 2020 and decreased to 47,01 in 2021. The Master's students graduations were increasing from 2018 to 2020 and took a deep drop in 2021. This drop could have been due to Covid-19 effects from 2020 affecting students performance and possibly staff members as well. It is not pleasing to see such high number of graduations with Master's that do not correlate to the number of outputs generated by this group of researchers and TUT. In addition, if each graduate's draft manuscript was to be published, much more publications would be generated by this group of students. The situation would be even worse if the number of staff holding a Master's qualification were to be considered. The UoT should put more emphasis on this group of researchers if research publications outputs were to be improved at the university. This situation could be the same at all universities.

A good number of publications outputs were contributed by authors holding a Doctoral qualification in all the years (73,66% in 2018; 61,89% in 2019; 78,38% in 2020 and 79,74% in 2021). The trend that was observed with Master's qualification holders research publications outputs is also noticed with Doctoral holders. There was a decrease in publications from 2018 to 2019. It was however exciting to see an increase in publications from 2019 to 2021 without a drop in between the years. This steady growth should be encouraged to maintain or even improve on the number of publications produced by Doctoral degree holders.

In 2018, a total of 58 students graduated with a Doctoral degree, 66 in 2019, 91 in 2020 and 69 in 2021 (UoT 2023b, 23). This is in agreement with the number of outputs generated, that is, 217,68 in 2018 which increased to 223,58 in 2019 and then 257,32 in 2020 and decreased to 218,5 in 2021. The decrease in Doctoral qualification holders, especially on the side of students graduates, could have been due to Covid-19 effects from 2020 affecting students performance and possibly staff members as well.

A significant number of outputs produced in 2019, about 16,84%, were from authors whose qualifications level was missing. This missing information could have been due to incompleteness of information captured when students and staff were registered.

Qualification level	2018		2019		2020		2021	
	Units	%	Units	%	Units	%	Units	%
No Master's or Doctoral	14,23	4,81	15,98	4,42	12,91	3,93	8,50	3,10
With Master's	53,03	17,94	60,87	16,85	58,05	17,68	47,01	17,16
With Doctoral	217,68	73,66	223,58	61,89	257,32	78,38	218,50	79,74
Missing total	10,59	3,58	60,85	16,84	0,00	0,00	0,00	0,00
Total	295,53	100,00	361,28	100,00	328,28	100,00	274,01	100,00

Table 6. Qualification level of authors contributing to publications outputs between 2018 and 2021

The data in Table 7 and Figure 1 below shows that more Doctoral holders contributed to the research publications outputs between 2018 and 2021. About 52,45% contributions were seen in 2018, which decreased slightly in 2019 to 51,88%. An improvement was seen in 2020 to 54.42% and most con-tributors were in 2021. This was followed by the Master's qualification holders wherein an increase from 33,11% contributes to 2018 outputs, which increased to 33,46% in 2019 and the 33,89% in 2020. A slight decrease to 28,48% was suffered in 2021.

There were authors without a Master's qualification who contributed to research publications outputs between 2018 and 2021. A lot of these contributors, about 14,66%, were in 2019.

Qualification	2018		2019		2020		2021	
	N	%	N	%	N	%	n	%
No Master's or Doctoral qualification	57	13,47	63	14,66	49	11,69	43	9,21
Master's qualification holders	140	33,11	144	33,46	142	33,89	122	28,48
Doctoral qualification holders	221	52,45	223	51,88	228	54,42	268	62,31

Table 7. Percentage of authors with different qualification contributing to publications outputs between 2018 and 2021

| Not specified | 4 | 0,88 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 422 | 100 | 430 | 100 | 419 | 100 | 467 | 100 |
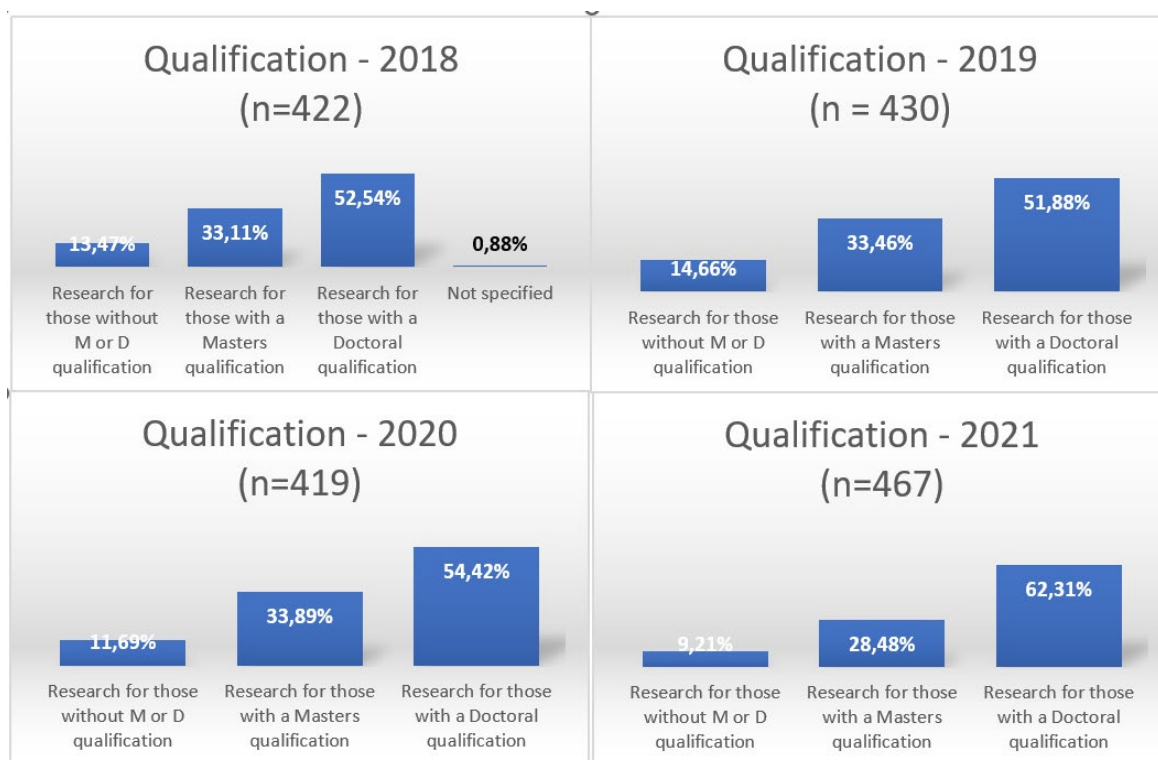
Figure 1: Qualification for authors from 2018 to 2021

4.3. **Gender of authors who contributed to publication outputs between 2018 and 2021**

In terms of gender of authors who contributed to research publications units at UoT, very few females contributed to publications outputs as it is presented in Table 8 below. The data shows that 28,7% of females co-authored publications in 2018 which decreased to 24,25% in 2019 and then increased to 26,07% in 2020 and was steady at 26,67 in 2021. Again in 2019, the report indicates that 16,85% of authors' gender was missing.

Table 8. Gender of authors who contributed to publication outputs between 2018 and 2021								
Gender	**2018**		**2019**		**2020**		**2021**	
	Units	**%**	**Units**	**%**	**Units**	**%**	**Units**	**%**
Female	84,82	28,70	87,60	24,25	85,58	26,07	73,08	26,67

Male	200,57	67,87	212,83	58,91	242,70	73,93	200,93	73,33
Missing total	10,14	3,43	60,87	16,85	0,00	0,00	0,00	0,00
Total	295,53	100,00	361,30	100,00	328,28	100,00	274,01	100,00

As per data in Table 9 and Figure 2 below indicated, only 31% of the 422 researchers who contributed to research outputs in 2018 were females. A slight increase to 39% was seen in 2019 as the number of contributors increased from 422 in 2018 to 430 in 2019. This was the highest percentage of female researchers who contributed to publications outputs at the UoT in the years covered in the study. In 2020, the number of researchers declined to 419, the lowest number in the four years reported in this study. The number of female researchers decreased to 32 %, which was still 1% higher than the lowest value in 2018. A big improvement was seen in 2021, wherein 34% of 467 researchers who published their work were females.

Gender	2018		2019		2020		2021	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Female	132	31%	168	39%	132	32%	157	34%
Male	290	69%	262	61%	287	68%	310	66%
Total	422	100%	430	100%	419	100%	467	100%

Table 9. Number/percentage of authors who contributed to outputs per gender between 2018 and 2021

According to the institutional enrolment plan (UoT 2022, Table 17), at least 51% of students enrolled in 2018 and 2019 should have been females and 50% are expected in 2020 and 2021. It should be noted that no data on gender of staff employed at UoT was available in the institutional enrolment plan. However, if these targets were to be considered, it is clear that female contribution to research publications outputs was not even close to 50% of all authors from 2018 to 2021. This is, thus, another area the universities can focus on improving and if much attention was to be paid on this, a lot of females would be developed and contribute significantly to research publications outputs of the UoT.
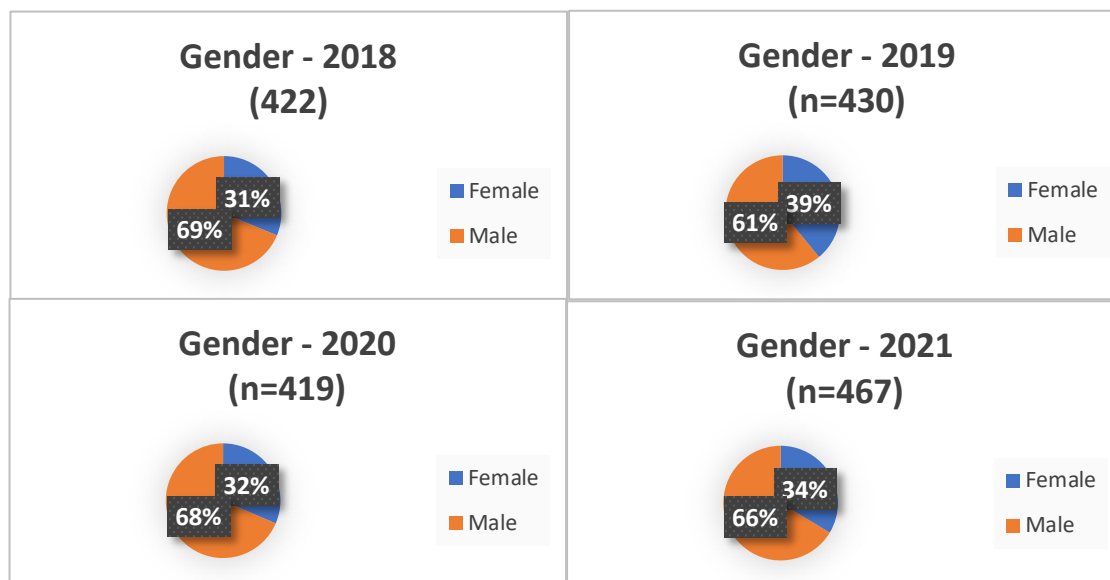
Figure 2: Number/percentage of authors by gender from 2018 to 2021

4.4. Citizenship of authors contributing to outputs

The UoT employs multinationals, however, the contribution of South African citizens was higher than those outside the borders of South Africa as presented in Table 10 below. The contribution of South Africans to research publications outputs in 2018 was 51,12% which decreased to 43,11% in 2019 and increased a bit to 46,51% in 2020 and steeped in 2021 to 61,99%. The other noticeable contribution was made by authors from other African countries who contributed to 35,98% in 2018; followed by 34,85% in 2019 and increased to 44,78% in 2020 and then dropped to 32,66% in 2021. While the highest contribution to outputs by other Africans was in 2020, the South African contribution was highest in 2021.

Table 10. Citizenship of authors contributing to outputs between 2018 and 2021								
Citizenship	**2018**		**2019**		**2020**		**2021**	
	Units	**%**	**Units**	**%**	**Units**	**%**	**Units**	**%**
Asian country	19,27	6,52	9,87	2,73	19,45	5,92	9,06	3,31
European & North America	7,79	2,64	8,65	2,39	9,16	2,79	5,60	2,04
Other African countries	106,34	35,98	125,91	34,85	146,99	44,78	89,50	32,66
South African	151,08	51,12	155,76	43,11	152,68	46,51	169,85	61,99

Missing total	11,05	3,74	61,12	16,92	0,00	0,00	0,00	0,00
Total	295,53	100,00	361,30	100,00	328,28	100,00	274,01	100,00

As presented in Table 11 and Figure 3 below, during the four years that the current study is focused on, just over 60% of authors were South Africans. In 2018, about 62% of South African citizens contributed to research publications outputs. This is pleasing even though their publication units contribution was around 50%. The most South African authors contributed 64% in 2019 which decreased to 60% in 2020 and increased again to 61% in 2021.

Authors from other African countries were the second most contributors of research publications outputs between 2018 and 2021 at around 31% average. In 2018, about 32% of this group of authors generated publications at the UoT which decreased to 31% in 2019 and increased to 35% in 2020, and then decreased to 34% in 2021. It would be interesting to know the level of qualifications of these authors and their gender. Additional work should be done in future to determine if these contributors were mostly constituting of students or academic staff members.

Less than 6% of authors who published research outputs were from Asian, European and North American countries. A good number of authors were from Asian countries with 4% of them contributing to outputs in 2018 and 2019; then 3% in 2020 and 2021. About 1% of European authors published with the UoT in 2019 which increased to 2% in 2018, 2020 and 2021.

Table 11. Percentage of Citizenship of authors contributing to outputs between 2018 and 2021								
Country of Birth	**2018**		**2019**		**2020**		**2021**	
	n	**%**	**N**	**%**	**n**	**%**	**n**	**%**
Asian country	17	4	17	4	13	3	10	3
European and North America	8	2	4	1	8	2	9	2
Other African countries	135	32	133	31	147	35	124	34
South African	262	62	275	64	251	60	324	61
Total	422	100	430	100	419	100	467	100

The data can be used to determine if authors from all countries that collaborate with the UoT publish with them. This can also be used to guide which countries to target for future collaboration. Additional study on whether the authors from these countries are collaborating with researchers from their own country could assist in identifying areas of possible collaborations with other universities outside the borders of South Africa.
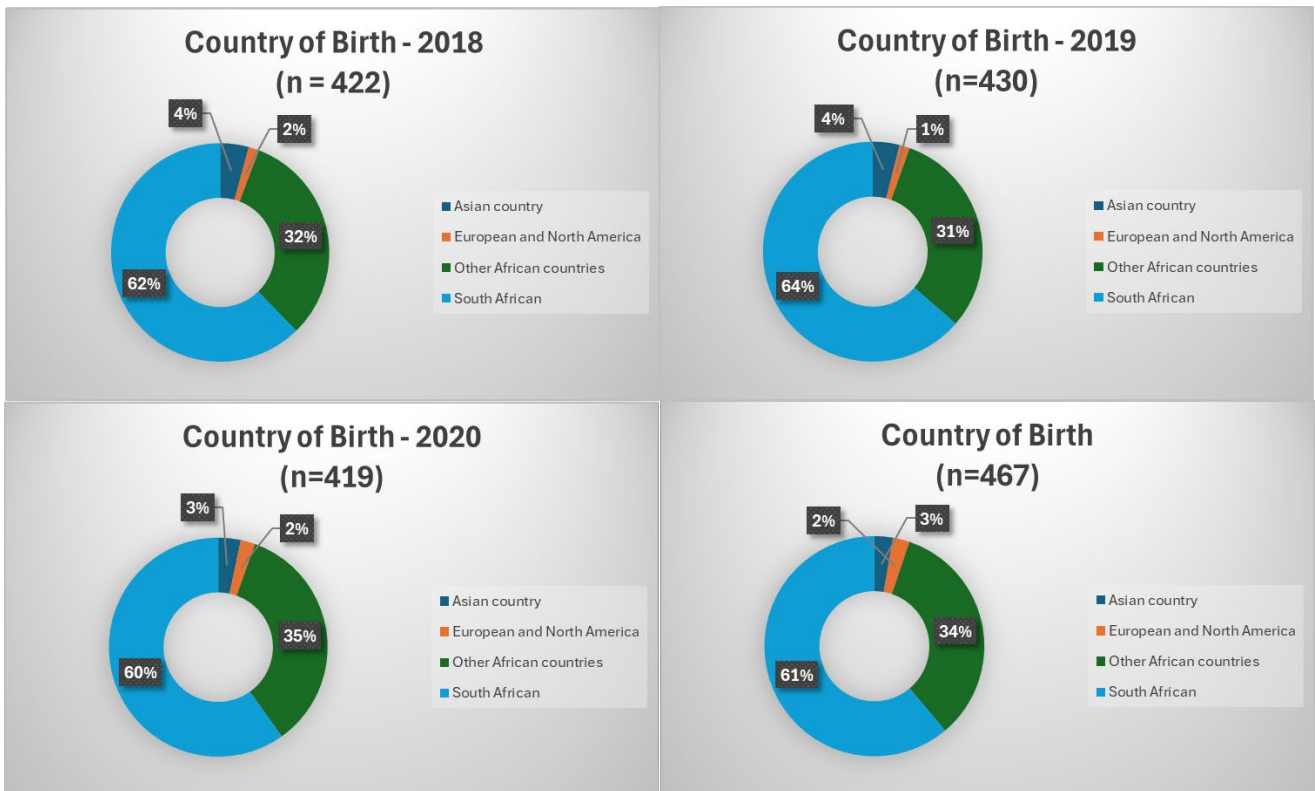
Figure 3: Country of Birth of authors from 2018 to 2021

4.5. **Percentage of age of authors who contributed to outputs**

For the category on age, it was not possible to report since 2019 information was not available for authors. However, the data presented in Table 12 below shows that the age group that contributed to most research publications outputs in 2018 were aged 46-55, followed by those aged between 36-45, and then 31-35s, with the less than 30s also contributing better than the 56-65s and those older than 65. Unfortunately, almost 10% of the authors had no age attached to them so, this makes it difficult to conclude on this 2018 group. This trend was seen also in 2020, though the 56-65s published more than the 31-35s. However, the older than 65s still contributed less to outputs in 2020. In 2021, though with not too wide a margin, the aged 36-45 published more than the 45-55 age group. Similar to 2020, the 56-65 age group published more that the 31-35 age group in 2021. In this year, the authors older than 65 authored a little more than those under the age of 30.

A large number of generators of the publications outputs in 2018 and 2020 were between the ages of 46 and 55. This group of authors co-authored 31,19% and 30,12% of publications in 2018 and 2020, respectively. The second highest number of authors were aged between 36 and 45 and published 23% of outputs in 2018 and 22% in 2020. This was followed by authors aged between 31 and 35 only in 2018.

In 2021, authors aged between 36 and 45 contributed 28,84% of the publications followed by the age group of 46-55s. Researchers close to retirement, aged between 56-65, contributed less than authors aged between 36 to 55 throughout the years. This is good since a large number of contributors of outputs at a UoT is amongst this cohort of researchers. Some outputs in 2018, still higher than those by authors close to retirement, were published by authors under the age of 30. The group older than 65 have contributed the least research outputs for 2018 and 2020 but just 1,5% higher than less than 30 years in 2021.

Table 12. Percentage of age of authors who contributed to outputs between 2018 and 2021						
Age range	**2018**		**2020**		**2021**	
	Units	**%**	**Units**	**%**	**Units**	**%**
Less or equal to 30	30,98	10,48	20,44	6,23	17,24	6,29
31-35	37,22	12,59	40,35	12,29	38,33	13,99
36-45	67,94	22,99	92,60	28,21	79,02	28,84
46-55	92,17	31,19	98,88	30,12	75,31	27,48
56-65	27,37	9,26	56,72	17,28	42,77	15,61
Older than 65	10,44	3,53	19,30	5,88	21,34	7,79
Missing total	29,41	9,95	0	0,00	0,00	0,00
Total	295,53	100,00	328,28	100,00	274,01	100,00

In summary, as presented in Table 13 and Figure 4 below, most authors were between the ages of 36-45 followed by those in the age group of 46-55 and then the 31-35 year olds. Only in 2018, the authors younger than 30 were more than the 31-35 year olds. The 56-65 year olds were more than the under 30 year olds.

Unlike what was seen in terms of the contributors of research publications, there were more authors aged between 36-45 in 2018 followed by those aged between 46-55, then under 30 followed by 36-45 year olds with 56-65 coming next just before the older than 65s. This trend was the same in 2020 and 2021 except that the 31-35 year olds authors were more than the 30 year olds in both years.

Table 13. Percentage of age of authors who contributed to outputs between 2018 and 2021						
	2018		**2020**		**2021**	
Age (in years)	**N**	**%**	**N**	**%**	**n**	**%**
Less or equal to 30	78	18,48	63	15,04	57	11,9
31-35	75	17,77	73	17,42	86	17,9
36-45	109	25,83	121	28,88	133	27,7
46-55	98	23,22	98	23,39	100	23,7
56-65	44	10,43	53	12,65	68	14,1
Older than 65	12	2,84	11	2,62	23	4,8
Not specified	6	1,42	0	0,00	0	0,0
Total	422	100	419	100,00	467	100,0
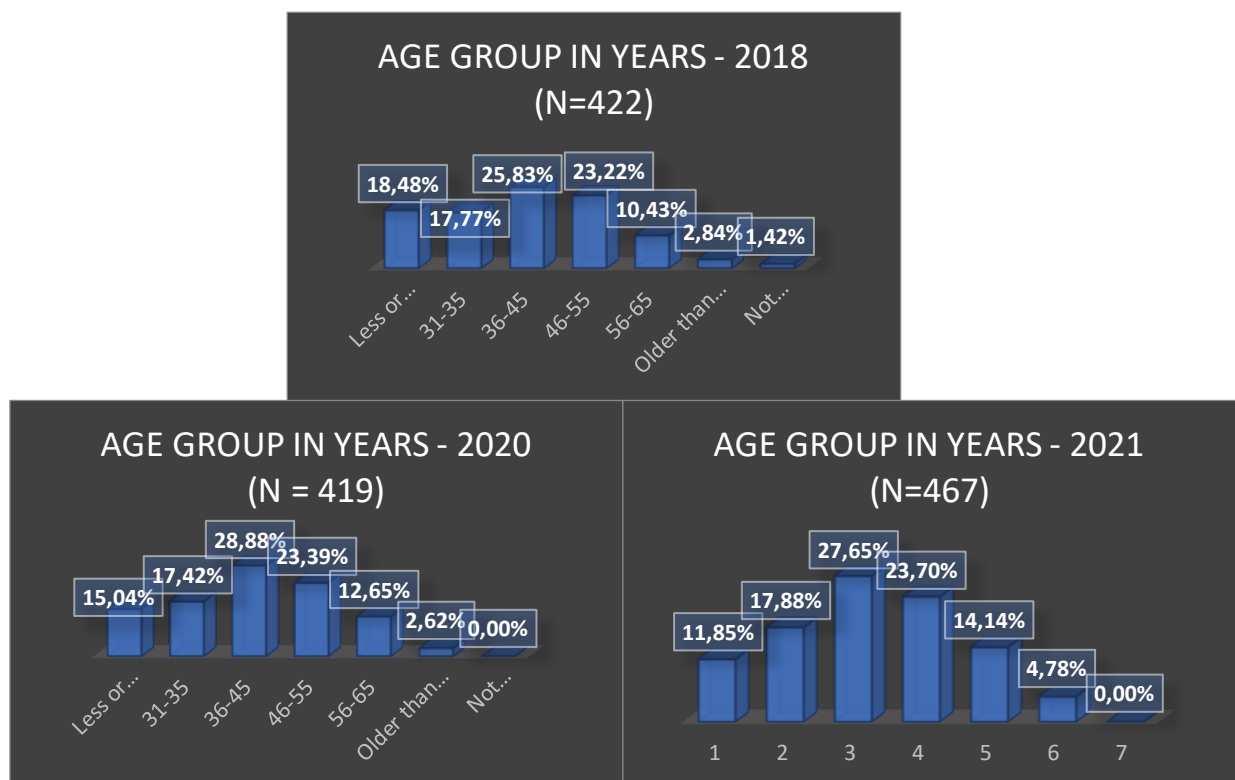
Figure 4: Age groups of authors in years, 2018, 2019 and 2021

4.6.   **Employment status of contributors of publications outputs**

The employee status of the authors of the publications outputs at the UoT is presented in Table 14 below. The data did not have all information needed for this section. No data was available for 2018 and 2019. The information was complete for 2020 but for 2021 there was no information on Post-doctoral Research Fellows, South African Research Chairs Initiative (SARChIs).

It is evident and pleasing to see that most of the publications of the UoT were contributed by permanent employees. In 2020, about 61,56% of publications outputs were co-authored by permanent employees. This was increased to 65,84% in 2021. It is also exciting to note that the second largest contributor of outputs at UoT was students of the University who co-authored 18,91% of publications in 2020 and that increased to 21,22% in 2021. This means that 80,47% of publications of the UoT were contributed by permanent employees and students of the university in 2020 and in 2021 it was 87% by the same type of authors. Postdoctoral Research Fellows have contributed 8,23% in 2020 followed by 7,86% contribution by temporary appointed staff. The contribution by temporary appointed staff increased to 12,78% in 2021. The SARChI research chairs contributed just 2,17% in 2020. This could be because some chairs did not indicate that they were SARChIs. Visiting Professors co-authored 1,27% in 2020 and 0,17% in 2021. The co-authorship with visiting scholars at UoT decreased in 2021.

The results show that not much research is published with visiting scholars at the university. If these are to assist in increasing research publications outputs at the UoT, their relationships with UoT researchers must be clear and contributions be stipulated.

Table 14. Employment status of contributors of publications outputs in 2020 and 2021				
Employee status	**2020**		**2021**	
	Units	**%**	**Units**	**%**
Permanent	202,09	61,56	179,10	65,84
Contract/Tempo	25,81	7,86	34,75	12,78
Postdoctoral Research Fellow	27,01	8,23		
Student	62,09	18,91	57,71	21,22
SARChI Research Chair	7,12	2,17		
Visiting scholar	4,16	1,27	0,45	0,17

Other	0	0	2,00	0,74
Total	328,28	100,00	272,01	100,00

In terms of employment status of authors who published at the UoT, most of them were permanent employees as presented in Table 15 and Figure 5. In 2020, about 43,94% of authors published at the UoT and this number increased to 50,5% in 2021. The second most generators of publications were students who were 36,82% in 2020 and 36,6% in 2021. No data was available for 2018 and 2019. About 8,08% of authors who were appointed on contracts or temporary published in 2020 and 11,8% in 2021. The category named other contains data for postdoctoral research fellows, Chairs, visiting scholars and other that is seen in Table 14 above. Thus, about 11,16% of these authors published with the UoT in 2020 and this was decreased to 1,1% in 2021. The reason for the decline could be Covid-19 effect from the previous year which was less active due to lockdown.

The publication status of the UoT is healthy and satisfying as most authors are permanent employees, meaning the UoT is not chasing numbers by getting external people to publish with it. The employment status of the authors should be investigated further to identify how many of the permanent employees held Doctoral and Master's degrees. Such a study would be of great assistance to the university as the numbers as seen are frightening.

Table 15. Percentage of employment status of contributors of publications outputs in 2020 and 2021				
	2020		**2021**	
Employee status	**N**	**%**	**n**	**%**
Permanent	184	43,94	236	50,5
Contract/Temporary	34	8,08	55	11,8
Student	154	36,82	171	36,6
Other categories	47	11,16	5	1,1
Total	419	100	467	100
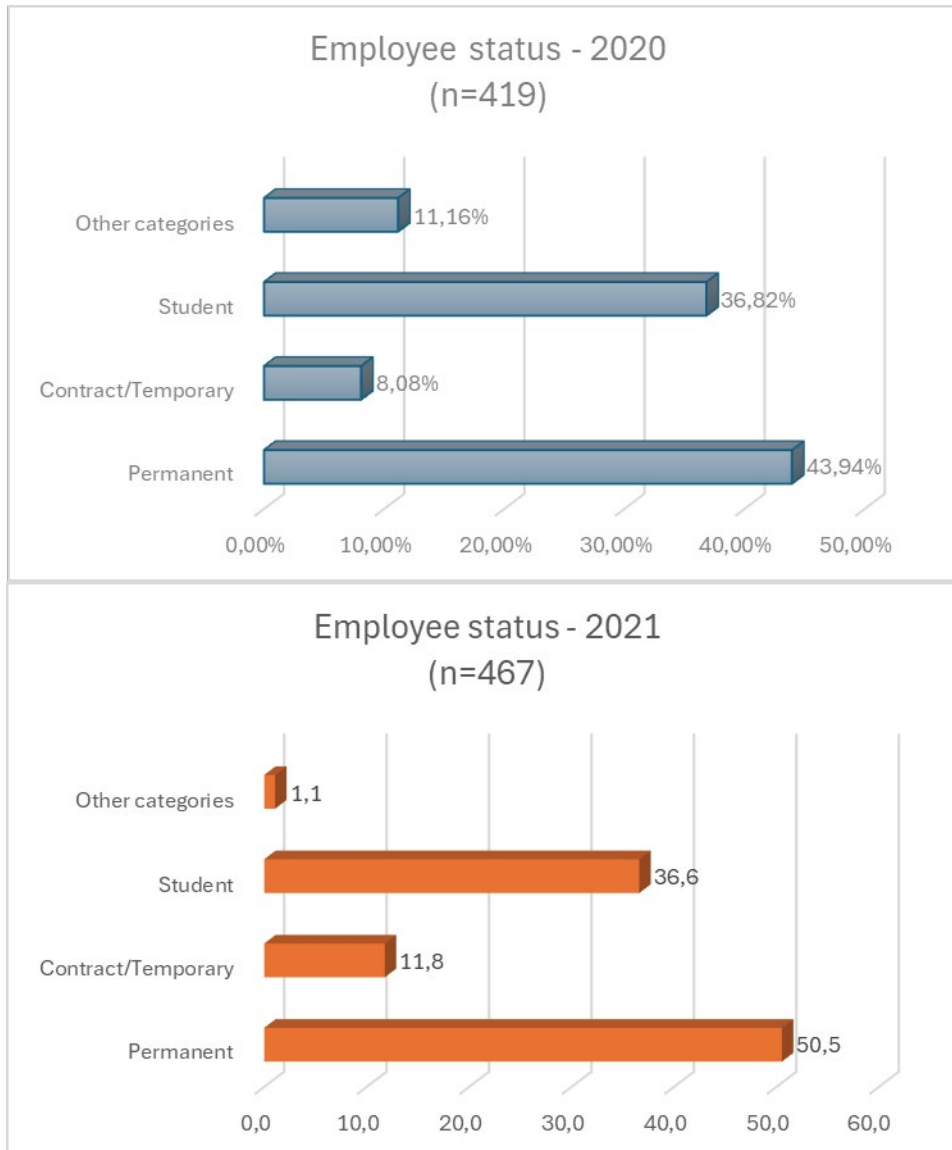
Figure 5. Employee status of authors in 2020 and 2021

4.7. Group comparisons of mean differences between DHET awarded unit and the demographical variables, gender, age group, qualification and country of birth

Comparisons were computed using t-test and Analysis of Variance (ANOVA) to measure whether there were significant differences in mean of DHET units awarded amongst different demographic groupings (gender, age group, highest qualification and country of birth for the authors). All comparison were done for each year from 2018 to 2020.

T-test was used for gender because of the mean difference group comparisons were just between two groups (male versus female). ANOVA was used to measure if there was a significant difference with groups that were three or more.

4.7.1. Comparisons for the differences between Gender and mean differences number of units awarded

Tables 16a and 16b presents the summary statistics and t-test for DHET units awarded per gender. Mean values for male and females were 0.6402 (SD = 0,95) and 0,6501 (SD = 1,35). The mean difference was -0,0991 (see Table 16b) which is insignificant in comparison to p value which was 0,945. In simple terms, as indicated in Table 16b, this means that the number of units contributed by females and males were more or less the same.

Table 16a. Summary statistics for DHET units awarded for gender at a UoT in 2018		
Gender	Mean	Standard Deviation (SD)
Male	0,6402	0,95450
Female	0,6501	1,35143

Table 16b. T-test results for mean differences between male and females according to the number of units awarded in 2018				
	p-value	T	Df	Mean difference
DHET Units Awarded	0,945	-0,088	442	-0,00991

Tables 17a and 17b below presents the summary statistics and t-test for DHET units awarded and gender for the year 2019. Mean values between for gender where 1,9498 for males and 5,6368 for females. For this year, the data indicates that there was significant difference in the mean values observed of 0,2853 and p-value of <0,001 as presented in Table 17b.

Table 17a. Summary statistics for DHET units for gender, UoT in South Africa in 2019		
Gender	Mean	Std. Deviation
Male	1,9498	1,97217
Female	5,6368	8,20169

Table 17b. T-test results for mean differences between male and females according to the number of units awarded in 2019				
	p-value	T	df	Mean difference
DHET Units Awarded	<0,001	-12,92	1288	0,2853

Tables 18a and 18b presents the summary statistics and t-test for DHET units awarded and gender in 2020. The mean difference of -0,197 observed was not statistically significant because the t-test had a value greater a significant level 0,05 (P value = 0115). The mean values observed for male and female as in table 18a were 0,6483 and 0,8457 respectively.

Table 18a. Summary statistics for DHET units for gender, UoT in South Africa in 2020			
Gender	Mean	Std. Deviation	Std. Error Mean
Female	0,6483	1,10680	0,09633
Male	0,8457	1,14127	0,06737

Table 18b. T-test results for mean differences between male and females according to the number of units awarded, 2020				
	p-value	**T**	**df**	**Mean difference**
DHET Units Awarded	0,115	-1,660	417	-0,197

Tables 19a and 19b below presents the summary statistics and group comparison t-test between the gender variable in 2021. Males and females had means values of 0,6482 (SD=0,79049) and 0, 75828 (SD=0,75825), respectively. The mean difference between males and females of -0,183 was statistically significant but the p-value of 0,031 was less than the significant level of 0,05.

Table 19a. Summary statistics for DHET units for gender, UoT in South Africa in 2021		
Gender	**Mean**	**Std. Deviation**
Male	0,6482	0,79049
Female	0,4654	0,75828

Table 19b. T-test results for mean differences between male and females according to the number of units awarded, 2021				
	p-value	**t**	**df**	**Mean difference**
DHET Units Awarded	0,031	2,392	465	-0,183

4.7.2. Comparisons for the differences between Age group and mean differences number of units awarded per year for 2018 to 2021

The Analysis of variance (ANOVA) is used to test whether there are significant differences in the mean scores of more than two groups (in this case Age groups). However, ANOVA is an omnibus test statistic, it does not tell which specific groups were different from each other on the dependent variable (DHET Units Awards). Thus, by performing the Post Hoc test, this information could be shown in the multiple comparisons table. The Post Hoc test were not included due to the time limitation as a result of the delays in approving the study.

Table 20 presents Analysis of variance to measure at least a pair of different age groups that differ significantly. Since the p-value of 0,025, represented by Sig. in Table 20, was less than the significance level of 0,05, it meant that at least two groups differed significantly (F = 2,591; p-value = 0,025).

Table 20. Analysis of Variance for DHET Units Awards between different age groups in 2018					
Age groups	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	16,037	5	3,207	2,591	0,025
Within Groups	496,331	401	1,238		
Total	512,368	406			

Data for 2019 was insufficient, hence no information.

The analysis of variance (ANOVA) where the mean difference of the DHET Unit awarded was compared against different age groups in 2020 is presented in Table 21. An indication from the ANOVA was that there was a significant difference amongst age groups with p-value = 0.025. Therefore, this meant that the mean differences of the DHET units awarded differed significant for at least two age groups.

Table 21. Analysis of Variance for DHET Units Awards between different age groups in 2020

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	33,746	5	6,749	5,544	<0,001
Within Groups	502,768	413	1,217		
Total	536,514	418			

The analysis of variance (ANOVA) where the mean difference of the DHET units awarded was compared against different age groups in 2021 is presented in Table 22. An indication from the ANOVA was that there was a significant difference amongst age group with p-value = 0.001. This meant that the differences in means of DHET units awarded differed significantly for at least two age groups.

Table 22. Analysis of Analysis for DHET Units Awards between different age groups in 2021

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	11,890	5	2,378	3,995	0,001
Within Groups	274,375	461	0,595		
Total	286,265	466			

4.7.3. **Comparisons for the differences between country of birth and mean differences in number of units awarded per year for 2018 to 2021**

Table 23 present the analysis of variance for DHET awarded units and country of birth in 2018. The ANOVA results showed that in 2018 the group difference between countries of birth and DHET units awarded was not statistically significant because the p-value (Sig.) was greater than level of significance of 0.05.

Table 23. Analysis of Variance for DHET Units Awards between different country of birth in 2018					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8,687	4	2,172	1,858	0,117
Within Groups	513,004	439	1,169		
Total	521,691	443			

Table 24 below presents analysis of variance (ANOVA) for DHET unit awarded versus highest qualification. A significant difference was observed amongst county of birth. The level of significance was 0,05 and therefore p-value from the ANOVA was less than 0,010 and this meant that significant difference between different countries of birth was observed.

Table 24. Analysis of Variance for awarded DHET units between different country of birth in 2019					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	16,754	3	5,585	3,851	0,010
Within Groups	616,259	425	1,450		
Total	633,013	428			

Analysis of variance (ANOVA) was used to measure whether there was a significant difference between countries of birth mean of DHET units awarded in 2020, Table 25. The p-value of 0,001 of the ANOVA indicated that there was a significant difference in the mean between different birth country of authors based on the DHET units awarded. The p-value was less than the significance of level of 0,05.

Table 25. Analysis of Variance for DHET Units Awards between different country of birth in 2020

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	20,046	3	6,682	5,369	0,001
Within Groups	516,468	415	1,245		
Total	536,514	418			

Table 26 shows, analysis of variance (ANOVA) where the mean difference of the DHET units awarded was compared against different country of birth in 2021. An indication from the ANOVA was that there was insignificant difference amongst country of birth (p-value = 0,054). This means that the mean differences of the DHET units awarded did not differ significantly for groups of countries of birth.

Table 26. Analysis of Variance for DHET Units Awards between different country of birth in 2021

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	4,675	3	1,558	2,562	0,054
Within Groups	281,590	463	0,608		
Total	286,265	466			

4.7.4. **Comparisons for the differences between highest qualification and mean differences number of units awarded per year for 2018 to 2021**

Table 27 used analysis of variance (ANOVA) table to measure whether there was a significant difference between different highest qualification mean of DHET units awarded in 2018. The p-value of <0,01 of the ANOVA indicated that there was a significant difference in the mean between different highest qualification level of authors based on the DHET units awarded. The p-value was less than the significance of level of 0,05.

Table 27. Analysis of Variance for DHET Units Awards between different highest qualification in 2018					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	38,709	3	12,903	11,755	<0,001
Within Groups	482,982	440	1,098		
Total	521,691	443			

Table 28 presents analysis of variance (ANOVA) where the mean difference of the DHET unit awarded was compared to different highest qualification groups in 2019. An indication from the ANOVA was that, there was a significant difference amongst highest qualification groups (p-value <0,001). This meant that the differences in means of DHET units awarded differed significantly for at least two groups of highest qualification level of authors.

Table 28. Analysis of Variance for DHET Units Awards between different highest qualification in 2019					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	22,875	2	11,438	8,002	<,001
Within Groups	610,339	427	1,429		
Total	633,215	429			

Table 29 below presents analysis of variance (ANOVA) for DHET units awarded versus highest qualification groups in 2020. A significant difference was observed amongst highest qualification levels. The level of significance was 0,05 and therefore p-value from the ANOVA was less than 0,001 and this means that a significant difference between groups of highest qualification was observed.

Table 29. Analysis of Variance for DHET Units Awards between different highest qualification in 2020.					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	60,346	2	30,173	26,360	<0,001
Within Groups	476,168	416	1,145		
Total	536,514	418			

In Table 30 below presents analysis of variance (ANOVA) for DHET units awarded versus highest qualification. A significant difference was observed amongst highest qualification levels. The p-values of 0,001 was less than the level of significance which was 0,05 and this meant that significant difference between different countries of birth was observed.

Table 30. Analysis of Variance for DHET Units Awards between different highest qualification in 2021					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	22,024	2	11,012	19,337	<0,001
Within Groups	264,241	464	0,569		
Total	286,265	466			

5 CONCLUSIONS AND RECOMMENDATIONS

The study was executed with slight difficulties as there was interruption of service on the approval of Ethics at the UoT. When the application for Ethics was done, the outcome of 2022 publications was not yet available and this was received in 2024. The data of the years before 2018 did not have too many categories as seen in the years that the study focused on. These restrictions and challenges led to some of the data being presented without all fields in some years and non availability of data in other years.

The study has contributed significantly to assessment of the UoT's research outputs performance, understanding of factors affecting research productivity, insights into qualifications of authors, country of origin of authors, employment status, gender, age-related contributions, policy recommendations and advancing knowledge in the field.

The study has also provided an analysis of the UoT's research output performance, specifically focusing on the per capita research publications outputs and comparing it to the national average. It is clear from the study that almost half of the total number of academics contributed to research outputs at the UoT. Most of these people were holding Doctoral degrees since the number of contributors and Doctoral holders correlated. It was noted that Master's degree holders had also published at this UoT.

Based on the study's findings, it could be recommended that the per capita outputs for universities be determined based on the number of Doctoral holders that are permanently employed at a university. The high research publications outputs contributed by traditional universities could be due to the high number of Doctoral holders appointed at those universities. Thus, UoTs should also focus on appointing more staff members with a Doctoral qualification if they want to increase their research outputs performance. Alternatively, the UoT should prioritise the development of staff to get Doctoral qualifications. This means that resource allocations will have to be improved and performance management systems be implemented to give incentives to staff members who teach and do research at the same time. These findings should contribute to the existing body of knowledge on research performance in higher education institutions. The insights could add depth to the broader understanding of research productivity in the academic sector.

The low contribution of research publications outputs by the UoT could not be attributed to the implementation challenges associated with the new system, Clarivate Converis Research Information Management System (CC-RIMS) and DHET Research Outputs Submission System (ROSS) that

were thought to might have hindered research productivity and output submission. The new system has actually reduced the burden of hard copy collection and submission to the Department. Hard copy submissions can be attributed to also low submission of outputs that results in low publications outputs awarded to universities. Universities that have not decided on purchasing systems for outputs submissions should do so as this could be beneficial for such institutions.

It is evident that the COVID-19 pandemic hampered research by disrupting data collecting, collaboration, and resource availability and this could be seen in the decrease in outputs generation in 2021, which was a year after the pandemic. Universities should always be prepared for disruptions of this nature or even worse to avoid losing subsidy due to non-submissions of quality outputs to the DHET.

There was little impact on the contribution of research publications outputs as a result of retirement of skilled researchers and the addition of less experienced researchers who may have contributed little to research outputs.

Individual goals need to be set and a strong performance management system would improve on the researchers' contribution to research publications outputs.

5.1.   Qualifications level of authors of research publications outputs

As presented in the discussions, the number of authors who contributed to research publications outputs has been fluctuating on an annual basis. On average, 434 authors were responsible for an average of 314,78 outputs units generated annually at TUT which correlates with the number of staff members with Doctoral degrees at the UoT. This behaviour would be changed by ensuring that each staff member with a Master's and a Doctoral qualification publishes on an annual basis as the UoT strategy demands (UoT 2022). All drafts manuscripts expected from Master's graduates and a submitted publication from the Doctoral student would increase the number of outputs by doubling the awarded outputs units. University should just consider enforcing publications expectations from its staff members with Master's and Doctoral qualification including students and postdoctoral researcher fellows.

The study showed that researchers without Master's and Doctoral, followed by those with Master's and then the ones with Doctoral published more than others at this UoT. Since the data does not separate students from employees, it is possible that some authors without Master's and Doctoral might have been students at levels even lower than Master's. During the years focused in this study, very few publications were written with authors without a postgraduate qualification.

It was gratifying to see that authors with Master's qualifications also contributed to research outputs of the UoT. These numbers were fluctuating which might have been due to lower number of students ensuring that their draft papers are submitted for publications. This could be improved by amending the policy on institutional targets expected from a graduating Master's student. Established researchers should be encouraged to co-publish with staff members holding a Master's qualifications in order for them to change this publication pattern at the UoT. The required manuscript should be tracked by Heads of the Departments throughout the years in order to ensure that it eventually get published. Supervisors must assist the university to make sure that it does not lose work that has been supported by the university over the years.

The effects of Covid-19 could be seen in the drop of performance in 2021 as opposed to other years. Though other authors managed to do more than it was expected of them in this 2021. Performance of staff members could also have been affected by Covid-19. The number of Master's student graduating did not correlate with the publications awarded. This could be corrected by the UoT encouraging each graduate to ensure that their draft manuscript are always published. In addition, the number of outputs would be increased if the number of staff holding a Master's qualification were to also be encouraged to make sure that they publish their work upon graduating.

It was clear from the study that a number of research publications outputs were published by researchers who held a Doctoral qualification in the years studies. There was a steady growth in publications by this group of researchers which must be maintained to improve the number of publications produced by Doctoral degree holders. There was a decrease of outputs generated by Doctoral qualification holders, especially on the side of students graduates, which could have been due to Covid-19 effects from 2020 affecting students performance and possibly staff members as well.

The data showed that more Doctoral than lower qualifications holders contributed to the research publications outputs between 2018 and 2021. This was followed by the Master's qualification holders. There were authors without a Master's qualification who contributed to research publications outputs between 2018 and 2021. A lot of these contributors were in 2019.

5.2. Gender of authors who contributed to publication outputs between 2018 and 2021

There were very few female authors, less than 40%, who contributed to research publications outputs during the period studied. This was still low as compared to the national average of 43,1% in 2021 (DHET, 2023). The missing data for 2019 shows that 16,85% of authors' gender was not provided. It is unclear if this was voluntarily by authors or was due to omissions by data capturers.

If institutional enrolment plan was to be compared with, due to lack of targets set for gender on staff members, which expected the institution to have enrolled about 50% of female students, it is clear that female authors' contribution to research publications outputs was not even close to 50% of all authors from 2018 to 2021. This is another area that the university can focus on improving, by giving more time to female researchers to publish and contribute maximally to outputs of the university.

5.3. Citizenship of authors contributing to outputs

It was very pleasing to see that most authors were South Africans, over 60%, being higher than any other nation employed by the university. The authors from other African countries seemed to have made a noticeable contribution following the South African authors. These authors were the second most contributors of research publications outputs between 2018 and 2021 at around 31% average. An additional work on gender of these authors grouped per citizenship would be interesting, including the knowledge on their level of qualifications. It will also be interesting to know if these authors were not students but employees of the university.

The contribution by authors from Asia and Europe was less than 6% of authors, with Europeans contributing only 1% and Asians 5%.

The UoT can use this data to determine if all authors that collaborates with the university eventually publish together. The study can alternatively be used to guide the UoT on which countries to target for future collaboration. Additional study on whether the authors from these countries are collaborating with researchers from their own country could assist in identifying areas of possible collaborations with other universities outside the borders of South Africa.

5.4.   Percentage of age of authors who contributed to outputs

The contribution of different age groups to research outputs has offered valuable information on research productivity patterns across different academic stages. This is another healthy status for the university since most contributors were still under 50. In most of the years, the age groups that contributed to most research publications outputs at the UoT were 36-45, 46-55, and then 31-35s. Those aged less than 30s contributed better than the 56-65s and those older than 65. The number would be different if the 10% of the authors who had no age attached to them so, had provided their information. The less contribution by retired researchers could be attributed to the number of those retained at a level of Professors for contribution to research publications outputs. It was again pleasing to see that younger academics are publishing more at UoT than older cohort. This was aligned with the large number of contributors of outputs at a UoT who were amongst this cohort of researchers. It was only in one year that authors in the age group of 31-35 years produced less than the 30-year-olds.

In 2018, 2020 and 2021, there were more authors aged between 36-45 in 2018 followed by those aged between 46-55, then under 30 followed by 36–45-year-olds with 56-65 coming next just before the older than 65s. However, in both 2020 and 2021, the 30-year-olds were less than the 31–35-year-olds authors.

5.5.   Employment status of contributors of publications outputs

The data for the employee status of the authors of the publications outputs at the UoT was complete for 2020 only. Not all the information needed for this section for 2018, 2019 and 2021 was available. Information on Postdoctoral Research Fellows and SARChIs was also unavailable.

The data showed that most of the publications of the UoT were produced by permanent employees. The second biggest group of authors were students. Up to 875 of publications were co-authored by students and permanent staff members of the UoT. The contribution by Postdoctoral Research Fellows was insignificant but in some cases it was better than for temporary appointed staff. The established researchers in the form of SARChI research chairs, visiting Professors co-authored publications were insignificant.

Visiting Professor could publish more, but in the year of study, the results showed that they did not publish much with the UoT. Their relationships with UoT researchers must be clear and expected contributions be stipulated.

In terms of employment status of authors who published at the UoT, there was no data for 2018 and 2019. It was great to see that most of the research publications outputs at the UoT were produced by permanent employees and students and that the UoT did not depend much on the adjunct appointments to contribute to its research publications outputs. This is a good indication of a UoT that is generating subsidy through its own capacity not external. Further studies on employment status of the authors should be performed to determine how many, of the current authors, permanent employees held Doctoral and Master's degrees. The UoT would benefit greatly from the study and ensure that measures are in place to develop capacity of our staff members further.

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