University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Reducing Inter-Campus Air Travel Emissions

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Prepared for: Sustainability Operations-UBC Okanagan, Sustainability and Engineering- UBC Vancouver, Financial Operations Travel Program

Course Code: CHBE 573

University of British Columbia

Date: 30 April 2021

EXECUTIVE SUMMARY

Air travel accounts for 12% of global transportation GHG emissions, and 2.5% of overall GHG emissions [1][2]. Aviation emissions comprises of operations and infrastructure processes such as: burning fuels, construction, and maintenance. However, more than 80% of the aviation emissions are from burning aviation fuel during air travel. This is especially problematic since emissions from air travel remain in the atmosphere for centuries. Current research along with Government intervention have attempted to solve this problem using technological innovation and policies. In particular, the Government of Canada and the Canadian aviation industry have developed Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation [3].

In line with the Government of Canada, the University of British Columbia (UBC) created the UBC Climate Action Plan in 2010 to help combat air travel emissions, and other climate change related problems facing our environment [4]. The plan aims for a 100% reduction target in GHG emissions by 2050. Through the implementation of the UBC Climate Action Plan, UBC has developed various projects one of which is the SEEDS (i.e. Social Ecological Economic Development Studies) Sustainability program which is geared towards creating interdisciplinary collaborations between students, faculty, staff and community partners to find solutions to sustainability challenges both on and off campus. One of those challenges is high volume of air travel emissions from the domestic flights along the UBC Okanagan and UBC Vancouver route.

Our SEEDS project aims to reduce these air travel emissions along the intercampus air travel route. To execute the project, we collaborated with UBC faculty, staff, and students as well as industry professionals from the BC Climate Policy Program. Using travel data containing UBC's travel frequency as well as travel related financial activity, we sought to understand the impact of high travel frequency along the intercampus air travel route and identify the major root causes for this problem. This involved an investigation into the amount of GHG emission from this route, the different departments, and faculties responsible for high amounts of air travel between campuses, and the financial implications of their activities.

From our study, we observed that the intercampus route accounts for ~17% of UBC's overall travels in 2019 and a total CO_2 emission of over 140 tCO_2e (UBC's 2019 total CO_2 emissions was 17,700 tCO_2e), which was higher than the total of all other UBC domestic flights. On studying the travel behaviour of the subcategories (i.e. faculties and departments), we observed that for the faculties, the office of the VP Academic and Provost dominated for both campuses on the number of flights along the intercampus route in 2019. When looking at the departments with the highest frequency of travel, we observed significantly higher volume from the International Student Initiative; a similar trend was also observed in the financial analysis. We postulated that the higher frequency of travel from this faculty and department was because of an internal mandate for personnel to use the UBC-backed flight booking platform, Concur.

Our findings helped identify the root causes for the high travel frequency, however there were some limitations with the datasets which could potentially affect the level of accuracy and precision with the analysis. Some of the limitations encountered are small sample size and ambiguity in data classification. Using our findings, we developed customized survey questions for travel behaviour surveys targeted at the faculties and departments with the highest frequency of air travel, to gain a more in-depth understanding on the problem. We also offered recommendations to subsequently reduce air travel emissions along this route and the aviation industry long term.

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LIST OF ABBREVIATIONS

- UBC: University of British Columbia
- UBCV: UBC Vancouver campus
- UBCO: UBC Okanagan campus
- SEEDS: Social Ecological Economic Development Studies
- GHG: Greenhouse Gas
- CAP: Climate Action Plan
- tCO2e: Tonnes of Carbon Dioxide equivalent

1. INTRODUCTION

Aviation emissions entail GHG emissions that encompass airport infrastructure and operations such as: construction, operation, manufacturing, maintenance, and burning fossil fuels. However, most of the emissions from aircraft engines are produced by the combustion of fossil fuels. These fuel derived emissions from domestic flights are recorded per country; however international flights are not, which has led to countries' unwillingness to reduce volume of international trips [1]. In addition, commercial and military aviation emissions have made a huge contribution in increasing the greenhouse effect. In general, carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter generated by the combustion of jet fuel are some of the important contributors to global warming. But the most significant among them is carbon dioxide which is mixed and accumulated homogeneously in the troposphere. According to data from the International Air Transport Association (IATA), in 2019, the aviation industry contributed 2.5% of global carbon dioxide emissions [5]. Aviation is a fast-growing industry, and therefore, there is a tremendous need to address the aircraft greenhouse gas (GHG) emissions.

As a result, currently, many scholars are showing a growing concern related to air travel environmental impacts. Many universities worldwide, including the University of British Columbia, have signed a petition asking universities to reduce the number of work-related flights for their employees and citing air travel as an essential contributor to global climate change [6]. According to a study conducted at the University of British Columbia, where 705 academic travellers participated, the emissions from air travel have nothing to do with academic productivity [7]. Hence, the academic professionals comprising faculty, research associates, and instructors could reduce their air travel emissions without making significant career sacrifices.

The University of British Columbia (UBC) created the UBC Climate Action Plan in 2010 to help reduce the air travel emission along with other climate change related problems facing our environment. The UBC Climate Action Plan 2020 Update hopes to achieve a 67 percent GHG emissions reduction by 2020, below 2007 levels, and a 100% reduction by 2050. UBC's climate policy is constantly adapting to face the critical challenges of addressing GHG emissions at an institutional level. The initiative is supported by Canada's federal government who has shown interest in creating new management strategies that contribute to achieving provincial and national goals. Based on consultation feedback, expert suggestions, and analysis, three of the four action areas (reducing emissions through behavior changes, and reducing emissions from vehicles, and buildings owned by UBC) have been identified and will be implemented in the plan. Campus and community planning will work with other UBC departments to further analyse the identified areas of action and energy supply plans to ensure that the recommendations are technically and economically feasible. According to the UBC Climate Action Plan, scope 3 accounts for off-campus emissions including commuting, business travel, building lifecycle, and solid waste. Scope 3 emissions are primarily off-campus emissions, and they will be included in the UBC's new Climate Action Plan (CAP) 2030. The CAP is looking to address Scope 3 emissions for the first time to respond to the UBC Climate Emergency Declaration that mandates addressing indirect emissions. Table 1 below shows UBCV 2019 Scope 3 emissions, where emissions of staff and faculty air travels occupy the second place with the most CO_2 emission of 17,694 tCO2e [4]. This leads to a need for an action over which UBC has influence but limited control and requires involving staff and faculty and creating awareness of the positive impact of air travel behavioural change towards reducing emissions.

This project is a joint effort between two UBC campuses (CHBE 573 course at UBCV and a self-directed study at UBCO) to reduce UBC's intercampus air travel emissions associated with faculty, staff, and students. The CHBE team aims to perform data analysis on the information provided through UBC Travel services and conduct a literature review to propose possible strategies to reduce the frequency of inter-campus air travel. The self-directed study will then work on the possible solutions by focusing on designing and administering qualitative research methods such as surveys, interviews, focus groups to gather information from faculty and staff on both campuses while targeting high-travel staff and faculty.

Table 1. UBC Vancouver Campus – 2019 Greenhouse Gas Emissions (Scope 3)

Scope	Components	GHG Emissions (tCO2e)
Scope 3 – Not required to be offset	Business flights (staff and faculty)	17,694
	Solid waste	1,021
	Commuting	35,114
	Building lifecycle	13,241

2. METHODOLOGY

2.1 SYSTEM'S MAP

In the initial phase of our SEEDS project, one of the first sets of tasks our group embarked on, was to develop a systems map with the goal of visualizing our thought process in order to capture/identify the various factors that we need to take into consideration. This step was necessary because not only did it enable us to come up with a tangible representation of our thought process, but it also allowed us to effectively communicate our ideas with other stakeholders such as our partners and our professor.

The figure below depicts our System's map as well as the color code of the nodes highlighting the root causes, problems, constraints, and outcomes:

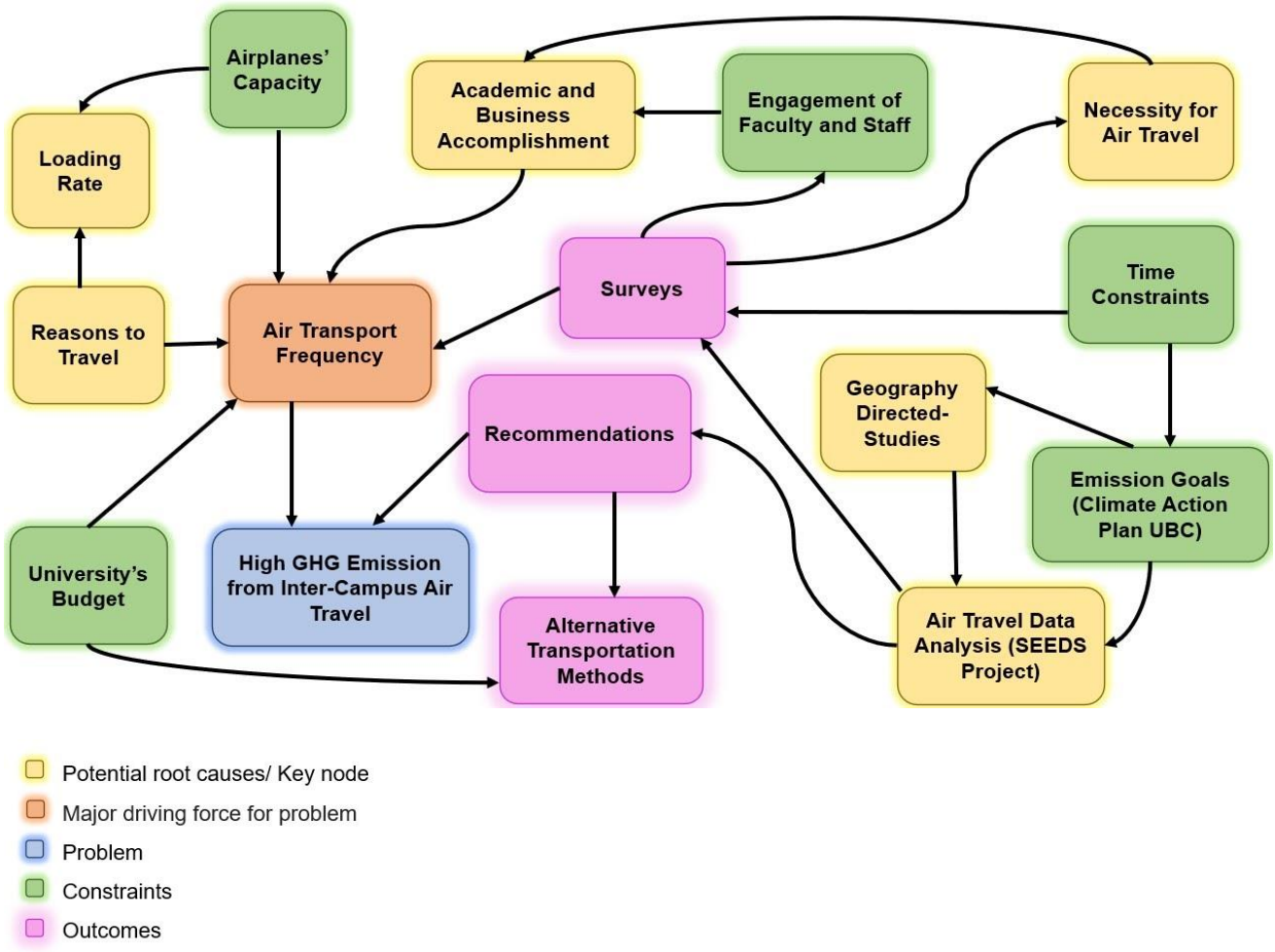

Figure 1: Systems map showing root causes, problems, constraints, and outcomes

2.2 DATA ANALYSIS

Before beginning any form of analysis and modeling, it was important to understand the resources we were being provided and would be working with. The data sources provided to the team by our partners are shown in the table below:

Table 2. Description of data sources

Source	Description	Files obtained
UBC Financial management tool (FMS)	This is a data collection tool that UBC uses to carry out financial analysis and was particularly useful in understanding the costs associated with air travel.	The data files provided through the FMS include: • 2019_FMS_Air_Emlp_Stud_NonEmpl • AllTravelExp_FMIS_2019_CalendarYear_v2 • AllTravelExp_FMIS_FY20-20_Q1-Q2 – Copy • AllTravelExp_FMIS_1Apr20 to 31Oct20_byTrvllerType
Travel agencies	Data from travel agencies (Direct Travel and North South) are contracted vendors	The data files obtained through these agencies include: • DirectTravel-2019_ComprehensiveReport_DT_Seeds_v2 • CityPair_DTravel_2019 • CityPair_DTravel_2020 • NorthSouth-2019_ComprehensiveReport_NST
Emissions Report	Data from travel agencies quantifying the CO_2 emissions from different travel routes.	The files include: • EmissionReport_DTravel_2019.pdf • EmissionsReport_DTravel_2020.pdf • EmissionsReport_NST_2020.pdf • EmissionsReport_NSTravel_2019.xlsx

In order to carry out the analysis and modelling of the data provided; it was important to consider what tools were at our disposal in order to carry out this task. Examples of data analysis tools available to us include MS Excel, PYTHON and MATLAB. Of these MS Excel seemed the most logical tool to utilize as we believed our partners would be most familiar with this. Moreover, our approach towards reviewing the data involved dividing the various data files amongst ourselves to analyze and model individually; after which we come together to identify the patterns

between our various datasets. Another advantage of this approach is that it would also help us identify any discrepancy and inconsistency within our datasets.

Moreover, it is important to note that according to the dataset obtained from the travel agencies, (North-South Travel and Direct Travel), a total number of 1,444 flights between the Kelowna-Vancouver corridor were recorded between both travel agencies in 2019. Out of the 1,444 flights, 1,223 (84.7%) were booked using Direct Travel, while 221 (15.3%) were booked using North-South Travel. This suggests that Direct Travel is the most utilized and possibly the most familiar travel agency.

2.3 CHALLENGES/LIMITATIONS WITH DATA ANALYSIS

Though the analysis and modelling aspect was a success, there were considerable challenges that the team experienced during this process mainly due to the structure and quality of the various datasets that were provided. Considering this, they are stated below as follows:

Table 3. Challenges experienced with the datasets

Filenames	Challenges experienced	Recommendations
2019_FMS_Air_Emlp_Stud_NonEmpl AllTravelExp_FMIS_2019_CalendarYear_v2 AllTravelExp_FMIS_FY20-20_Q1-Q2 – Copy AllTravelExp_FMIS_1Apr20 to 31Oct20_byTrvllerType	Difficulty in obtaining sufficient data between 2020-2021 due to the COVID-19 pandemic Main identifiers (e.g. “Non-Research”, “Research”, “Conferences”, “Field Trips”) were not explicitly described	No possible recommendations as COVID is an anomaly Ensuring an apt description of the main identifiers in order to obtain a better understanding of observed trends
CityPair_DTravel_2019 CityPair_DTravel_2020	Datasets contain transaction count and not the number of flights. Hence, the transaction count cannot be assumed to represent the number of flights between the UBCV-UBCO route. Dataset does not contain an attribute describing the date of flights. Hence, it would not be possible to develop a timeline	If possible, air travel agencies should strive to record the number of flights as opposed to transaction count. Aim to include/record the date/time of flights as this

	showing the volume /rate of number of flights during the years 2019 and 2020	would help to track flight volume/frequency in future
DirectTravel-2019_ComprehensiveReport_DT_Seeds_v2 NorthWest-2019_ComprehensiveReport_NST	Presence of inconsistencies in faculty and department names. In general, the lack of consistent format made the data somewhat disorganized	It is advisable to ensure consistency in format in case of future work
EmissionReport_DTravel_2019.pdf EmissionsReport_DTravel_2020.pdf EmissionsReport_NST_2020.pdf EmissionsReport_NSTravel_2019.xlsx	The main challenge is that the domestic and international flights were collated together which made it somewhat challenging to find and compare domestic flights with the Kelowna-Vancouver route specifically	The main suggestion is ensuring a more organized dataset for future work

3. RESULTS AND DISCUSSION

For our analysis, we focused majorly on the datasets captured in the 2019 calendar year before the COVID-19 pandemic. This was pertinent to our analysis and future predictions because our analysis assumes that future travel behavior will return to status quo post-pandemic. We also emphasized data targeted at domestic flights and most importantly, the UBC Intercampus flights (i.e. Vancouver and Okanagan campuses).

3.1 UBC AIR TRAVEL ACTIVITY

Data Source: CityPair_DTravel_2019.xlsx
Target: UBC Vancouver (UBCV) and UBC Okanagan (UBCO) activity combined

For the analysis of the UBC City Pair data, the data is based on the combined activity of both UBC campuses. We directly related the transaction count data to the frequency of air travel. As showed in Figure 2, we observed that domestic flights dominated in transaction count with inter-campus air travel accounting for approximately 17% of total travel (>10,000) in 2019. This is a significant number of miles traveled compared to the total, which could lead to significant GHG emissions from these trips. To better understand this, we explored the effect of air travel on GHG emissions in UBC.

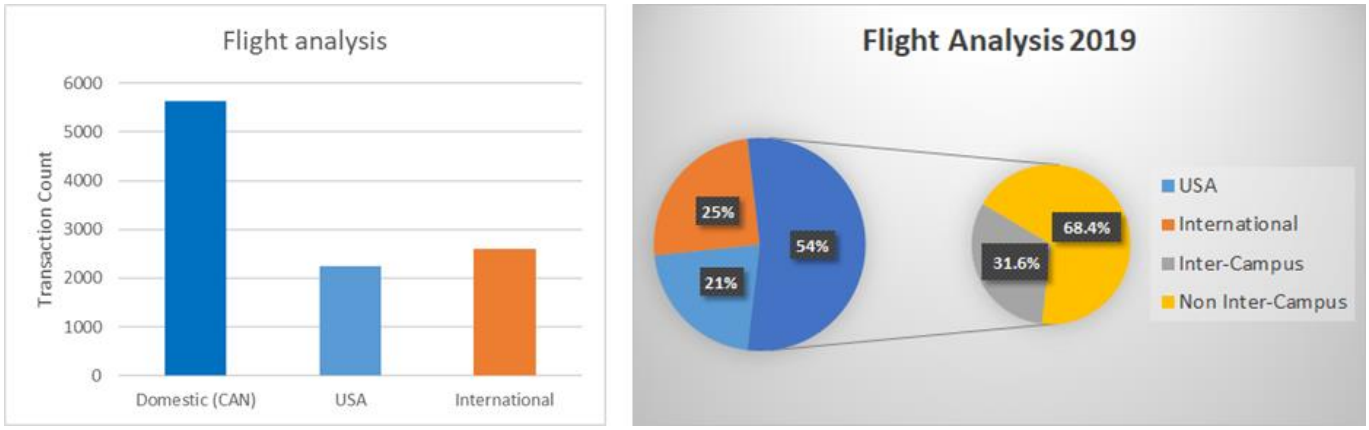

Figure 2. **Flight Analysis of UBC's Overall Transaction Count**

3.2 EFFECT OF AIR TRAVEL ON GHG EMISSIONS

Data Source: EmissionReport_DTravel_2019.pdf; EmissionsReport_NSTravel_2019.xlsx
Target: Combined UBC activity

To further understand the impact of the UBC intercampus air travel on the environment, we analyzed the emission reports from Direct Travel and North South. From Figure 3, we observed that the UBC Kelowna-Vancouver route dominated the domestic haul flights in CO_2 emissions. This shows the pressing need for UBC to reduce the frequency of travel via this route to positively impact the air travel emissions.

To investigate the potential ways to reduce the frequency of travel via this route, we need to understand the root cause of this high number of trips at both UBC campuses. Possibly by exploring different subsets of travelers at UBC Vancouver and Okanagan.

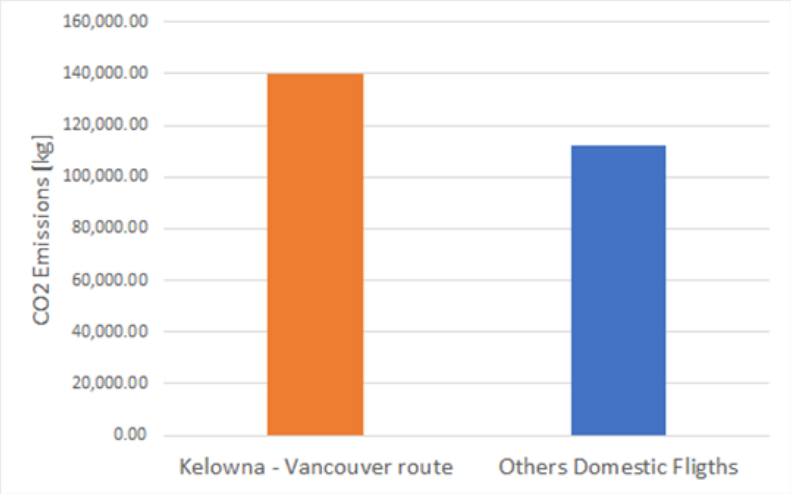

Figure 3. **Comparison between the Kelowna-Vancouver route CO2 emissions vs other domestic flights for UBC.**

3.3 UNDERSTANDING THE TRAVEL BEHAVIOR OF DIFFERENT SUBDIVISIONS IN UBC CAMPUSES

Data Source: 2019_ComprehensiveReport_DT_Seeds_v2.xlsx; 2019_ComprehensiveReport_NST.xlsx
Target: UBCV and UBCO activity only

Using the Comprehensive reports provided by Direct Travel and North South, we analyzed the potential root causes of the travel high frequency via the Vancouver-Kelowna (UBCV-UBCO) route.

For our analysis, we looked at the transaction count specifically for air travel (i.e. removing hotels and cars) and used that to quantify the travel frequency per subset (i.e. faculty and department). We then used the total paid amount for air travel to estimate the travel cost per subset.

We estimated the total domestic flights along the UBCV-UBCO route for each faculty from the UBC Okanagan campus specifically (Figure 4). We observed that the office of VP Academic and Provost has far more flights than other faculties at UBC Okanagan.

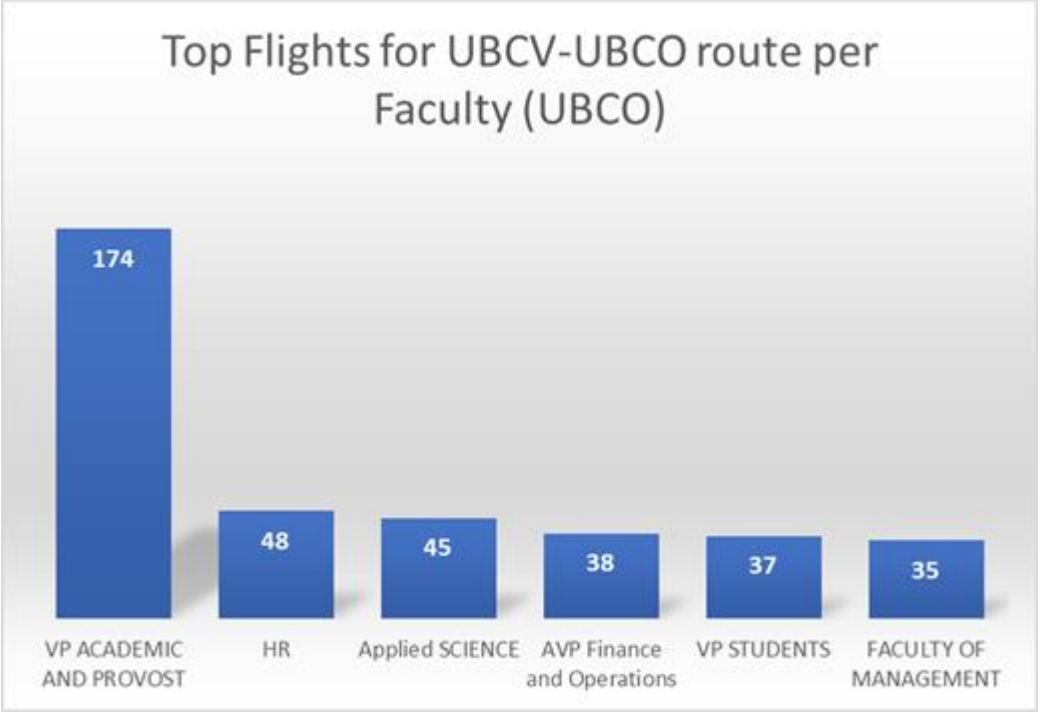

Figure 4. **Faculties at UBC Okanagan with the highest travel frequency via the UBCV-UBCO route**

On looking at the flight frequency by different faculties at the Vancouver campus specifically, we observed a similar occurrence as in the Okanagan campus with the office of VP Academic and Provost dominating but close behind is the Faculty of Medicine (Figure 5). The administrative faculties hold the majority of the total flights, but the Faculty of Medicine will be a key faculty to target our future surveys at.

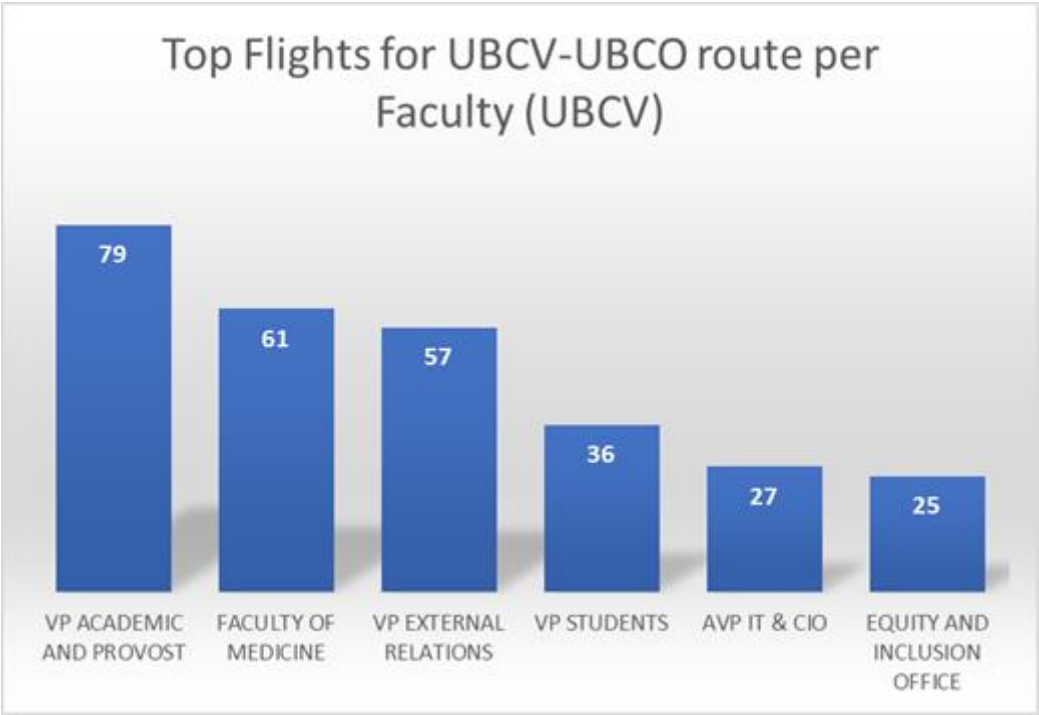

Figure 5. **Faculties at UBC Vancouver with the highest travel frequency via the UBCV-UBCO route**

We then proceeded to carry out a similar study on the departments at UBCV and UBCO as seen in Figure 6 and Figure 7 respectively. Based on the findings in Figure 8 we observed a tie between two departments, the Campus Community Planning and International Student Initiative. The high number of flights in those categories is majorly due to the high amount of funds allocated to their travel budget. Figure 9 which is focused on the Okanagan campus shows a similar result with the International Student Initiative leading again. We postulate that a reduction in the frequency of air Travel at the International Student Initiative would have an immensely positive effect on the reduction of GHG emissions.

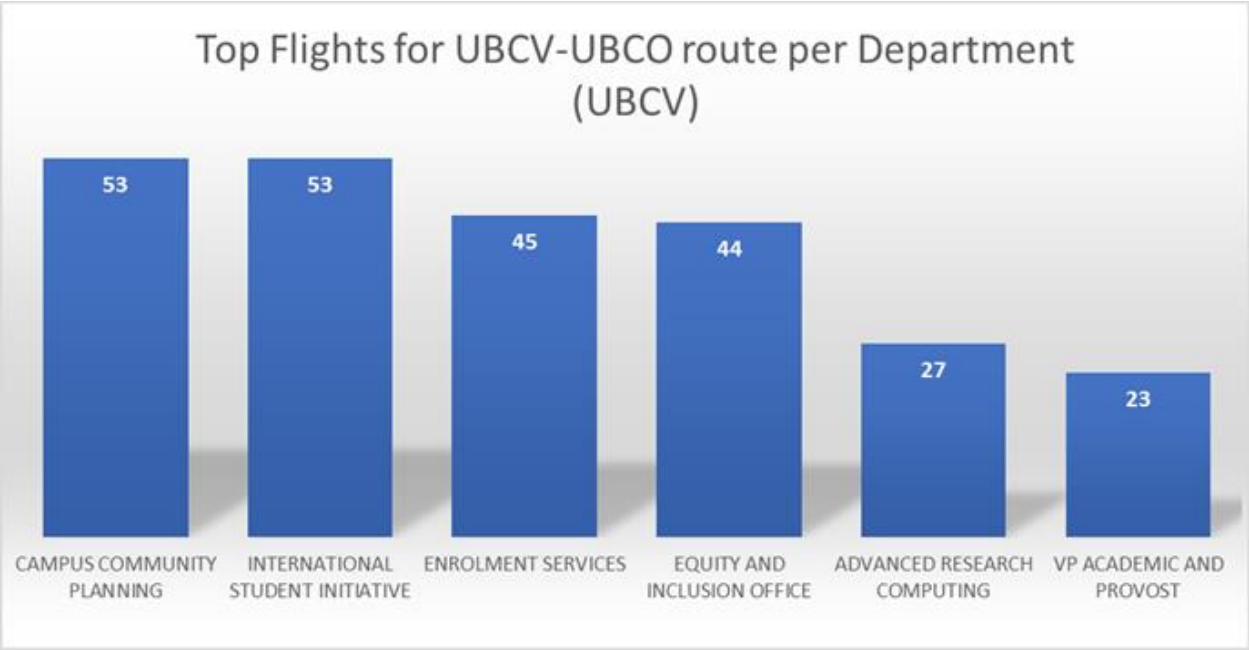

Figure 6. **Departments at UBC Vancouver with the highest travel frequency via the UBCV-UBCO route**

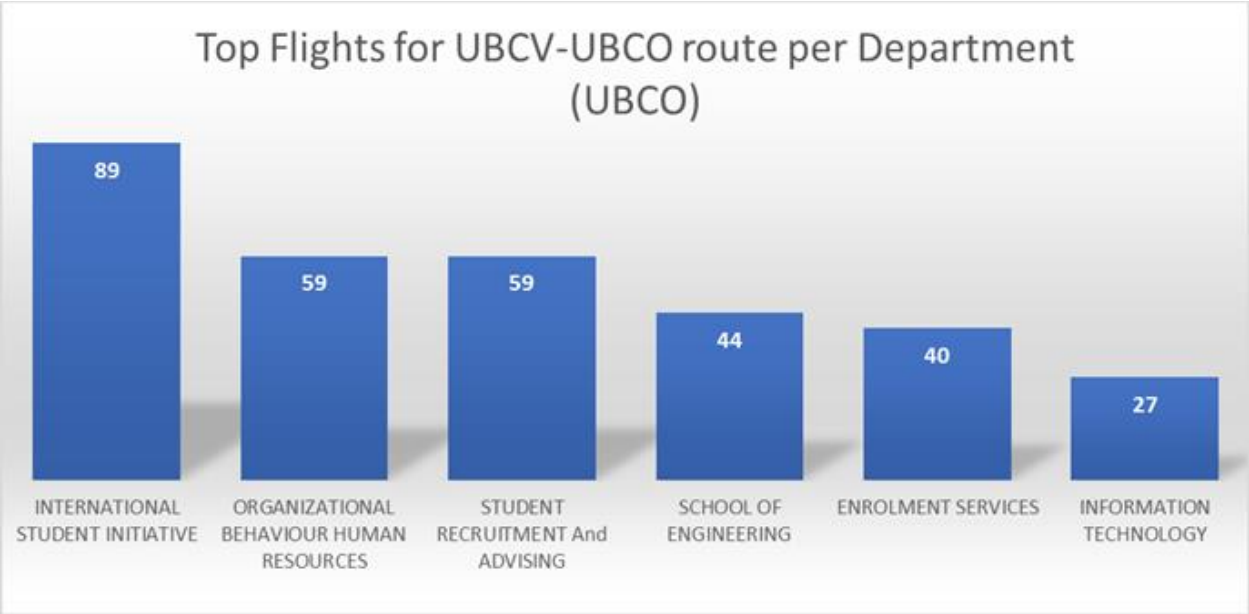

Figure 7. **Departments at UBC Okanagan with the highest travel frequency via the UBCV-UBCO route.**

We also studied the different groups of people by UBC employee status (i.e. Faculty, Staff, Student etc.). From the study (Figure 8), the UBC staff have the overwhelming majority of the trips via the UBCV-UBCO route. Making the staff a major target for the travel behavior surveys.

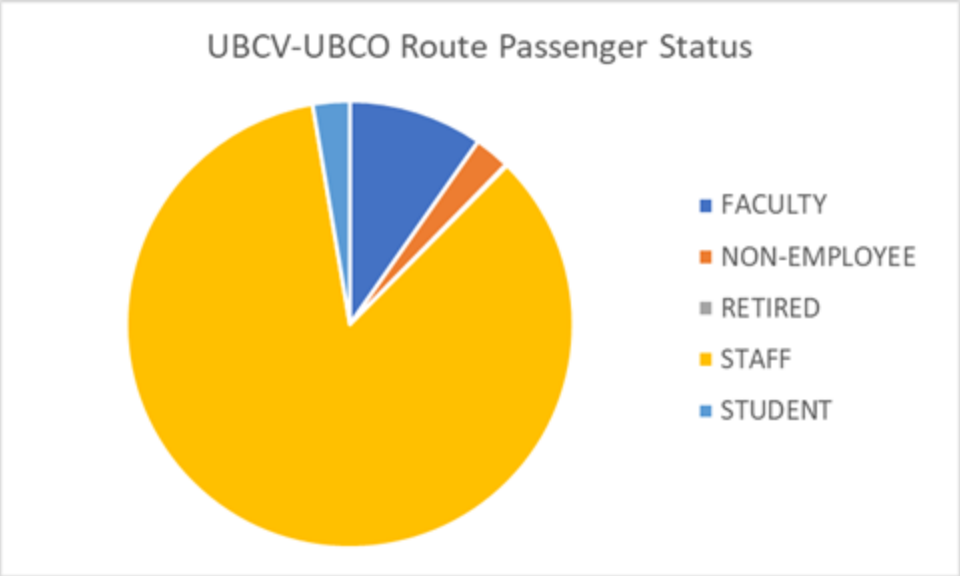

Figure 8. **Comparing air travel frequency by UBC employee status for UBCV-UBCO travel route.**

3.4 FINANCIAL IMPLICATIONS OF UBC TRAVEL

Data Source: 2019_ComprehensiveReport_DT_Seeds_v2.xlsx; 2019_ComprehensiveReport_NST.xlsx
Target: UBCV and UBCO activity only

We then analyzed the financial implications of air travel for both the Vancouver and Okanagan campuses by using the total amount paid for air travel for domestic flights along the UBCV-UBCO route specifically. As seen in Figure 9 and Figure 10, we analyzed the cost breakdown of the different departments in the UBC Vancouver and Okanagan campuses respectively and we observed different leaders in travel expenditures.

For the Vancouver campus, the International Student Initiative dominates; however, we noticed a lower cost in the Campus Community Planning department regardless of their high number of flights seen in Figure 11. This could be because of return trips vs one-way trips, fluctuating flight costs, cancelled flights, and refunded payments. For the Okanagan campus (Figure 12), we also observed rearrangement of the top departments in number flights and the travel cost with the Student Recruitment and Planning Leading followed by the School of Engineering. The high expenditure for travel can be reduced and potentially diverted to other sustainable ventures.

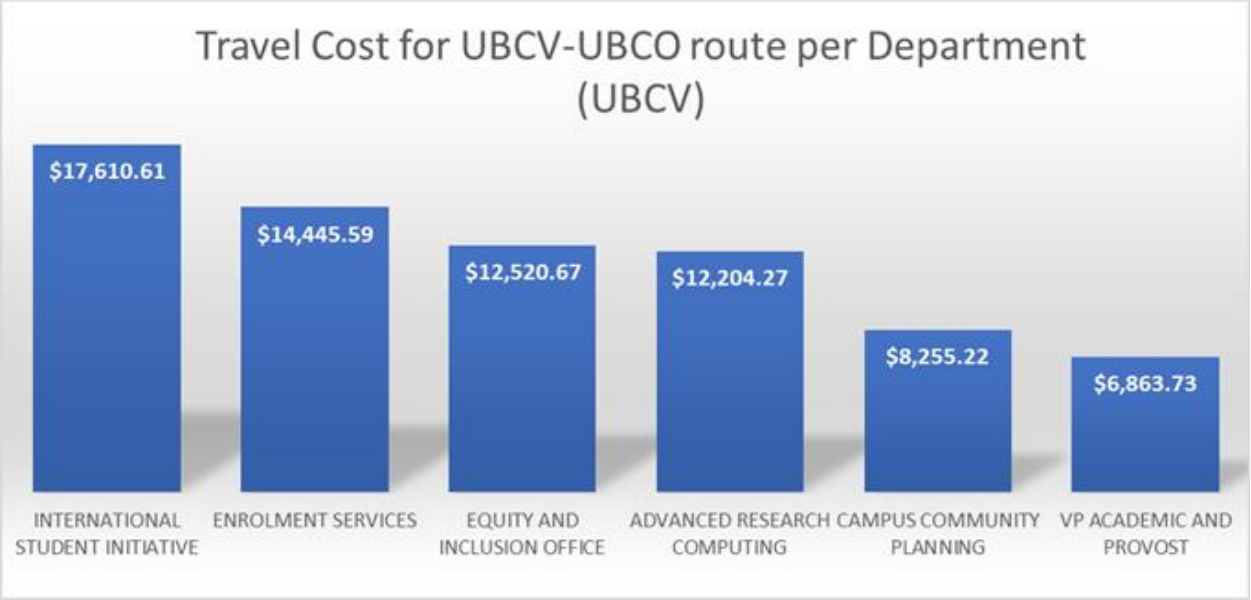

Figure 9. **Departments at UBC Vancouver with the highest travel cost via the UBCV-UBCO route.**

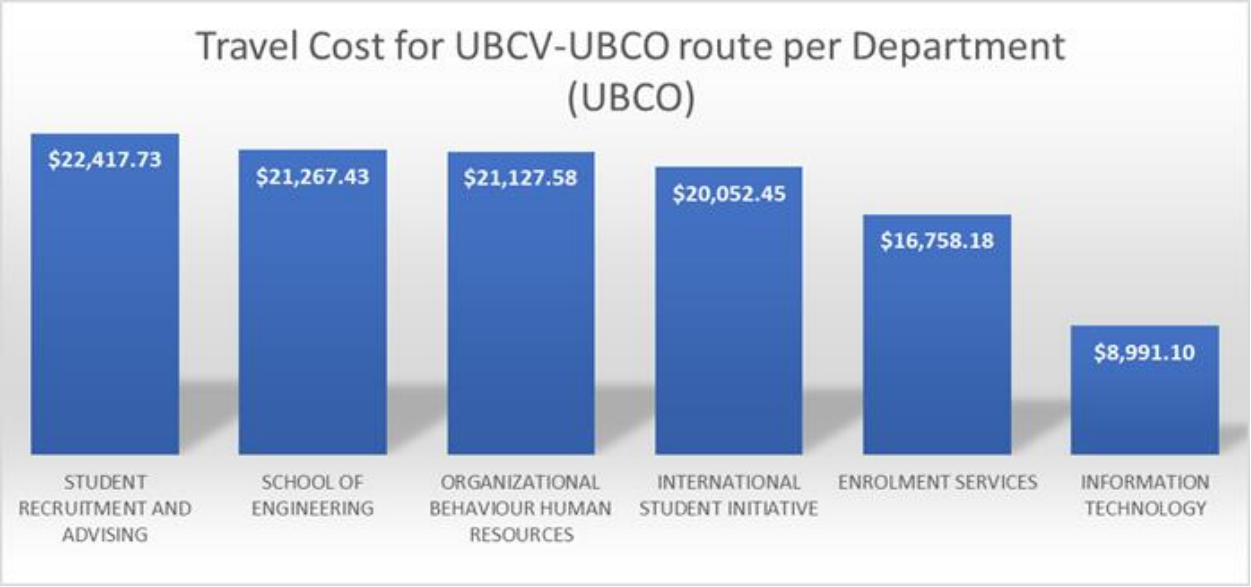

Figure 10. **Departments at UBC Okanagan with the highest travel cost via the UBCV-UBCO route.**

Focusing on the faculties for travel cost analysis, we observed that there was a similarity in faculty travel frequency and costs. In Figure 11 and Figure 12, we observed that the office of VP Academic and Provost has a significantly higher cost in both campuses with the ratio being higher in the Okanagan campus. We believed that indeed, targeting the VP Academic's office for surveys would be an impactful move in potentially reducing air travel emissions long term.

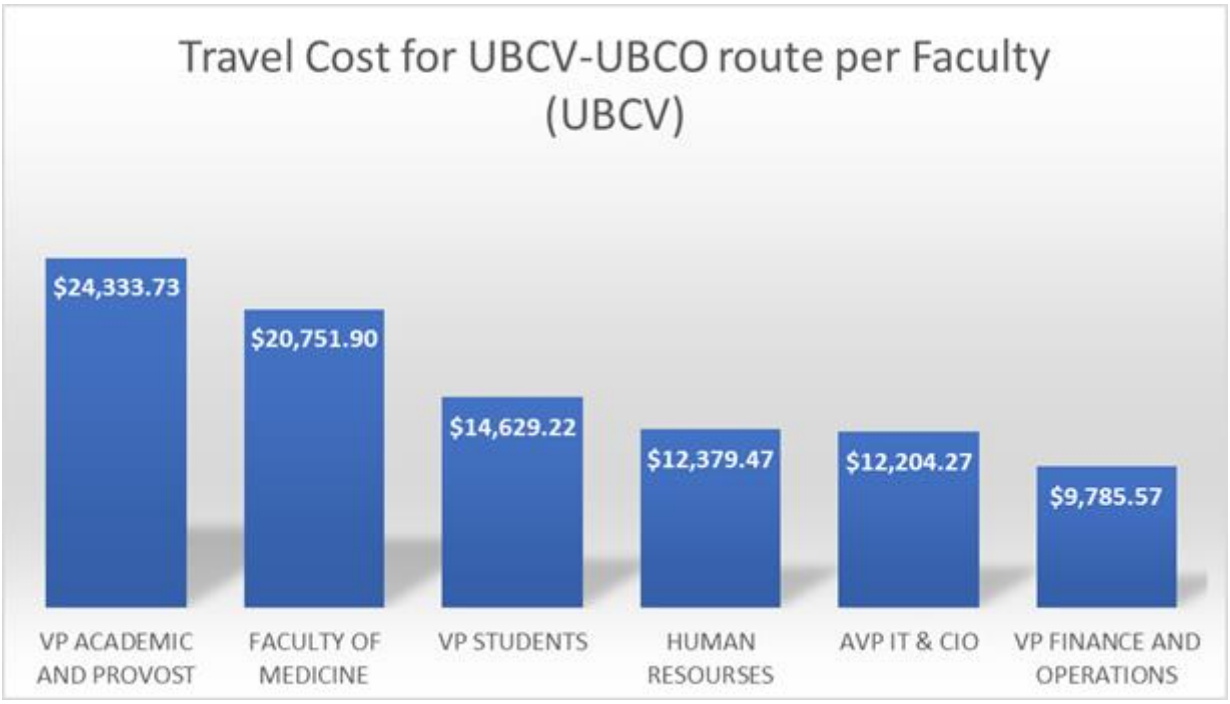

Figure 11. **Faculties at UBC Vancouver with the highest travel cost via the UBCV-UBCO route.**

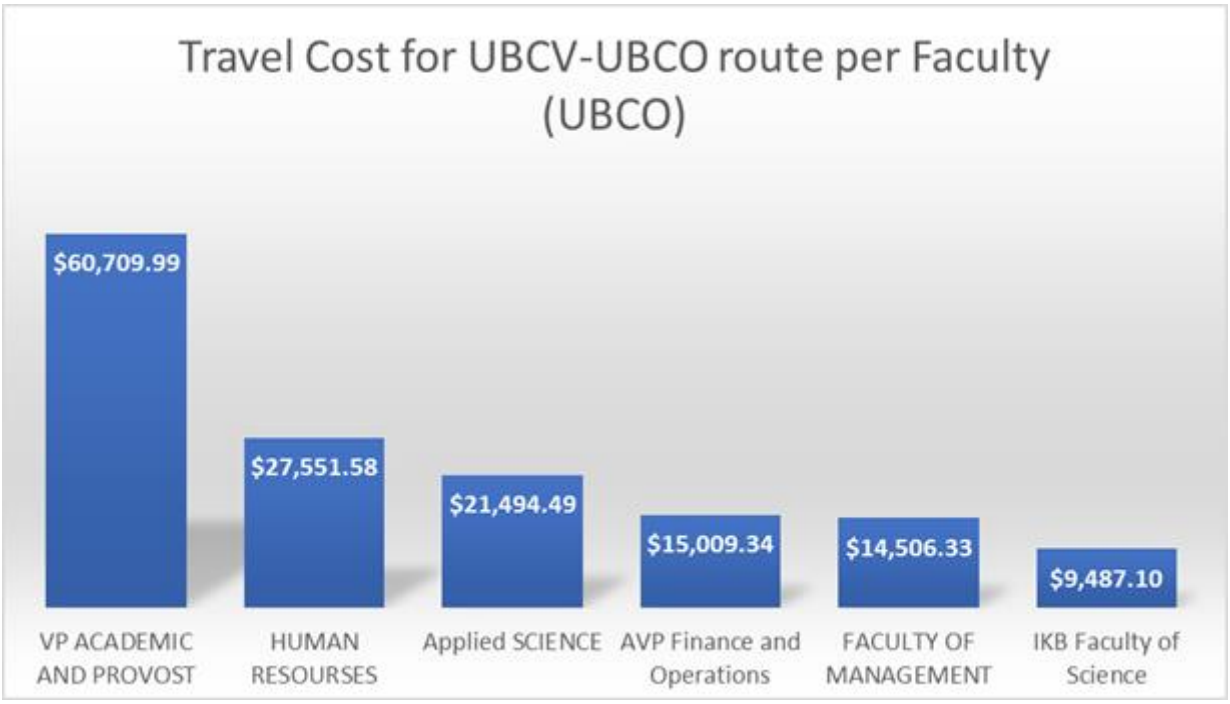

Figure 12. **Faculties at UBC Okanagan with the highest travel cost via the UBCV-UBCO route.**

We then decided to look at the travel behavior of UBC, as a whole, during an active calendar year.

Data Source: AllTravelExp_FMIS_CalendarYear_2019.xlsx
Target: UBC combined activity

For this analysis, we directly related the travel cost to distance traveled, and in turn, GHG emissions. According to Figure 13, we observed that there is a higher travel cost for research during the months of January to March & October to December for both 2018 and 2019. We believed this is because of heightened research activities during this period leading to the pressing need for travel during that period. We also observed a steady travel cost for non-research activities all year for both 2018 and 2019.

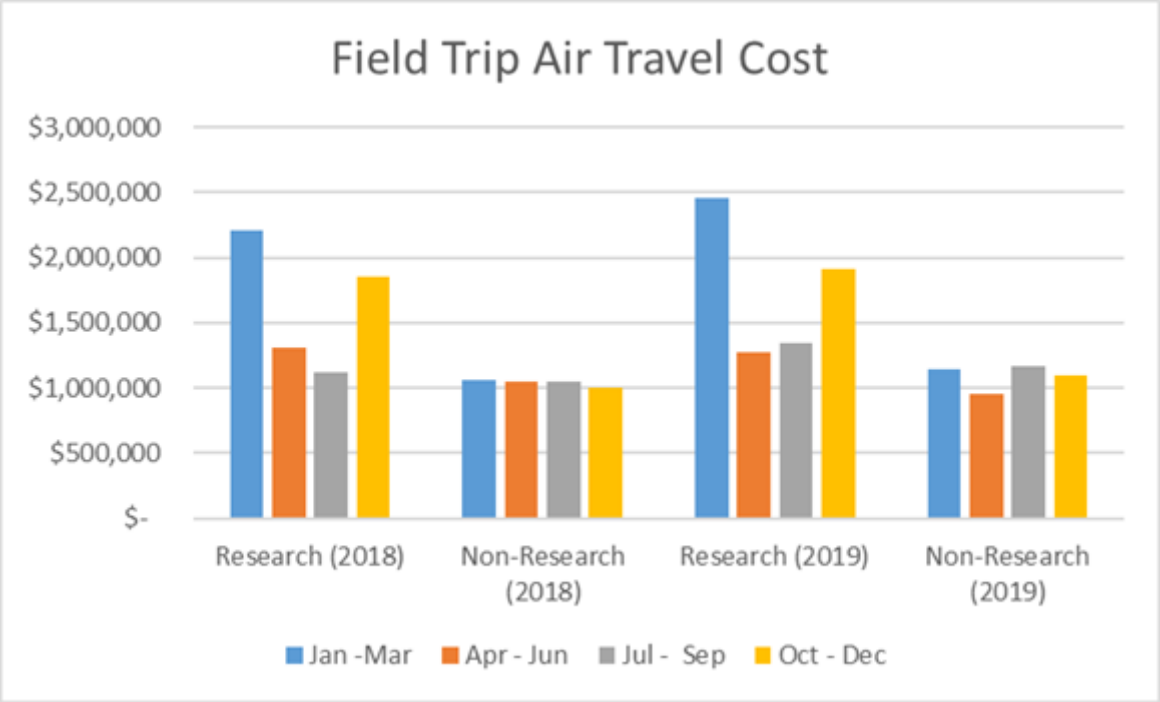

Figure 13. **UBC Air Travel Cost for Field Trips in 2018 & 2019 calendar year (all routes).**

When we investigated the data from Figure 14, we also saw a higher cost for air travel between January – March for both 2018 and 2019 with respect to research. There also seemed to be a higher cost for non-research air travel during the time between July – September. These seemed to be peak periods for these categories.

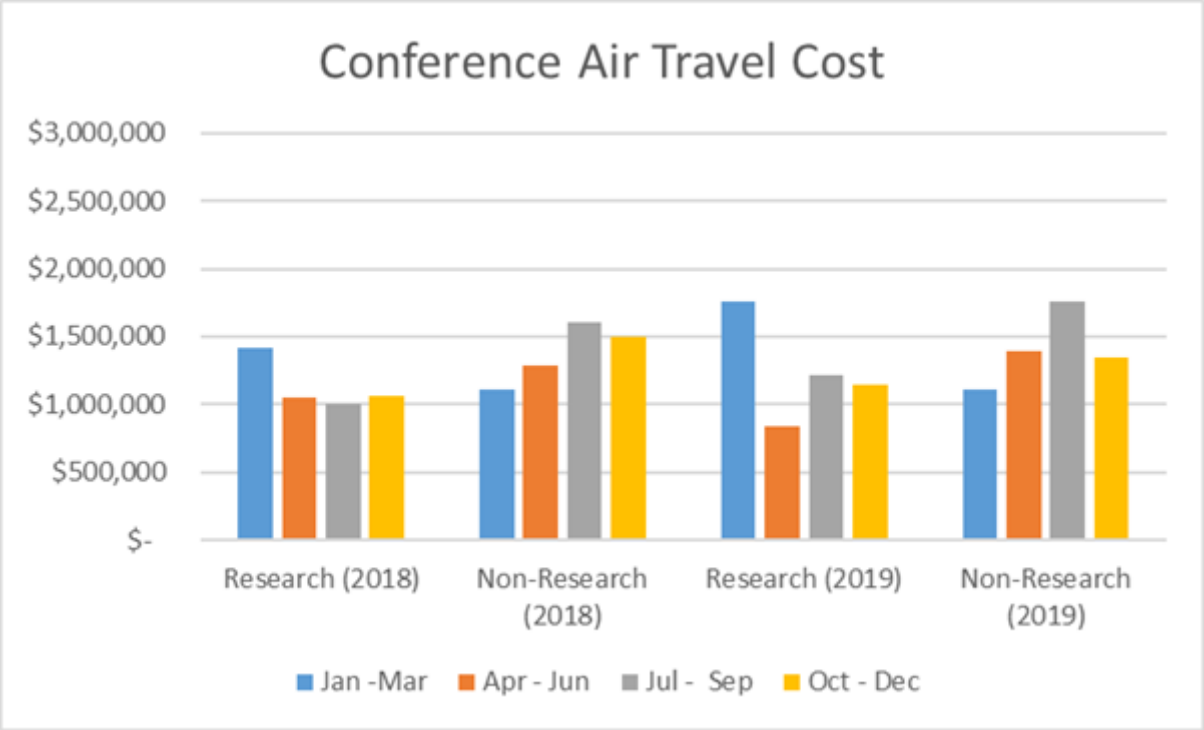

Figure 14. **UBC Air Travel Cost for Conference Trips in 2018 & 2019 calendar year (all routes).**

For the air travel cost summary for 2018 – 2020 as seen in Figure 15, we observed that higher cost is incurred for the research activities when compared to the non-research activities. We also observed that for field trips, the research air travel cost is significantly higher than that of non-research activities for both 2018 and 2019. However, we also saw that the air travel cost for non-research activities was higher for conferences. This is an interesting finding for the understanding of what the activities dominate the different types of travel. This should help drive the path forward.

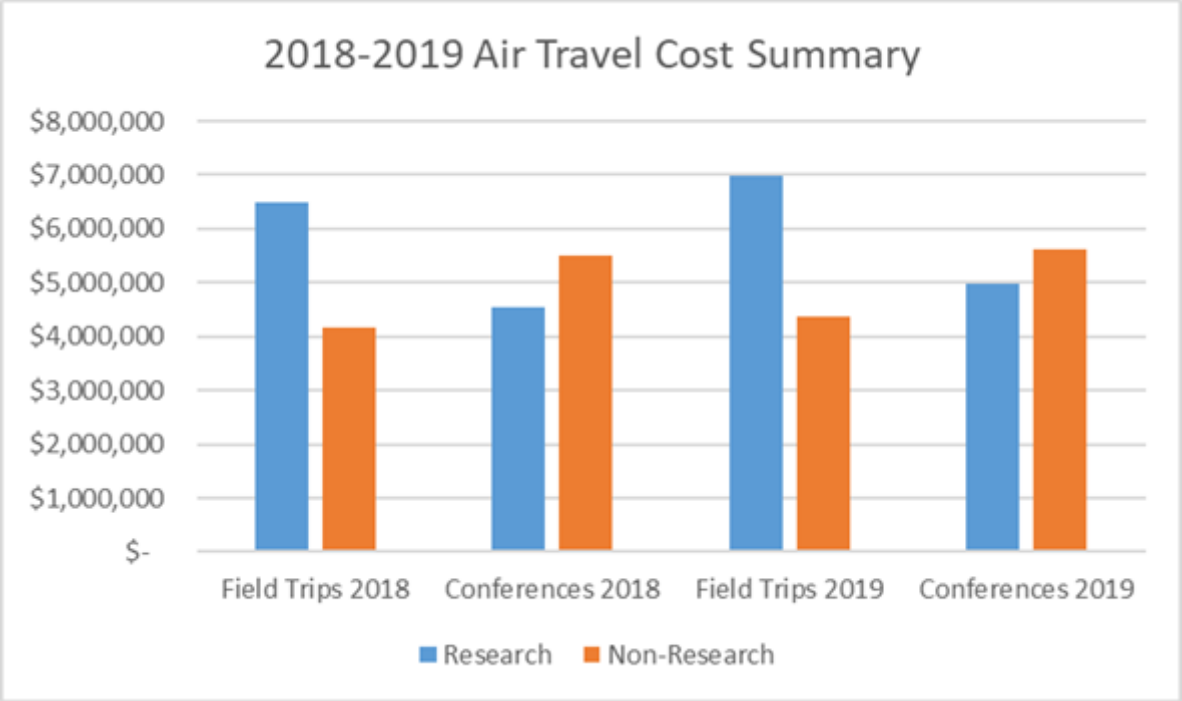

Figure 15. Comparison between research and non-research-based travel for UBC in 2018 & 2019 calendar year (all routes).

4. CONCLUSION

Air Travel GHG Emissions is a great problem facing our environment. It is a major cause of global warming and it accounts for a significant percentage of overall GHG emissions yearly. Different nations and institutions have been taking measures in recent years to combat this problem. One of these institutions is the University of British Columbia (UBC) with the development of their UBC Climate Action Plan. The Climate Action Plan looks to combat global warming from multiple fronts one of them being the air travel emissions. Using the SEEDS program UBC aims to tackle the problems by active participation of faculty and students.

With our SEEDS project, we aimed to identify the root causes of high air travel GHG emissions between the UBC Vancouver and Okanagan corridor. To accomplish this we carried out a data analysis on UBC travel data from previous years to draw insight and used the information to direct potential survey questions to target high frequency travelers and also offer recommendations to the stakeholders involved in the project.

From our analysis, it was evident that the UBCV-UBCO travel route accounts for a significant amount of the flights (~17%) and GHG emissions (>140 tCO_2e) by UBC, highlighting the necessity for reducing the emissions along this route. We explored the corridor data for the specific departments and faculties which have the highest travel frequency along this route, and we observed that the majority of travelers were from the administrative sector of the university asides from the faculty of Medicine and Engineering. This gave us insight into the target groups for the potential surveys. However, we postulate that the reason for the higher frequency in the administrative sector is due to the higher usage of the UBC-backed travel platform (**Concur**) by this department.

In this study, we analyzed UBC's travel behavior, the major department and faculties flying, financial implications, and different peak periods of travel. Using our findings, we generated potential survey questions which will bring us closer to solving the problem. We believe that understanding the gravity of the situation is a vital step to solving the problem but even more so being pragmatic about finding solutions. To that end, we have also provided some recommendations based on our study.

5. RECOMMENDATIONS

From the results and conclusion above, there is indeed room for adequate improvement. When we considered the subcategories (i.e. faculties, departments) that contributed to the highest number of flights as well as the frequency and reasons of these flights, there are a few recommendations that can be put forward. For example:

First, targeting the administrative office for a survey to better understand the reasons for high-frequency air travel. The goal of this approach is to understand the reasons for their high number of flights and possibly categorize them into essential and non-essential travel. This may then lead to a further review of those travels that fall into the non-essential category with the aim of reducing them if not eliminating them totally.

Moreover, Incentivizing the university's flight booking model. The goal of this approach is to ensure credible and authentic data gathering for the purpose of future data analysis. This is because our group observed significant discrepancies and inconsistencies when reviewing the current data set. Hence, this would lead to a more accurate analysis and more authentic/targeted recommendations.

Furthermore, optimizing booking schedules at peak periods to reduce the number of flights needed. The goal of this approach is to not necessarily reduce the total number of people flying within a particular period but reduce the number of flights they would be booked on. For example, as opposed to the 1 individual per flight that is generally practiced, another approach would be to book the total number of people that need to fly from Vancouver to Okanagan in a week on a particular day; as this would greatly reduce the number of planes that would be booked in total.

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APPENDICES

APPENDIX A: SURVEY QUESTIONS FOR POTENTIAL TARGET GROUPS

Based on our analysis carried out in the previous subsections, we compiled survey questions to help with drawing more insight on how to reduce air travel frequency and potentially reduce the air travel GHG emissions. They are as follows:

Target: Frequent Travelers with UBC (Majorly Concur users)

- What are the major reasons for air travel by the administrative office?
- How have the travels been affected by COVID19, what were the compromises (e.g. video conferencing, fewer flights, stopping less important trips)?
- How necessary are these travels for effective engagement?
- When are your peak travel periods? Why?
- Which campus do you operate at?
- Would you be willing to replace in-person meetings for online meetings? Why or Why not?
- Is the booking platform user friendly?

Target: Non-Concur users

- Do you know about the incentives and benefits of using the UBC Concur platform?
- How do you travel?
- Is the platform user friendly? (Suggestion: We can make them to test the platform if they haven't before)
- Would you be willing to use a university backed flight scheduling platform?
- What would make you use the Concur platform more often?
- Why do you prefer using other travel bookings platforms?

Target: Travel Regulatory Department

- What has been done to increase usage of Concur?
- Have marketing strategies been used to create awareness about Concur? If so, which?
- What scheduling system is in place for optimal flight travel?
- How do you regulate travel?
- What is the department's major priority? Cost savings for customers or reduced travel distance (i.e. more direct flights and fewer connections)?