Evaluation of business travel as a potential customer field of a local AAM market

1st Pertz Jan
Institute of Air Transport, Air Transport Management
German Aerospace Center (DLR)
Hamburg, Germany
Jan.Pertz@dlr.de
2nd Lütjens Klaus
Institute of Air Transport, Air Transport Management
German Aerospace Center (DLR)
Hamburg, Germany
Klaus.Luetjens@dlr.de
3rd Prof. Dr. Gollnick Volker
Institute of Air Transportation Systems
Technical University Hamburg
Hamburg, Germany
volker.gollnick@tuhh.de

***Abstract*—Several studies examine Advanced Air Mobility (AAM) demand focusing on commuting and airport shuttle trips at this moment. Little activities are concentrating on business travel in general nor for AAM demand in special. Business travel as a generic term for any corporate purposed transport consists of four categories: Meetings, Incentives, Conventions and Exhibitions (MICE). Every business traffic comes along with its own character which has to be considered when modelling. After the transport generation based on their travel purpose and location, a discrete choice model evaluates different modes of transport to determine the market share for AAM. As business travel is expected to have a greater value of time, the modal share of AAM is anticipated be higher compared to more cost-sensitive use cases such as commuting. On the other hand, however, the market size of the overall business traffic could weaken this group of potential AAM passengers. In the field of this poorly investigated demand share, this approach presents a possibility of modeling local business traffic. Furthermore, this study assumes an adopted AAM mode of transport for this passenger group, which helps to understand the characteristics of future AAM demand.**

***Index Terms*—demand, business, advanced air mobility, discrete choice**

I. Introduction

Independent of the booking classes economy, business and first class, business travelers yield up to 75 % of the airlines revenue [1]. On a corporate travel in conventional aviation, an employee spends about 230 € or 18% of the total cost for ground transportation [2]. For this reason, airlines are interested to understand the behavior and reasons of choice of business travelers in order to optimize their offers, and thus their revenue. A part of corporate travel is being done by using business aviation. In addition to various other benefits, business aviation passengers value the time savings it provides. [3].

Corporate travel has been defined in various ways. A common definition subdivides this market into four segments called MICE: Meetings, Incentives, Conventions and Exhibitions. Further studies divide into individual business travel, meetings, exhibitions, incentive trips and corporate hospitality [4], [5]. The more general terms business tourism can include leisure aspects as well, in which a distinct separation of the travel purpose can not be well-defined. So, multipurpose travel combines different travel motivation, business and leisure in this case [6]. While a face-to-face meeting requires corporate travel, the origin country real income as well as the price of tourism and further economic variables influence the total business travel market [7], [8].

Since drone traffic for cargo and passenger transport started with the definition of Urban Air Mobility (UAM) by the FAA, this term includes urban applications of unmanned air operations [9]. As an extension, the definitions Advanced Air Mobility (AAM) by NASA and Innovative Air Mobility (IAM) by the European Commission consider rural operation areas as well [10], [11]. Since business trips are not limited to urban areas necessarily, this study keeps ongoing with the definition AAM as a new kind of transport mode. In detail, AAM investigates the scope of a metropolitan area including at least one major city and further places of interest around.

Advanced Air Mobility (AAM) as a regional and urban transport mode by using short and mid-range aircraft, has to figure out its potential field of customers. As explained before, business travel accounts for 75 % of airlines revenue. Since its analogy to conventional aviation, any corporate purposed travel should be considered in the AAM airlines transport offer. At this point, the travel purpose business needs to be clarified and discriminated between commuting e.g. for an AAM application.

II. BUSINESS TRAVEL MODELLING

In this study, the business travel model is limited to corporate meetings in the metropolitan area of Hamburg. The model follows the steps trip generation (II-A), the mode share (II-B) and the route assignment (II-C).

A. *Trip generation and distribution for corporate purposes*

The transport modeling starts with a trip generation. For the purpose of corporate travel, a business passenger begins his trip at a business cell and ends his trip at a business cell. Thereby, a business cell is defined as a cell, in which at least one person is employed. Meanwhile, a business cell can contain inhabitants as well. When cross merging all business cells, the model returns a network of itineraries between business locations. By setting up minimal distance between origin and destination, short and irrelevant AAM connections can be dropped. The mobility report for Germany presents mean and median values for local business journeys in Germany [12]. This model assumes a minimal distance of $5.7\,km$ for AAM considerations, since this value represent the median length of business travel path in Germany. By choosing the median value, half of the total market are omitted in this model.

In a next step, business travelers are distributed on the itineraries based on the possible destination and on the total number of passengers leaving the origin cell. Fur this purpose, the market size is limited due to the employees working in the tertiary industry sector. This model distinguishes between several industry sectors and assumes different travel behavior for those sectors. As the primary and secondary industry sectors are linked to a certain transport mode, mechanic van or delivery truck e.g., this model only takes the tertiary sector into account, also known as the service sector [13]. Further subcategories differ in construction, trading, manufacturing, traffic and further services and administration. Here, the tertiary sector is curtailed to section $I - U$ [14]. Next, a modal share model splits the market size into the different transport modes.

B. *Mode share model*

Each itinerary gets considered individually by a mode share model, so that each itinerary characteristic results in a different transport mode mix. In general, the linear utility function for each transport mode consists of three terms.

$$U_{ni} = ASC_i + \beta x_{ni} + \epsilon_{ni} \tag{1}$$

where

- U_{ni} is the utility of alternative i for individual n,
- β is a vector of coefficients,
- x_{ni} is a vector of observed attributes,
- ASC_i is a specific term for alternative i ,
- ϵ_{ni} is a random error term.

While the error term is part of the unobserved part of the utility function, the ASC and β-parameters can be calculated and calibrated for each mode. In total, the modal share model calculates four different transport modes. Tab. I presents an overview for the car, taxi and public transport which are necessary to calibrate a discrete choice model. AAM as new transport mode is described in section III.

TABLE I: Modelling overview for transport mode, car, taxi and public, TrafficIndex as TI

Mode	Travel time		Travel Cost	
	OTP	TI	Base	Fare
Car	X	X		X
Taxi	X	X	X	X
Public	X		X	X

Both, the car and the taxi, use a road network to operate. To calculate the travel time on the road, the OpenTripPlaner (OTP) uses the origin and destination of the itinerary [15]. Since the OTP calculates the travel time without any congestion and traffic, the TrafficIndex by TomTom takes the average delay due to traffic jam into account [16]. By multiplying the OTP results with the TrafficIndex of 1.36 for Hamburg, the travel time represents a realistic scenario, that is $36\,\%$ longer in time in comparison to a free drive.

When choosing a taxi, a passenger can order a taxi to reduce waiting time, find a free taxi close by or wait for a passing one. All three scenarios depend on the location of single taxis and the travelers [17], [18]. While the total travel time, as a sum of in-vehicle time and out-vehicle time, for taxi can not be estimated individually for the synthetic market in this study, the average waiting time for taxi is set to $5\,min$. This number appends to the calculated travel time with the OTP and the TrafficIndex by TomTom. Taxi operators in Hamburg charge a base price and a fare per km. Both, the base and the fare, are fixed to $4.20\,€$ and $2.20\,€/km$ by the taxi companies in Hamburg [19].

In order to get a cost on each itinerary for the car, the travel distance is multiplied by a constant according to previous demand studies in Hamburg [20]. The fare per km for the car values $0.7\,€$.

To estimate the public transport, the OTP considers the public schedule and connection options in the public transport network. Here, no TrafficIndex is needed, since the public transport operates on a rail system without any influence by a road congestion. As long as a passenger travels inside the urban center of Hamburg, a ticket costs $3.40\,€$. When leaving the inner circle of the city and going to more rural areas, the passenger has to pay double the ticket price [21].

The calibration data is based on historical traffic demand for several traffic cells in Hamburg [22]. In order to filter the total traffic demand by travel purpose, the calibration module handles the traffic grid by the pre-defined origin-destination-pairs, similar to the trip generation module in section II-A. The calibration itself is performed by the open-source tool biogeme [23]. Table II presents the calibrated parameter for a mixed logit model with a gumbel distribution as a random error term.

In total, five estimated parameters describe passenger behavior in this study. In this study, passengers choose between a car, taxi, and public transport by taking travel time and travel cost into account. Travel time and travel cost are scaled with β_{time} and β_{cost}, respectively. Each transport mode has a unique alternative-specific constant ASC, that describes each transport mode specifically in addition. The second column presents the t-Test value to evaluate the model's fit. A given significant level α of 0.1 with five degrees of freedom is expressed by a t-value of 2.015, which can be exceeded by all five parameters [24].

Subsequently, a validation proofs the goodness of the calibration fit on the data sample [25]. Here, a k-fold cross validation with five sub-samples proves an average $\overline{\rho}^2$ of 0.33, which represents a good fit [26].

In general, the willingness-to-pay (WTP) describes the customer's readiness to buy a product. For transport models, the WTP can be described by the value-of-time (VOT) to be more specific. The VOT indicates the value for travel time savings. Equation 2 present the calculation of the VOT.

$$VOT = \frac{\beta_{time}}{\beta_{cost}} \approx 120\,€ \tag{2}$$

By calibrating the explained discrete choice model, the VOT of the considered use case stands for 2 € per saved minute of travel time. In comparison to further studies, business travellers attach more importance to travel time than other travelling groups, e.g. commuter [20], [27]. Studies on the mode choice by varying the cost on the other side are presented in section IV.

C. Route Assignment

After each itinerary receives its own transport mode mix and a passenger group decided on a certain mode, the passenger can pick between different routes, e.g. the fastest route, the shortest route, etc. At this point, a passenger will always pick the fastest route in terms of time, since the travel time impacts the discrete choice model.

III. IMPLEMENTING THE AAM MODE

The transport mode for AAM consists of three legs as shown in Fig. 1.

Leg 1 (green) and 3 (blue) can be calculated with the OTP. A passenger will walk from or to a vertiport, as long as the distance does not exceed a fixed threshold s. While walking, no cost occur for this leg. If the distance from or to a vertiport exceeds the limit s, a passenger will take a taxi independent of the travel distance. In this case, the passenger has to pay a base and a fare price as described in section II-B. The value s is set to $1.7\,km$, as the median distance pedestrians are willing to walk according to the mobility report [12]. For both legs, the travel time is calculated with the OTP and TrafficIndex in the same way as for the transport mode taxi.

TABLE II: Results for business travel calibration

Parameter	Value	t-test
ASC_{car}	5.9	200.0
ASC_{taxi}	4.03	49.6
ASC_{public}	6.60	119.0
β_{time}	-0.673	-2.07
β_{cost}	-1.320	-11.80

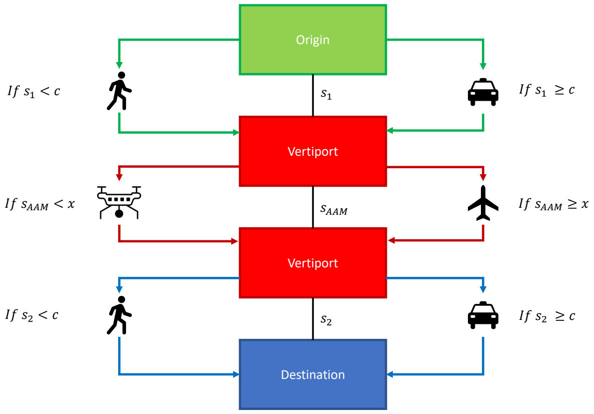


Fig. 1: AAM mode

All legs are connected by vertiports, a transport hub to link the air side to ground transportation. While vertiports account as an input set in this study, the vertiport sample is divided into an urban vertiport fraction, adopted by former demand studies, and a rural vertiport fraction [20]. The rural vertiport set contains 22 locations, that are placed on the main train station on the 22 biggest cities in the metropolitan area of Hamburg. In total, this study considers 43 vertiports which can be addressed by passengers to access the AAM mode.

For modelling the AAM flight, this study adopts a simplified flight profile including a vertical phase and a horizontal phase for the cruise. An AAM vehicle climbs in altitude with a constant climb rate and without any acceleration. After this, the vehicle flies to its destination coordinates with a constant cruise speed before descending in analogy to the climb phase. Since this study investigates urban areas as well as rural areas, two different vehicle types serve the air transportation. When reaching 60 % (as an assumption) of the max range of the first vehicle in cruise distance, the route will be operated by the second vehicle configuration. In that case, the vehicle performance will change, but not the flight profiles. The vehicle configuration differ in their general setup. While the first configuration, respectively a multicopter, operates on short distances in a city, the second configuration, respectively a vectored thrust, servers longer itineraries to connect different cities and rural areas. Tab. III shows the technical setup for both applications as well as the economics.

TABLE III: AAM Intra City and Regional

Parameter	Unit	Intra City	Regional
climb rate	m/s	7.5	10
descent rate	m/s	7.5	10
cruise speed	km/h	110	332
range	km	65	240
base fare	€	6	0
fare per km	€/km	5	2

Here, the ticket for AAM consist of a base fare and a fare per km that are adopted from previous economic viability studies in Germany [28]. The business class in manned aviation differs not only in the ticket price but also in the space and service provided in the cabin during the flight compared to economy class bookings. While there is a spatial separation between several booking classes in airlines, an AAM cabin is expected to have a standard cabin, regardless of the customer's background and travel purpose. Therefore, all passengers should be considered equally and not be charged different ticket fares individually in an AAM system

IV. RESULTS

For the metropolitan area of Hamburg, the model calculates $1,885,157$ potential itineraries. Fig.2 presents a distribution of the road distance of all calculated itineraries.

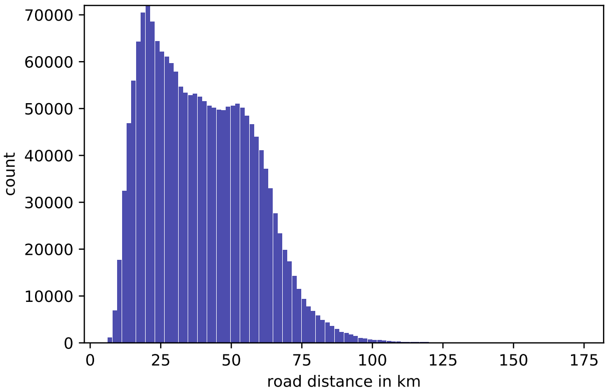


Fig. 2: Histogram of the road distance in the network (1885157 itineraries in total)

While the histogram shows a global peak at around $25\,km$ that represents itineraries inside the Hamburg city center, a further local peak at about $55\,km$ represents the commuter belt of Hamburg. Medium and large size cities around Hamburg are located within the equivalent distance.

In total $246,502$ business passengers travel between offices in this model. On $1,006$ itineraries, there is at least one AAM passenger. To sum this up, there are $1,287$ AAM passengers, distributed on 257 vertiport connections. The presentation of the results is based on the diagrams of Fig. 3.

To understand the characteristics of each mode, Fig. 3a presents the cost of each transport mode over the AAM distance. Hamburg's public transport service provider charges a fixed ticket price independent of the travel distance. As a result, all green markers representing the public transport gather around a horizontal line. The ticket price doubles when leaving the inner tariff zone, which is negligibly low here. Furthermore, all other transport modes scale with the travel distance. Here, the car and the taxi mode nearly present a linear curve with a slope matching the fare per km. In contrast to that, the AAM mode can be split in two red linear fits. This is because of the differences in the AAM vehicle variations and its economics. As presented in Tab. III, the fare per km varies between both configurations. When the AAM flight distance exceeds the $39\,km$ (see section III), the economics change. This value is in range with the distance of the commuter belt as shown in Fig. 2. As long as the commuter belt counts towards the second AAM vehicle configuration, this sub mode catches a populated area, also a potential field of customers. The remaining spray of the red markers occurs by the access and egress phase of AAM (green and blue phase of Fig. 1).

Fig. 3b and Fig. 3d underline the effect of the commuter belt on the AAM market. The first figure presents the AAM business passengers over the flight distance. While some short itineraries attract some passenger, the biggest fraction of the AAM demand fall upon itineraries of $40-60\,km$. Conditional on the vertiport placement, this demand represent trips from the city center to the commuter belt and the other way around. Shorter itineraries seems less attractive, since the first vehicle configuration comes with a higher fare per km, that reaches its peak at $30-40\,km$ of flight distance. In addition, Fig. 3d shows AAM demand over the corresponding costs. Here, the total travel cost of $140\,€$ fits with the demand peak in Fig. 3b. At this point it should be noticed, that the discussed demand peak highly depends on the threshold value for the maximal range of the first vehicle configuration. If the first configuration covers the commuter belt, AAM costs will increase and its demand will decrease. Even though business travel comes along with a high VOT the total demand drops about $50\,\%$ to 606 passengers when the first vehicle can perform with its full maximal range ($65\,km$) and servicing the commuter belt. Further developments of the vehicle manufacturers must be considered. Additionally, a cost model should be evaluated when a passenger scenario is fixed and the vehicle utilization can be estimated.

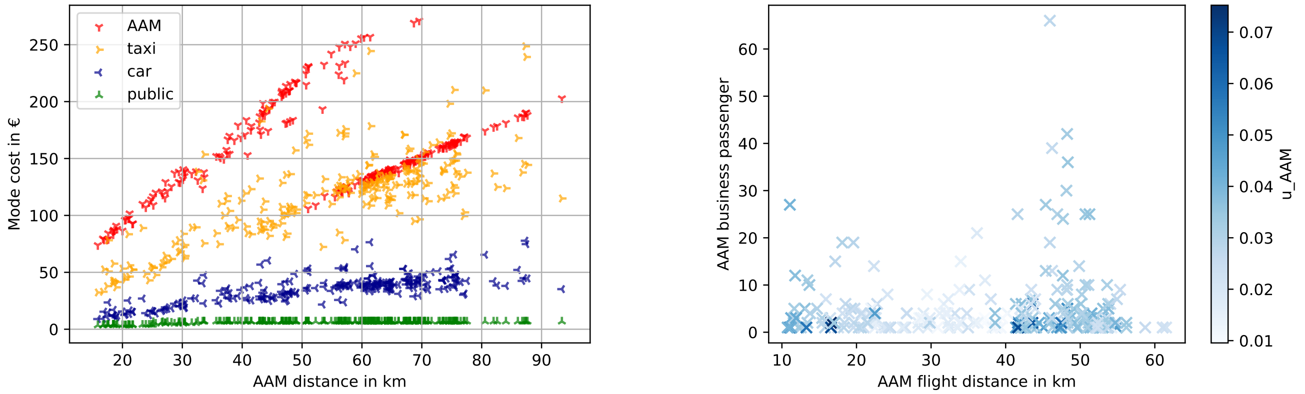
Since the taxi mode and the AAM mode do compete in terms of travel cost, at least for longer distances, Fig. 3c presents further analysis on the competition between those modes. For this purpose, two new metrics are introduced.

$$CO = \frac{AAM_{cost}}{taxi_{cost}} \tag{3}$$

$$TT = \frac{AAM_{time}}{taxi_{time}} \tag{4}$$

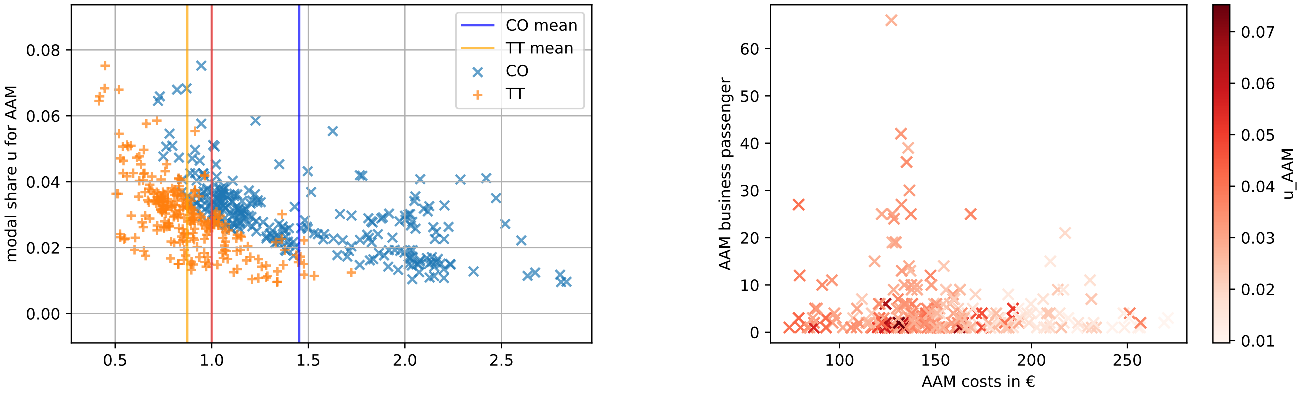
In Fig. 3c, the blue and orange markers present the metrics CO and TT for each single itinerary with at least one AAM passenger. Values on the x-axis of around 1 represent similar mode parameters for the taxi and AAM. Lower values imply a time or cost benefit for AAM, higher values than 1 represent AAM as a longer or more expensive alternative. In general, the travel time for AAM is about $85\,\%$ of the travel time by taxi, marked with the orange vertical line. Analogous, the travel cost for AAM is about $45\,\%$ higher than for taxi. In total $7,450$ business passengers choose the taxi mode. As a conclusion, the AAM mode presents shorter travel times than the taxi mode, meanwhile the costs for AAM are higher.

Given the VOT of $2\,€$ per minute for business passengers, the demand drops by $17\,\%$ when increasing the fare per km to $5.50\,€$ and $2.50\,€$ for the two configurations. In comparison to commuter studies, in which the demand drops by nearly $50\,\%$ when increasing the fare by $0.50\,€$, business demand is less manipulable in terms of total travel costs [20], [29] . Meanwhile, an increase of $0.50\,€$ for the taxi fare does not raise the AAM demand by $17\,\%$ in the same way since the taxi mode can be part of AAM access and egress. Instead, the AAM demand decreases by $2.5\,\%$. However, AAM demand growths about $6\,\%$ when the car mode costs $1.20\,€$ per km.



(a) Mode cost over AAM travel distance

(b) AAM modal share over the travel distance



(c) Comparison between taxi and AAM

(d) AAM modal share over the travel cost

Fig. 3: Results of business travel demand modelling

To summarize it up, AAM demand highly depends on the flight performance and thus its economics and less by travel cost changes of the taxi or car mode. At the same time, business passengers tend to react more slowly to changes in AAM than commuter passengers. From an employer's perspective, the total travel time becomes a new value when employees can use in-vehicle time for business activities, so the value of travel time should be reevaluated. Therefore, Hensher developed a theoretical approach that includes parameters such as productivity during the trip and the monetary value of the employee [30]. Since its heterogeneous nature and its complexity this approach may fail when data is not available. Due to the given data set of Hamburg and uncertainties in the business market model, this study can not evaluate employer's considerations concerning productivity during travelling.

V. OUTLOOK

As a part of MICE, the business-to-business model in this study is modeled as an office-to-office travel and covers only a portion of the overall business demand. Incentives, conventions and exhibitions are not included in the results and should be considered when examining the entire business travel market. However, the authors anticipate that office-to-office traffic will account for the largest fraction of the business market. Although the probability of taking a business trip is set to $100\,\%$ here, it is estimated to be considerably lower in reality. The post-coronavirus working environment has yet to establish itself to forecast in-person meetings versus online meetings. As a result of fewer face-to-face meetings, the size of the AAM business market size diminishes. Because of the unknown factor of total market size, this study focused on the total market behavior regarding changes in several transport modes. On top of that, each business trip is modelled between offices in this study. This assumptions excludes the possibility of carrying out a business trip that starts or ends at a residential traffic cell. In a next step, this hypothesis should be assessed again.

Compared to other customer segments, business passengers have a higher willingness to pay. The AAM business market responds sluggishly to changes in travel costs, for example. Therefore, the AAM business travel has a greater market share than commuting, according to the modal split in section II-B. However, further studies should consider additional attributes in the discrete choice model. As business passengers trust the transport mode to arrive at their destination on time, attributes indicating reliability and punctuality contribute to a better understanding of business passengers' behavior. Additionally, each business passenger can choose from four different transport modes, excluding rental cars or being a car passenger when traveling with a delegation of colleagues. Advanced studies may include several types of individual transport to complete the set of alternatives in the mode.

Modeling business travelers involves different subcategories of travel purposes, which makes the field of business travel heterogeneous and presents a challenge in developing a mathematical representation of passengers required for a discrete choice model. Since its diverseness, results of business travel demand implies uncertainties which has to be taken into account.

ACKNOWLEDGMENT

The authors would like to thank Antonio A. Trani and Nicolas Hinze (both Virginia Tech) and Jeremy C. Smith (NASA) for the cooperation, discussions and remarks during the ATM-X cooperation.

REFERENCES

[1] T. Brock, *How Much Airline Revenue Comes From Business Travelers?* The Investopedia Team, Ed., 2022. [Online]. Available: https://www.investopedia.com/ask/answers/041315/how-much-revenue-airline-industry-comes-business-travelers-compared-leisure-travelers.asp.

[2] *The Average Business Trip Costs $1,293 and Prices Will Increase in 2020: Runzheimer Report Reveals Insights on Business Travel Expenses; Hawaii Ranks Most Expensive State for Business Travel*, Boston, 3.10.2019. [Online]. Available: https://www.businesswire.com/news/home/20191003005109/en/The-Average-Business-Trip-Costs-1293-and-Prices-Will-Increase-in-2020.

[3] J. J. Sheehan, *Business and corporate aviation management: On demand air transportation*. New York and London: McGraw-Hill, 2003, ISBN: 9780071412278. DOI: 51245. [Online]. Available: http://www.loc.gov/catdir/bios/mh042/2003051245.html.

[4] R. Davidson and B. Cope, *Business travel: Conferences, incentive travel, exhibitions, corporate hospitality and corporate travel* (Pearson education). Harlow, England: Prentice Hall, 2003, ISBN: 978-0582404441.

[5] J. Swarbrooke, *Business Travel and Tourism*. Hoboken: Taylor & Francis, 2012, ISBN: 9780080490601. [Online]. Available: https://doi.org/10.4324/9780080490601.

[6] J. V. Beaverstock, B. Derudder, J. Faulconbridge, and F. Witlox, Eds., *International business travel in the global economy: Business Travel and Leisure Tourism: Comparative Trends in a Globalizing World* (Transport and mobility). Farnham, Surrey and Burlington, VT: Ashgate, 2010, ISBN: 0-7546-7942-X. [Online]. Available: http://site.ebrary.com/lib/academiccompletetitles/home.action.

[7] J. Urry, "Mobility and Proximity," *Sociology*, vol. 36, no. 2, pp. 255–274, 2002, ISSN: 0038-0385. DOI: 10.1177/0038038502036002002.

[8] N. Kulendran and K. Wilson, "Modelling Business Travel," *Tourism Economics*, vol. 6, no. 1, pp. 47–59, 2000, ISSN: 1354-8166. DOI: 10.5367/000000000101297460.

[9] Federal Aviation Administration, *Urban Air Mobility and Advanced Air Mobility: What is Urban Air Mobility*, U.S. Department of Transportation, Ed., Washington, DC 20591, 2022. [Online]. Available: https://www.faa.gov/uas/advanced_operations/urban_air_mobility/.

[10] National Aeronautics and Space Administration, *Advanced Air Mobility - What is AAM?* NASA, Ed., 2022. [Online]. Available: https://www.nasa.gov/sites/default/files/atoms/files/what-is-aam-student-guide_0.pdf.

[11] European commission, *A Drone Strategy 2.0 for a Smart and Sustainable Unmanned Aircraft Eco-System in Europe: SWD(2022) 366 final*, 2022. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022DC0652.

[12] infas Institute of for Applied Social Studies, *Mobility in Germany: Short Report Traffic - Structure - Trends*, Federal Ministry for Digital and Transport, Germany, Ed., Bonn, Germany, 2018.

[13] G. Danielli, N. Backhaus, and P. Laube, *Wirtschaftsgeografie und globalisierter Lebensraum: Lerntext, Aufgaben mit Lösungen und Kurztheorie ; [ein Geografie-Lehrmittel für Mittelschulen und das Selbststudium]*, 1. Aufl. Zürich: Compendio Bildungsmedien, 2002, ISBN: 9783715590257. [Online]. Available: https://permalink.obvsg.at/AC09444012.

[14] Statistisches Bundesamt, *Klassifikation der Wirtschaftszweige*, SFG Servicecenter Fachverlage, Ed., Wiesbaden, 2008. [Online]. Available: https://www.destatis.de/static/DE/dokumente/klassifikation-wz-2008-3100100089004.pdf.

[15] Sean Barbeau, Sheldon Brown, Andrew Byrd, *et al.*, *OpenTripPlanner2*, LGPL, Ed., 2022. [Online]. Available: http://docs.opentripplanner.org/en/latest/.

[16] TomTom International BV, *Traffic Index Rating: Ranking 2019*, tomtom.com, Ed., 2019. [Online]. Available: https://www.tomtom.com/en_gb/traffic-index/ranking/.

[17] X. Zheng, X. Liang, and K. Xu, "Where to wait for a taxi?" In *Proceedings of the ACM SIGKDD International Workshop on Urban Computing*, O. E. Wolfson and Y. Zheng, Eds., New York, NY, USA: ACM, 2012, pp. 149–156, ISBN: 9781450315425. DOI: 10.1145/2346496.2346520.

[18] Z. Sheng, Z. Lv, J. Li, *et al.*, "Taxi travel time prediction based on fusion of traffic condition features," *Computers and Electrical Engineering*, vol. 105, p. 108 530, 2023, ISSN: 00457906. DOI: 10.1016/j.compeleceng.2022.108530.

[19] S. Richartz, *Taxi calculator: Taxi fare Hamburg*, Bergheim, Germany, 18.04.2022. [Online]. Available: https://www.taxi-rechner.de/taxikosten-hamburg/41.

[20] J. Pertz, K. Lütjens, and V. Gollnick, "Approach of modeling passengers' commuting behavior for UAM traffic in Hamburg, Germany," in *25th ATRS World Conference*, vol. 2022, 2022.

[21] Hamburger Verkehrsverbund GmbH, *Timetable info, network and fare zone plans*, Hamburger Verkehrsverbund GmbH, Ed., Hamburg, Germany, 2022. [Online]. Available: https://www.hvv.de/.

[22] T. Kröger, *Small-scale traffic model for Hamburg and the surrounding area: Data sample: Data Transfer Agreement*, Free and Hanseatic City of Hamburg, Ministry of Transport and Mobility Transition, Directorate-General for Transport, Division-Transport Development, Ed., Hamburg, Germany, 13.07.2021.

[23] M. Bierlaire, *A short introduction to PandasBiogeme: Report TRANSP-OR 200605*, EPFL, Ed., 2020.

[24] K. Train, *Discrete choice methods with simulation*, Second edition. Cambridge et al.: Cambridge University Press, 2009, ISBN: 978-0-521-74738-7.

[25] L. Held, *Methoden der statistischen Inferenz: Likelihood und Bayes*. Heidelberg: Spektrum Akademischer Verlag, 2008, ISBN: 9783827419392.

[26] J. J. Louviere, D. A. Hensher, and J. D. Swait, *Stated choice methods: Analysis and application*, 1. publ. Cambridge: Cambridge Univ. Press, 2000, ISBN: 978-0-521-78830-4.

[27] Institute of Mobility Research, *Autonomous Driving: The Impact of Vehcile Automation on Mobility Behaviour*, ifmo, Ed., Germany, 2016. [Online]. Available: https://www.bmwgroup.com/content/dam/grpw/websites/bmwgroup_com/company/downloads/de/2016/2016-BMW-Group-IFMO-Publikation-Dezember.pdf.

[28] J. Pertz, M. Niklaß, M. Swaid, *et al.*, "Estimating the Economic Viability of Advanced Air Mobility Use Cases: Towards the Slope of Enlightenment," *Drones*, vol. 7, no. 2, p. 75, 2023. DOI: 10.3390/drones7020075.

[29] M. Rimjha, S. Hotle, A. Trani, N. Hinze, and J. C. Smith, "Urban Air Mobility Demand Estimation for Airport Access: A Los Angeles International Airport Case Study," in *2021 Integrated Communications Navigation and Surveillance Conference (ICNS)*, 2021, pp. 1–15. DOI: 10.1109/ICNS52807.2021.9441659.

[30] D. A. Hensher, *Value of business travel time*, 1. ed. Oxford, New York, Toronto, Sydney, Paris, Kronberg (Taunus): Pergamon Press, 1977, ISBN: 9780080218564.