

Characteristics of Potential User Groups of New Forms of Mobility Using the Example of Urban Air Mobility

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Urban air mobility (UAM) is a novel form of air transport revolutionising the way passengers travel intercity, intracity, arrive at and depart from airports. Trials already demonstrated the technical feasibility, however, little is known about UAM passengers. This paper attempts to identify potential first mover users for UAM services. Findings of an in-depth literature review show that business travellers and high-net-worth individuals are identified as the two main first mover groups. These potential users are described in more detail, using future trends, socioeconomics, and trip characteristics. Management implications, such as for transport infrastructure, pricing, or in-flight services, are derived from findings of an expert workshop with nine mobility researchers. Several studies already assessed characteristics of air travellers and urban passengers of novel mobility concepts, such as ride-hailing services. This paper aims to combine several research foci: air passenger, urban passenger characteristics, and research on tourism in order to identify potential, new customer segments for novel mobility concepts, such as for UAM services.

Keywords: *novel concept of mobility, urban air mobility, passenger characteristics, passenger segmentation*

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1. Introduction

The principle of urban air mobility (UAM) is defined here as an operation of flying, passenger carrying vehicles in populated areas, enabled through distributed electric propulsion resulting in a low noise footprint and through electric battery storage keeping emissions in the city to a minimum.

Since the first commercial helicopter operations started in the 1950s mainly in the US and European cities, other terminologies such as flying car, air taxi, personal air transportation, or more recently on-demand air mobility were used (Vascik & Hansman, 2017). A majority of these commercial operations ceased in the USA and Europe in late 1960s to mid 1970s due to noise, safety, and operating cost issues. However, helicopter services as city centre airport shuttle still exist today in New York, Sao Paulo, or Monaco. Other urban air mobility services, which are currently operated by helicopters, are medical emergency cases.⁴ For the last ten years, significant progress in electrical power transmission, battery storage, and distributed propulsion systems (Duffy, Wakayama, & Hupp, 2017) together with progress in communication, sensor, and data science technologies led to a serious consideration of applying commercial, aerial services in highly populated urban areas. In the early 2019, more than 150 flying vehicle concepts are under development (The Vertical Flight Society, 2018) ranging from various companies from traditional aviation, automotive, US technology companies up to start-up companies. First demonstration projects are expected to start in the 2020 timeframe and first commercial operations are envisaged in 2025 (Baur et al., 2018). However, fundamentally different aircraft configurations show that there is still no common understanding of the technical requirements UAM places on an aircraft (Shamiyeh, Bijewitz, & Hornung, 2017). Besides, the technical maturation of the flying vehicle, aviation authorities in Europe (EASA) and the USA (FAA) are currently defining certification rules for these vehicles as well as operating and management rules of autonomous flying vehicles in air space (Booz Allen Hamilton, 2018).

Another challenge is the identification of potential user groups as little literature has been published about potential customer groups⁵ using UAM mobility services. This paper attempts to tackle that uncertainty. In Section 2, three UAM use cases are presented. Conducting a review of existing work, this paper attempts to identify potential first mover passenger groups in Section 3, defined here as those customers who might potential use UAM services

⁴ This use case is not considered in this paper.

⁵ The words user group, customers and passenger group are used interchangeable in this paper.

first. General trends of potential first mover groups are discussed in Section 4. Conducting an interactive workshop with mobility researchers, managerial implications for UAM operations are derived and presented with a case study in Section 5. In the last section, the paper closes elaborating on further research gaps.

2. Possible Use Cases of UAM

One of the greatest challenges is the passenger transport in highly populated urban areas by autonomous flying vehicles. Due to safety concerns during take-off and landing phases, it is expected that passenger UAM vehicles will be likely to operate from dedicated take-off and landing infrastructure (landing pads). Depending on the range and type of operations, three possible use cases of UAM transporting passengers can be defined: (1) **intercity flights** running with scheduled and medium-range operations, (2) **air taxi** services with on demand and point-to-point, short-range operations, and (3) **airport shuttle** services running on scheduled, short- to medium-range operations adjusted to arrivals and departures of flights, running from airports to points of interests.

Various studies predict large market growth potentials (Baur et al., 2018; Booz Allen Hamilton, 2018; Grandl et al., 2018; TransportUP, 2018). As seen in the forecast by Baur et al. (2018) predicted growing passenger drone numbers in operation for all three use cases until 2050 are 98.000 worldwide (see Figure 1). The largest share of passengers is predicted for the use case two (air taxi), however, it is uncertain which use case will be in place first. Further applications are possible, such as an electric vertical take-off and landing aircraft (eVTOL) operating between points of interest in the city and more rural areas (Wanner, 2018). Such scenario could also add benefits from the societal point of view, as rural areas often lack sufficient coverage of mobility offers (Kluge, Paul, Urban, & Ureta, 2018).

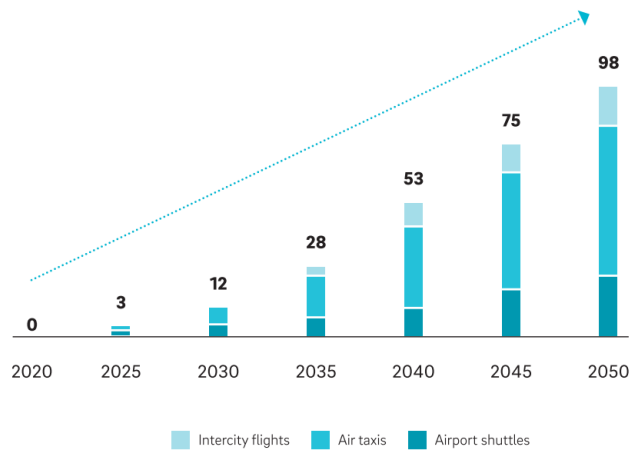


Figure 1: Forecasted number of passenger drone operations (in '000) (Baur et al., 2018)⁶.

3. Literature Review on Potential UAM Users

3.1 Prior studies

Several studies already look into general, mode-independent future passenger groups (Future Foundation, 2015; Kluge, Paul, Ureta, & Ploetner, 2018; Paul et al., 2018) and into passenger types of more novel, urban mobility concepts, such as ride-hailing services offered by companies like Lyft and Uber (Young & Farber, 2019). Very little literature was published on potential customer groups of UAM services. Recently, reports have been distributed by consulting companies, such as by Booz Allen Hamilton, Porsche Consulting, and Roland Berger (Baur et al., 2018; Booz Allen Hamilton, 2018; Grandl et al., 2018). Booz Allen Hamilton shows in a market analysis that eVTOLs with 5-seats are estimated to cost around \$6.25 per passenger per mile and would hence be comparable to a luxury ground mode choice, such as limousine services. 2-seat vehicles are estimated at \$11 per mile per passenger, which lies within the price range of a helicopter ride. Hence, first mover passengers for UAM services should have sufficient finances at their disposal. Within consulting studies by Baur et al. and Grandl et al., potential UAM users are identified as those passengers who already use helicopter services today. Hence, 1) high-net-worth individuals and 2) top executives are two potential user groups. Proprietary Airbus research by the Boston Consulting Group assumes three potential target customer groups: 1) high income passengers, 2) senior professionals (business

⁶ Bauer et al. estimate around 100 cities to have UAM operations until 2050.

passengers), and 3) high spending customers for business travel purposes (also business passengers) (BCG, n.d.). A passenger survey for the case study of Munich city also supports the assumption that UAM will most probably be used for business trips (Fu, Rothfeld, & Antoniou, 2018).

On the other hand, a modelling project of the US market for small, on-demand and point-to-point aircraft operations by Smith et al. (2012) indicates competitive fares for comparable air transport services to UAM. In the long run, with an estimated price of \$0.20 to \$1.00 per seat per mile and around 665 million trips in 2035, such services could also become an affordable mode for many passenger segments. Due to the network effect, also observable in other transport networks, Thomsen (2018) supports the hypothesis that in the long run, UAM will become as affordable as a taxi service and available to a broad range of additional users. However, as those do not belong to the first mover customer group, they are not discussed further in this paper.

Table 1: Studies on potential user groups of UAM.

Authors	Year	Study type	Title	Potential UAM users identified	Business traveller identified	High-net-worth individuals identified
Baur et al. (Roland Berger Focus)	2018	Consulting study	Urban air mobility: The rise of a new mode of transportation	<ul style="list-style-type: none"> ▪ ultra high-net-worth individuals top executive (proxy user groups as both already commute by helicopter) 	X	X
BCG (proprietary Airbus research)	n/a	Workshop summary (presentation)	Qualitative consumer research	<ul style="list-style-type: none"> ▪ high income ▪ senior professional ▪ high spend for business travel 	X	X
Booz Allen Hamilton	2018	Consulting study	Urban air Mobility (UAM) Market Study	<ul style="list-style-type: none"> ▪ high-net-worth passenger (proxy: fares, 6.25\$ to 11\$ per pax per mile) 		X
Fu. M, Rothfeld, R. Antoniou, C.	2018	Conference paper	Exploring Preferences for Transportation Modes in an Urban Air Mobility Environment: a Munich Case Study	<ul style="list-style-type: none"> ▪ younger passenger (18 - 35) ▪ older passenger with high household income⁷ (56 - 65) ▪ business passenger (proxy user groups as trip purpose of UAM more seen for business trips) 	X	
Grandl et al. (Porsche Consulting)	2018	Consulting study	The Future of Vertical Mobility	<ul style="list-style-type: none"> ▪ helicopters passenger (proxy user group: passenger drones can replace helicopters helicopters passengers can be potential consumers for drones) 	X	X
Smith et al.	2012	Conference paper	Projected Demand and Potential Impacts to the National Airspace System of Autonomous, Electric, On-Demand Small Aircraft	<ul style="list-style-type: none"> ▪ broad range of additional users (proxy as in 2035: competitive fares, 0.20 to 1\$ per seat-mile) 		
Thomsen, M.	2018	Conference talk	Airbus Urban (Air) Mobility	<ul style="list-style-type: none"> ▪ broad range of additional users (proxy as due to network effects, UAM will become on the long run affordable and as cheap as a taxi service) 		

⁷ A high household income is not equally comparable to high-net-worth individuals and hence, not counting identification of those.

3.2 Potential First Movers

Prior work identifies business travellers and high-net-worth individuals (HNWI) as two main potential first mover groups using UAM services. The business traveller was mentioned or indicated by four studies and the HNWI by four studies as well. Long term, due to decreasing ticket prices, UAM services might be available for a broader range of users.

Results of the literature review are summarised in Table 1. Most papers and reports are published in the USA or in Germany. It is notable that most work was recently published by consulting firms and little is available in academic journals and if so mostly in form of conference papers. The general interest on UAM seems to be more on the business side, however, recent publications, such as by Fu et al. (2018) might indicate an increase of academic interest.

4. Trends on Potential, First Movers UAM Customers

As outlined above, two main customer groups have been identified as potential first users. Within this section, the focus is placed on the analysis of each user group's specific socio-economic characteristics, the respective future development, and how these factors influence the demand for urban air mobility services. The following socio-economic and mobility-specific trends are considered to have a significant impact on first mover user groups:

- **New work** (zukunftsInstitut, 2018): The overall trend “new work” or “work 4.0” comprises multiple developments that constitute a new way of working, both in the forms of new ways of collaborating as well as a changing working environment. Exclusive business passengers are characterised by a limited availability of time with, at the same time, a high-required flexibility regarding their travel itinerary. Furthermore, as coined by the term bleisure, business travellers often combine a work trip with leisure activities (Amadeus, n.d.).
- **High growth rates of luxury travel** (Amadeus, 2016b): Luxury travel becomes accessible to a higher share of the global population, ranging from those always travelling in a luxury way to those only demanding particular services and products on special occasions. These particular travellers demand particular luxurious experiences instead of just materialism, including one-off travel offers. *Figure 2* illustrates that the long-haul luxury travel market faces high growth until 2025, with the number of trips more than doubling between 2011 and 2025.

Growth of luxury travel trips by distance

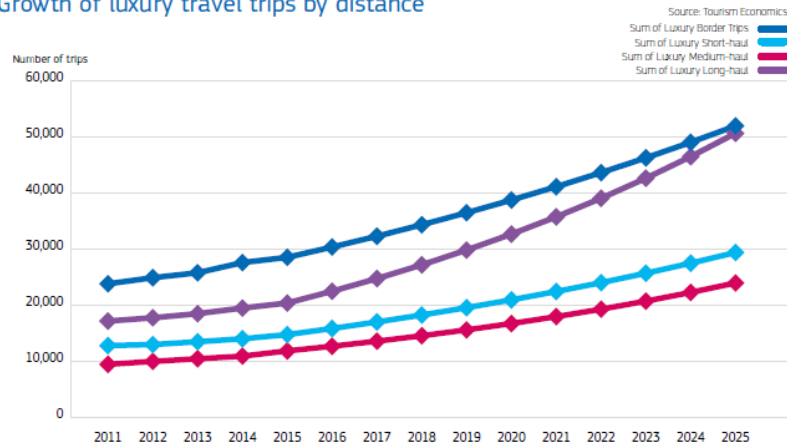


Figure 2: Growth of luxury travel, 2011-2025 (Amadeus, 2016b).

- Cultural-specific travellers:** This specifies a new emerging market segment with high purchasing power and specific requirements along the door-to-door journey based on cultural and religious needs, including mobility offers, accommodation, and entertainment programme. One particular example is Halal tourism (Amadeus, 2016a), which denotes Muslim travellers that wish to maintain their religious habits during their travel and select trip packages and destinations accordingly. Most of these travellers originate from MENA (Middle East and North Africa) countries, which partly exhibit a high level of purchasing power. Figure 3 shows the development of the gross domestic product (GDP) per capita in the MENA region, which is strongly driven by the economic growth in the Middle East. The travellers eligible to use UAM services are therefore considered to be part of the middle and upper class and exhibit a high willingness to pay for their travels.

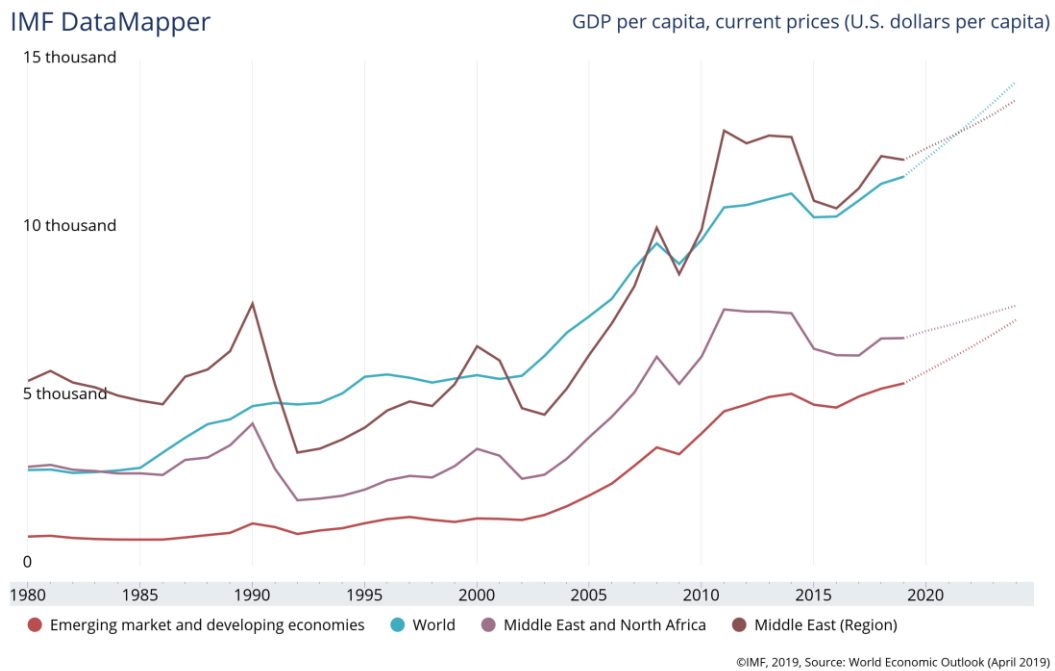


Figure 3: Real gross domestic product development 1980-2020 (IMF, 2018).

- **Mobility as a service (MaaS), seamless travel services and managed travel 3.0** (Amadeus, n.d.): Increasing demand for door-to-door booking and planning of a business or leisure trip; moving towards a predictive and personalised travel experience providing tailored services and human factors.
- **Enabling technologies** (OECD, 2018): Digital platforms as enablers to share and accumulate information in order to increase the overall resilience of the transport system, provide personalised mobility services as well as real-time information; virtual or augmented reality solutions as travel-enhancing devices as well recognition technology fostering the seamlessness of travel services.

These particular developments affect potential first mover users of UAM in different ways. The analysis of trends influencing potential first mover groups are applied in the following section to discuss implications for the overall UAM system.

5. Managerial Implications and Case Study

5.1 Expert Workshop on Managerial Insights

Based on the findings of this paper, implications for future UAM operations are derived in an interactive expert workshop with mobility researchers (N = 9), conducted in April 2019. The mobility-related research experience of the workshop participants ranges from one year to fourteen years, focusing on future of aviation, novel mobility concepts, and UAM in particular. In detail, it was discussed how trends presented above affect future UAM operations and system components. This includes infrastructure requirements, vehicle size and performance, interior, pricing, in-flight entertainment and services, seamlessness, and personalization. Key findings from the workshop are elaborated below.

- **Infrastructure requirements** Due to foreseen trends “new work” and “growth in luxury travel”, specific points of interest (co-working space, office locations, touristic sights in urban and rural areas, airports) emerge and are advised to be part of the UAM networking structure. On the one hand, business travellers might demand fast processes at the landing pads. Cultural-specific traveller might want designated prayer areas or gender-segregated space. On the other hand, luxury travellers could look more for luxurious infrastructure next to the transport service, such as high-end waiting lounges or shopping. Hence, requirements from the demand side could develop quite differently and it could be a challenge combining them. To ensure seamless mobility as a service, hop-on and hop-off options and connections to other transport modes for transfers might be essential. Data flow to other modes on the situational availability of UAM services, enabled through technology such as digital platforms, could improve UAM operations further.
- **Vehicle size and performance** Depending on the first mover groups, the travel party size could vary from 2 up to 5+ people, demanding the UAM vehicle to be adaptable to carry different number of passengers on-demand. A low noise level (especially applicable for inner-city services), a high degree of safety, and a comfortable flight in terms of flight stability might be required by luxury travellers. From small to larger items, the vehicle should be capable of storing them. To ensure UAM services as an integrated part of the existing infrastructure, emergency services and efficient charging facilities and capabilities should be in place as well.
- **Interior** The interior is the touchpoint between passenger and vehicle and should fulfil the requirements of the first movers. Meeting new working requirements and more applicable to medium-range UAM trips, the option for working on board should be provided. Glass exterior, luxurious interior with high quality design features but

also easy and barrier free vehicle access should be in place for the luxury traveller. Cultural-specific add-ons, such as a compass to Mecca or gender-segregated cabin options, should be kept in mind.

- **Pricing** In order to meet requirements derived from all trends, the pricing structure should be designed in a flexible and dynamic way, ranging from one trip fare, to corporate fares and monthly package options. Combined, single ticketing with other transport providers or hospitality companies (such as airline tickets including access and egress mode or hotel bookings) could serve first movers further.
- **In-flight entertainment and services** The in-flight entertainment content and services should provide value adding features for both business traveller and HNWI, which is especially applicable during medium-range intercity flights (UAM use case 1). A stable Wi-Fi connection on board is one main enabler here. Virtual reality and augmented reality can enhance in-flight entertainment options further. Additionally, in-flight amenities are possible to improve the UAM experience. Cultural-specific services, such as food or language options, can enhance in-flight service further.
- **Seamlessness** To ensure seamlessness, high connectivity and a smooth transfer of people and luggage is essential. Hence, UAM services shall be an integrated part of the overall transport system, in terms of infrastructure but also in line with data exchange between modes, enabled through advanced technology.
- **Personalization** As elaborated above, user needs and future trends can be different. UAM services shall be customized and on-demand to the first mover user groups, partly enabled through smart devices. Providing a unique travel experience individualized to the passenger is applicable for luxury and cultural travel.

Generally, cooperation of UAM operators with other modes of transport, corporations (for business travel), and the hospitality sector has been discussed throughout each aspect, such as for pricing options and integrating UAM into the overall transport system. Eventually, management implications also depend on the business model as UAM services could be offered by one operator or managed via a mobility platform. Other insights might only be applicable to a specific UAM use case described in Section 2. For instance, luggage handling is mostly relevant for use case three (airport shuttle) as airline passengers usually travel with luggage. On the other hand, in-flight entertainment and services are connected to use case one (intercity flights) as passengers will spend a longer amount of time in the vehicle. An overview of the workshop findings and assigned use cases can be found in the Appendix.

5.2 Specific use case applications

The trends highlighted in Section 4 and their impact on first mover requirements have in common that they foster exclusive and highly individualised travel demand, require UAM services to offer flexible mobility solutions, including door-to-door services and high-end features. Based on the defined three use cases, the trends affecting first movers as well as the impact on the UAM system, initial use case applications for the different first movers are outlined in Table 2.

Table 2: Feasible use case applications for first mover groups.

Intercity / Air Taxi / Airport Shuttle	
HNWI	<ul style="list-style-type: none">▪ Enabling specific services and facilities along the journey to cater for cultural and religious needs▪ Personalised, family-oriented airport access solutions ensuring seamless door-to-door travel▪ Mobility services to connect exclusive tourism destinations with transport nodes such as airports
BT	<ul style="list-style-type: none">▪ On-demand mobility services providing high degree of flexibility and offering “on-the-spot” pick-up services at corporate locations▪ Offering end-to-end business booking packages meeting corporate requirements

This overview provides initial ideas for future UAM business models, matching technical feasibility and infrastructural conditions with future user requirements.

5.3 Limitations

The research approach of this paper and the respective findings can be increased in several ways by providing methodological grounding. As mentioned, there is currently little academic literature to analyse, showing a research gap in this very field. The literature review used in this paper shows first insights. A quantitative analysis, such as by conducting a meta-analysis as described by Russo (2007), could increase our findings. The workshop output could also be further improved by applying a structured expert assessment, such as by using the Delphi-survey approach (Linstone & Turoff, 1975).

6. Conclusion

This paper studied potential first mover groups for UAM services. Research findings of an in-depth literature review showed that business travellers and high-net-worth individuals are two feasible potential first mover groups. Main trends affecting these two customer segments are presented, such as cultural-specific travel requirements, the increase in luxury travel, or the changing work environment. Management implications, for factors such as infrastructure, vehicle size and performance or pricing are derived from findings of an expert workshop with nine mobility researchers. However, additional research is needed to characterize the two first mover groups further.

Acknowledgments

The authors would like to thank all experts who provided valuable input during the workshop in April 2019.

Appendix

Table 3: Workshop results with assigned UAM use case [one, two and/or three as described in Section 2]

	New work	Luxury travel	Cultural-specific travellers	MaaS, seamless travel, travel 3.0.	Enabling technologies
Infrastructure requirements	<ul style="list-style-type: none"> ▪ Adaption of network structure (direct connection to/from co-working space, office, site) [1,2] ▪ Fast processes (e.g. no or short security) [1,2,3] ▪ Cooperation with companies and co-working-spaces [1,2,3] 	<ul style="list-style-type: none"> ▪ Easy access (for elderly passengers) [1,2,3] ▪ Luxurious infrastructure (waiting lounges, shopping options) [1,2,3] ▪ Connection to points of interest in urban and rural areas and airports [1,2] 	<ul style="list-style-type: none"> ▪ Designated prayer areas [1,2,3] ▪ Gender segregation space [1,2,3] 	<ul style="list-style-type: none"> ▪ Hop-on and hop-off options [2] ▪ Easy connections to other modes (for transfer) [1,2,3] 	<ul style="list-style-type: none"> ▪ Data flow to other modes (e.g. on situational availability) [1,2,3]
Vehicle size and performance	<ul style="list-style-type: none"> ▪ Travel with 2 - 4 people [1,2,3] 	<ul style="list-style-type: none"> ▪ Low noise [1,3] ▪ High safety [1,2,3] ▪ Comfortable in-flight (flight stability) [1,2,3] 	<ul style="list-style-type: none"> ▪ Travel with groups of 5+ people [1,2,3] 	<ul style="list-style-type: none"> ▪ Emergency services [1,2,3] ▪ Efficient charging facilities / capabilities [1,2,3] ▪ Luggage: small to large transport items (e.g. bike, dogs) [1,2,3,] 	
Interior	<ul style="list-style-type: none"> ▪ Flying office / work options on board [1,2,3] 	<ul style="list-style-type: none"> ▪ Glass exterior (panorama) [1,2] ▪ Luxurious interior with high quality design features [1,2,3] ▪ Easy and barrier free vehicle access [1,2,3] 	<ul style="list-style-type: none"> ▪ Compass to Mecca [1,2,3] ▪ Gender segregation cabin [1,2,3] 		<ul style="list-style-type: none"> ▪ Comparable to autonomous ground vehicle design [1,2,3] ▪ Light weight materials [1,2,3]
Pricing	<ul style="list-style-type: none"> ▪ Comparable to taxi fares [2,3,] Monthly package pricing option [1,2,3] 	<ul style="list-style-type: none"> ▪ Pricing less important [1,2,3] ▪ Single ticketing offers in cooperation's with hotels and airlines [2,3,] 	<ul style="list-style-type: none"> ▪ Vehicle- and flight based pricing (not passenger based) for larger groups [1,2,3] 	<ul style="list-style-type: none"> ▪ Competitive fares [1,2,3] ▪ Overall ticket package [1,2,3] ▪ Single ticketing, single booking [2,3,] 	<ul style="list-style-type: none"> ▪ Dynamic pricing options related to current demand [2,3]
In-flight entertainment and services	<ul style="list-style-type: none"> ▪ Value-adding features (private or working-related features) [1] ▪ Wi-Fi on board [1] 	<ul style="list-style-type: none"> ▪ In-flight amenities [1] ▪ In-flight entertainment options [1] ▪ In-flight tourist information [2] 	<ul style="list-style-type: none"> ▪ In-flight entertainment options for children [1] ▪ Specialized services e.g. food, language [1] 		<ul style="list-style-type: none"> ▪ Advanced technology as enabler [1,2,3]
Seamlessness	<ul style="list-style-type: none"> ▪ High connectivity [1, 2,3,] 	<ul style="list-style-type: none"> ▪ Smooth transfer of people and luggage [1,3] 		<ul style="list-style-type: none"> ▪ Integration of UAM into overall transport system [2,3] ▪ Baggage forwarding and handling [1,3] 	
Personalization	<ul style="list-style-type: none"> ▪ Increased personalization compared to today [1,2,3] 	<ul style="list-style-type: none"> ▪ Personalized content (e.g. sightseeing flight) [2] ▪ Individualization (provide unique travel experience) [1,2,] 		<ul style="list-style-type: none"> ▪ On-demand [2,3] ▪ Use of smart device for personalization 1,2,3] 	<ul style="list-style-type: none"> ▪ Use of VR on-board [1] ▪ Customized services [1,2,3] ▪ People can use own devices [1,2,3]

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