Amsterdam Smart City & Amsterdam International Airport Management

Gaurav Bhatia

Module: International Logistics Management
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Lecturer: Prof. Dr. Markus Holz

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Abstract

With the ongoing technical revolution, new trends and technologies are changing the life and standard of living of people. From smartphones to TV, everything is coming with the tag of smart. At the same time, cities are experiencing a drastic evolution into the smart concept. Major cities in all the countries are trying to adapt to the standards of smart cities quickly and continuously. Hence numerous initiatives are being developed in the structure of the smart cities project. The concept of smart cities is perceived from six main areas that include Mobility, Government, Economy, Environment, People, and above all the living conditions of the people in a country which plays a significant role in the smart cities concept. This report is focused on the first area, i.e., "smart mobility" in Amsterdam due to the countries outstanding idea to integrate and optimize the entire inner-city logistics for the benefit of the people and the country as a whole. In this report, Transport and Logistics-related activities in Amsterdam are discussed. A survey with residents is done and data analysis on the survey is performed. SWOT analysis and benchmarking on the analyzed data is done. Lastly, recommendations based on the findings were outlined.

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1 Introduction

1.1 Smart Cities

From the beginning of Science fiction movies, TV shows, etc., forecasted imaginary cities which are heavily equipped with the latest technologies, distributed systems, devices connected remotely, and making decisions based on real-time data processing, is fast becoming a reality. Batty describes smart city as[1] "as a city in which ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies" (Batty et al. 2012). Other authors (Trindade et al. 2017) describes the smart city as an umbrella term which is made up of several subsets such as[2], "smart economy, smart urbanization, sustainable and smart environment, digitization, smart energy, smart mobility, and smart health all working in a synchronized manner for a common objective."

TU Vienna research also suggested that "due to fast economic and technological changes cities are facing growing competition for investors, tourists, distribution and consumption over the last decades has a substantial effect on city development."[3] This report also highlighted that competitive and effective strategic strategies are needed that will lead and develop cities into smart cities. In fact, The European Union commission also understands this need and already started various initiatives to develop effective strategies to mitigate the congestion due to increasing urbanization that hinders the development of smart cities. It is also worth noticing that recent research work states that "more than 50 % of the population expected to live in the metropolitan cities by 2050. This increasing population will also affect the people mobility as the majority of the population are daily commuters, who majorly relied on traffic management of the city.

Mackinsy's 2018 report on smart cities also suggested that Smart cities not only add digital intelligence to existing urban systems but also making it possible to do more with limited resources. Integration of applications provides real-time transparent information to users which helps them to make better decisions more accurately. These tools can be used to reduce the commuting time from one place to another for the citizens and making it more convenient for traveling purposes.It is to be noted that in smart cities the targets are not only people but also logistics and services.[4]

An efficient, compact, and friendly transport system is needed which can handle

[1]Batty, Michael, Kay W. Axhausen, Fosca Giannotti, Alexei Pozdnoukhov, Armando Bazzani, Monica Wachowicz, Georgios Ouzounis, and Yuval Portugali. "Smart cities of the future." The European Physical Journal Special Topics 214, no. 1 (2012): 481-518.

[2]Trindade, Evelin Priscila, Marcus Phoebe Farias Hinnig, Eduardo Moreira da Costa, Jamile Sabatini Marques, Rogério Cid Bastos, and Tan Yigitcanlar. "Sustainable development of smart cities: A systematic review of the literature." Journal of Open Innovation: Technology, Market, and Complexity 3, no. 3 (2017): 11.

[3]Giffinger, Rudolf, and Nataša Pichler-Milanović. Smart cities: Ranking of European medium-sized cities. Centre of Regional Science, Vienna University of Technology, 2007.

[4]Mckinsy Company Report, "MGI-Smart-Cities-Full-Report: SMART CITIES: Digital solution for a livable future," 2018, accessed on 24.07.2021 at 23:53.
https://www.mckinsey.com/business-functions/operations/our-insights/smart-cities-digital-solutions-for-a-more-livable-future

smart mobility on pillars of accessibility, innovation, safety, and affordability.[5]

1.1.1 Amsterdam Smart City

When it comes to mobility, Amsterdam's smart city is considered a leader in providing smart mobility. Being an early adapter, Amsterdam started implementing Smart cities strategies in 2008. [6] In 2016, Amsterdam was named as " European Capital of Innovation" by European Commission. Amsterdam is also famous for its innovative measures to support the environment. With the already present concept of smart parking, shared mobility, etc., it's interesting to see that 90% of citizens don't own their own parking space.[7] Amsterdam smart city project with effective mobility was made possible by the visionary Government, creative and supportive local population.[8]

Lewald stated that "the future idea to regarding smart city is the first aim at making mobility smarter and cleaner" [9] With a futuristic vision, Amsterdam is focusing to be emissions-free by 2025, with businesses and research initiatives focused on smart mobility & quickly changing the face of local transport. Cars, buses, and boats are all evolving into electric vehicles. As visionary steps, Amsterdam implemented that all taxis traveling from Amsterdam Airport Schiphol must be electric taxis only. Besides that, there are many pilot projects conducted in Amsterdam for many years with the aim to make the city with effective mobility with less pollution. The path to attaining a smart city is to aim towards the three principles: people, processes, and technology.

Amsterdam has also adopted a Climate program named New Amsterdam Climate to monitor the carbon dioxide level and save energy throughout the city. Such processes are involved only after evaluating the demands of the citizens of the city. And then later, smart technologies are implemented to improve the quality of life and create real economic opportunities. Other projects such as(Kourtit et al. 2017) vehicle 2 grid are also being implemented which aims to store energy for later use with the help of Electric cars.[10]

[5]COMM/DG/UNIT, "Smart Cities - Digital Single Market - European Commission", accessed on 21.07.2021 at 23:20.
https://digital-strategy.ec.europa.eu/en/policies/smart-cities-and-communities

[6]Bee smart city - AMSTERDAM SMART CITY: A WORLD LEADER IN SMART CITY DEVELOPMENT, accessed on 23.07.2021 at 13:09.
https://hub.beesmart.city/city-portraits/smart-city-portrait-Amsterdam

[7]Smart mobility in Amsterdam, accessed on 24.07.2021 at 16:15.
https://www.iamsterdam.com/en/business/key-sectors/smart-mobility

[8]Arup specialist and communication team, "Arup Smart Cities", 2010, accessed on 24.07.2021 at 23:31
https://www.arup.com/perspectives/publications/research/section/smart-cities

[9]Lewald, A. (2017). Unlocking Mobility's Potential. How to Make Mobility Smarter and Cleaner. World News – Climate Change The New Economy. Retrieved from http://climatechange-theneweconomy.com/sustainable- transport-kapsch/, accessed on 24.07.2021 at 23:36

[10]Kourtit, Karima, Peter Nijkamp, and Roger Stough. "Foreword: Digital support tools for smart cities." Socio-Economic Planning Sciences 100, no. 58 (2017): 1-2.

2 Background

2.1 Transport related activities in Amsterdam

With a population of 1,157,519 located in 219 kmsq[11], Amsterdam has a well-organized & structured transportation system that not only ensures swift mobility but also a smooth movement of goods and services. As a tourist destination, the city attracts 19 million tourists every year[12].

The Amsterdam Metro system was first implemented in 1977 with 4 lines of which 3 of the metro lines begin their journey from the central station operated by GVB. With 52 stations, the Metro controls major areas within Amsterdam, as well as the surrounding towns that include Amstelveen, Diemen, and Ouder-Amst. There are 16 tram routes in total where line 5 is the busiest tram line which provides one an interesting way to around the city and also runs regularly until 12:15 am. The entire countries total parking capacity for vehicles is 4,454 located at 10 various centers in the country[13]. Total bicycles used are 881,000 footnoteAmsterdam portal for information, "Amsterdam Bike rentals", accessed on 26.07.2021 at 10:30, https://www.amsterdam.info/transport/bike-rentals/ with 7 ferries that commute people through and along the Amstel river. It's also worth noticing that 21% of the newly registered vehicles in 2020 were Electric Vehicles[14] . According to a report by Crow, "In 2020, the Netherlands had 730,000 people making use of shared cars, which is a 42% increase compared to 2019 when there were still 515,000 users "[15].

2.2 Logistics Management in Amsterdam

Amsterdam airport is the third-busiest airport in the world and hosted around 72 million passengers in 2019. Due to such a large influx, it is also considered the busiest in Europe in terms of aircraft movements. Similarly, in 2019, Amsterdam airport becomes the 4th busiest airport in Europe was With an annual cargo tonnage of 1.74 million respectively. The statistics clearly depict that Amsterdam airport is playing a major role in logistics activities not only in Europe but also in the world[16].

Amsterdam also has two seaports, the ports of Rotterdam and Amsterdam. The cities port region ships over 97 million tons of cargo per year. Both the ports are very well connected to an extensive network of road, rail, waterways, and

[11]World population review, "Amsterdam Population", accessed on 26.07.2021 at 09:56 https://worldpopulationreview.com/world-cities/amsterdam-population

[12]Statista Research Department, Tourism in Amsterdam - Statistics and Facts, accessed on 26.07.2021 at 10:04.
https://www.statista.com/topics/6025/tourism-in-Amsterdam/

[13]Amsterdam portal for information, "Amsterdam Transportation", accessed on 26.07.2021 at 10:22, https://www.amsterdam.info/transport/

[14]Next web news, "21% of newly registered Dutch cars are EVs — here's how that happened", accessed on 26.07.2021 at 10:36.
https://thenextweb.com/news/newly-registered-netherlands-cars-are-evs-syndication

[15]Dutch review, "Car sharing in the Netherlands is on the rise: here's why it should continue", accessed on 26.07.2021 at 10:40.
https://dutchreview.com/expat/car-sharing-netherlands/

[16]2019, Annual Report. Amsterdam: Schiphol group,accessed on 26.07.2021 at 15:31 https://www.schiphol.nl/en/schiphol-group/page/annual-reports/

pipelines. Besides, that specialized service providers and strong IT backbone are the pillars of support that ensures optimized delivery of goods and service. The countries logistics board also ensure that goods and service are transported are clean, smart and faster manner.[17]

Amsterdam Logistics board also suggested that "As a logistics hub located in the strategic and central part in Europe, it easy to ensures excellent, congestion-free connections to other European markets by inland, rail, waterways, and road by supporting for receiving. handling, storing, processing and transshipping all types of goods effectively".[18] With more than 108 different airlines, Schiphol Airport provides 327 flight across the world and provide easy access to the most European nation, for travelers and cargo. [19]

Recently, Uber also launches its freight app in Amsterdam. The main aim of the app is to provide users (both consumers and suppliers) with leading technology, greater transparency, and more opportunity. The app works in a similar manner as Uber works for its taxi services. In addition, it gives truck drivers steady access to work while providing companies with a range of experienced professionals who are ready to handle their logistics needs. "The transfer of goods can also be monitored in real-time, making it easier for businesses in the country to send and receive items without expensive delays as well as facilities the handle, process, store and transship all kinds of goods".[20]

3 Research Objective

This research report focuses on Smart mobility in the city of Amsterdam with an analysis on Sustainable & Accessible Interconnectivity. The study analyzes the available facilities for people in terms of transportation & mobility. This shall further try to figure out the logistics-related activities and local's opinions on the same. Lastly, it provides recommendations with respect to research findings to help the city develop holistically.

3.1 Research Methodology

The research methodology is developed into three parts. In the first part, an in-depth analysis of the logistics and mobility of Amsterdam city is studied. Here a depth analysis of the flow of persons, logistics, etc., was discussed. In

[17] Amsterdam portal for information," Amsterdam logistics sector is booming", Accessed on 26.07.2021 at 15:38.
https://www.iamsterdam.com/en/business/news-and-insights/news/2017/why-the-Amsterdam-logistics-sector-is-booming

[18] "Amsterdam Logistic Board aims for smarter, cleaner and faster cooperation," accessed 26.07.2021 at 16:22
https://www.portofamsterdam.com/en/news-item/amsterdam-logistic-board-aims-smarter-cleaner-and-faster-cooperation, page 33

[19] "Port of Amsterdam, Port of partnerships — I Amsterdam," accessed 26.07.2021 at 17:12
https://www.iamsterdam.com/en/business/why-amsterdam/usp-connectivity/port-of-amsterdam

[20] Amsterdam publications, "Uber Freight cruises into Netherlands — I Amsterdam," accessed27.07.2021 at 13:40
https://www.iamsterdam.com/en/business/news-and-insights/news/2019/uber-freight-cruises-into-the-netherlands

the second part, an online survey is conducted with people living or visiting Amsterdam. Both open-ended and close-ended questionnaires would be used. Lastly, in the third part, the evaluation from external sources was discussed. Here a comparison with another European smart city of Stockholm, Sweden is done.

3.2 Data collection

Data collection was obtained using the Facebook users group which includes "Expat Republic Amsterdam" & " Indians in Amsterdam " respectively.The questionnaire is made up of a total of 7 questions mainly focus on a major aspect of logistics-wise activities in Amsterdam include convenience, accessibility, and sustainability. A total response of 31 people was collected when the survey was left open for 24 hours.

4 Data analysis of the results

31 responses were collected in 24 hours where 78% Residents and 22% were Tourists. The survey was focused on connectivity, connections, punctuality, information, and experience.

4.1 Transportation Modes

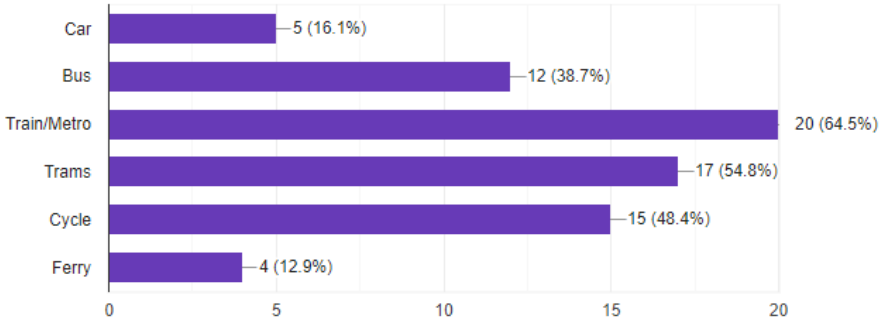


Figure 1: Preferred Transportation Modes

Figure 1 illustrates the survey results for a common mode of transportation in Amsterdam. Here users can choose multiple options which they preferred or usually use as a mode of transportation. 65.5% people voted that they use Trains and Metros as a proffered mode of transportation. Similarly, people traveling inside the city have a preference for trams followed by cycles. 12% users admit they also use Bus as a mode of communication. Lastly, Ferry was mostly used by tourists and visitors as a mode of communication and by locals only at times of need.

4.2 Transport connectivity in Amsterdam

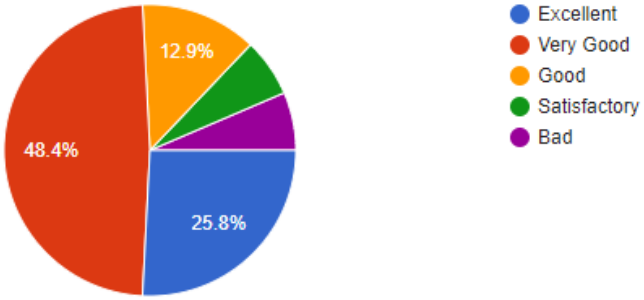


Figure 2: Transport Connectivity in Amsterdam

Figure 2 describes people's opinions on the connectivity of transport in Amsterdam. With 48% people consider the connectivity to be very good, 26% believe it is excellent. Together counted reach to 74% people who consider the connectivity as top-notch. It also to be noted that many people consider it under good and satisfactory, but there are 7% people who found it bad. Early shut down of buses and trams at night can also be one of the reasons for this review.

4.3 Punctuality of Public Transport

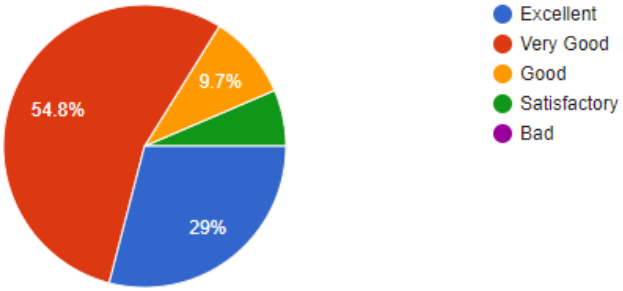


Figure 3: Punctuality of Public Transport in Amsterdam

Regarding Punctuality, 29% of people find the transportation facilities in time. Also, a major portion of 55% founds transportation facility to be very good. This high level of punctuality in public transport shows the high efficiency in traffic management. With punctual local transport, other travelers with cars, cycles, etc., also found it easier to travel by less congestion on the road. Besides that punctuality also highlighted that the city transportation system is very well connected with high quality of smart traffic management technologies.

4.4 Information on Transport Services

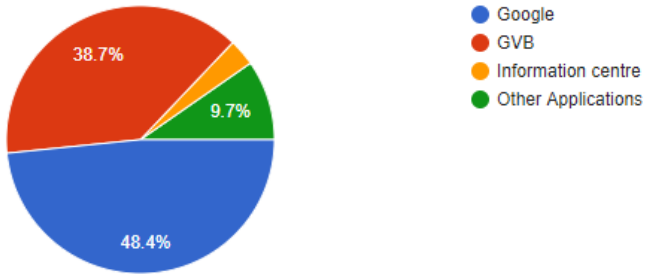


Figure 4: Information about Transport Services in Amsterdam

Figure 3 shows the data about from where people find information about the connectivity in the city.48% people said that they refer to google to check connectivity between 2 places. It gave them a fair idea on google maps that how to commute, traffic status, and real-time status of the streets. With 39%, the GVB app is the second preference of the residents. The GVB app is available for android and ios. There are many benefits from the GVB app such as "a user can see the difference in CO2 emissions from travel by public transport compared to an average car. Users can also Sign up for push notifications to receive up-to-the-minute notifications of any service disruptions with Up to date information on detours and disruptions. It also provides real-time departure and arrival information."[21] Besides that they are certain people who are mostly tourists and thus rely on info points to get the information.

4.5 Goods delivery experience

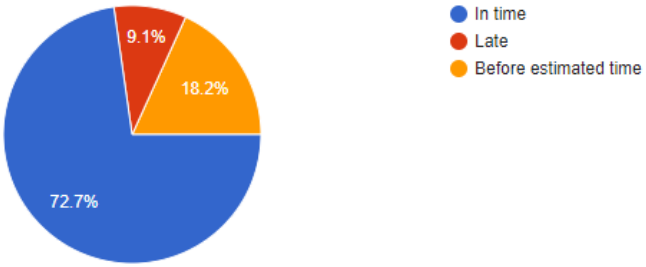


Figure 5: Goods Delivery Experience in Amsterdam

Figure 4 describes the goods delivery experience in the city. for instant food delivery services were selected with the aim was to see the real-time traffic congestion. 72% say they received food well in time, whereas 19% admit they received it before the estimated time. This makes the accuracy of around 91% and thus cross-verification of traffic congestion in Amsterdam can be verified.

[21]IAMAMSTERDAM: GVB app accessed on 20.07.2021 at 21:24
https://www.iamsterdam.com/en/plan-your-trip/practical-info/amsterdam-apps/gvb-app

It's also worth noting that for food delivery, E scooters are used and with a 90% delivery in time, it's worth noticing that E-bikes are running successfully in the streets without congestion.

5 SWOT Analysis

STRENGTH	OPPORTUNITIES
• Very good connectivity in mobility and logistics • Zero pollution is transportation control. • Well connected to all the European Countries. • Perfect integration of latest technologies in the management of transport & logistics. • Leading market for cargo transport via rail	• Electric vehicles growth and support • Sharing and rentals of bikes • Mission to reduce carbon emission in logistics to zero • Better advanced connectivity between airport and trains • Multi floor parking, Partnerships & Advanced traffic management
WEAKNESS	**THREATS**
• Under construction projects • Parking issues • Expensive travel cards & Tickets.	• Adverse climate condition • Proposed transportation cap in tourism might decrease revenue. • Budget cut

Table 1: SWOT Analysis of Amsterdam Smart City

SWOT analysis of Amsterdam smart city discuses the main points in Strength, Weaknesses, Opportunities and Threats. Many recent reports also suggested that "Despite the economic crisis hitting Europe, Amsterdam has recently recorded an increase in tourism. Huge investments have been made in order to obtain more business from the travel industry, but there are still some obstacles Amsterdam must overcome".[22]

[22]Eurometer Research Blog:"Amsterdam SWAT Analysis", accessed on 28.07.2021 at 16:46 https://blog.euromonitor.com/amsterdam-swot-analysis/

6 Benchmarking

With ambitious projects like going carbon neutral by 2045, climate positive by 2040, etc., Stockholm was named as the smartest city in the world.[23]

Stockholm is a member of the Growsmarter EU project which brings together" cities and industries to develop and spread twelve smart city solutions in energy, infrastructure, and transport sector. This is a long-term vision project and a part of the City's vision is aimed to reach the goal of becoming the world's smartest city by 2040."[24]

Municipal cooperation of Stockholm is also contributing effectively in this project by managing and optimizing the city's vehicle fleet and transportation."Gatubolaget offers and assists Stockholm management and municipal organizations leasing of electric and renewable fuel vehicles consist of cars, vans, trucks, small buses, and bikes running on electricity to improve their transportation system in the city."[25]

Stockholm is focused on 6 areas to build sustainable and smart mobility in the city. These are Biofuels, Cycling, Electrification, Geofencing, Public Transport, and Shared transport. Stockholm suggested that "In order to build smart and sustainable cities, different processes and functions need to work in harmony with each other. Still, each building block is complex in itself."[26]

7 Recommendations

Since 2009, the Amsterdam Smart City has facilitated over 80 pilot projects aimed at making the city smarter. In one early program, the Department of Research and Statistics went directly into individual government departments in the capital and access data directly.[27] Based on analysis and research there are certain recommendations that can be useful in the further development of the smart city. There are:

Focus and Support for Electrical Vehicle: As researched, the Registration of Electric Vehicles (EV) is increasing in numbers every year in Amsterdam. Im-

[23]Smart city Sweden:"Stockholm named world's smartest city", accessed on 29.07.2021 at 21:28
https://smartcitysweden.com/stockholm-named-worlds-smartest-city/

[24]Anna M Pozdnikova, "Smart city strategies "London-Stockholm-Vienna-Kyiv": in search of common ground and best practices," accessed on 29.07.2021 at 21:31, https://www.researchgate.net/publication/326126374$_Smart_city_strategies_London$ $-$ $Stockholm-Vienna-Kyiv_in_search_of_common_ground_and_best_practices$

[25]smart city sweden, "The Smart City Tour — Visit Programs - Smart City Sweden," accessed on 29.07.2021 at 21:37, https://smartcitysweden.com/visit-programs/81/the-smart-city-tour/

[26]Smart city Sweden: "Stockholm named world's smartest city", accessed on 29.07.2021 at 21:28
https://smartcitysweden.com/stockholm-named-worlds-smartest-city/

[27]Towards data science: 8 Years On, Amsterdam is Still Leading the Way as a Smart City, accessed on 28.07.2021 at 10:11
https://towardsdatascience.com/8-years-on-amsterdam-is-still-leading-the-way-as-a-smart-city-79bd91c7ac13

plementing Smart Grid technology among neighbors will help in providing clean and shared energy to charge an electric vehicles with. The solar cells on the roof will not only support the energy demands for the houses and also encourage more people to shift for EV.

Advanced Traffic Management System needs to be implemented. With advanced technologies like IoT, Real-time Data Analysis, Machine Learning, etc., City traffic management can be synchronized with the navigation system of the car. It will help to optimize the traffic flow in the city and also help users to save time, fuel, or energy. To add, it will also improve the traffic congestion and reduce the number of accidents in the city.

Multi Floor Automatic Smart parking: Taking inspiration from China, an advanced multiple parking system can be implemented. Many variants like push automatic multi-floor parking system, multi-layer parking, the advance rotary system, floor tower parking, hydraulic lift stacker elevator etc[28]

8 Conclusion

Examining the Amsterdam smart city from a logistics and mobility point of view, it's very clear that free flow of people, goods, information, and services are major pillars for Logistics and Mobility in the Smart City. Our research survey also suggested that currently, Amsterdam is doing great efforts in driving smart mobility in the right direction. After analyzing and researching with other smart cities like Amritsar and Stockholm, few suggestive measures are also proposed which can help Amsterdam smart city to improve and grow with their vision and keep improving citizens life and contribute to the environment more smartly in the future.

[28] AMRITSAR SMART CITY LIMITED: "Fully Automatic Multilevel Car Parking at Kairon Market, Amritsar", accessed on 28.07.2021 at 14:22
https://www.smartcityamritsar.com/files/tenders/file-42.pdf.mentioned technologies are suitable for both commercial and residential purpose and implementing them will for sure improve the

References

Batty et al. 2012
Batty, Michael; Axhausen, Kay W.; Giannotti, Fosca; Pozdnoukhov, Alexei; Bazzani, Armando; Wachowicz, Monica; Ouzounis, Georgios; Portugali, Yuval: Smart cities of the future. In: *The European Physical Journal Special Topics* 214 (2012), Nr. 1, pages 481–518

Bilotkach 2015
Bilotkach, Volodymyr: Are airports engines of economic development? A dynamic panel data approach. In: *Urban Studies* 52 (2015), Nr. 9, pages 1577–1593

Bouyakoub et al. 2017
Bouyakoub, Samia; Belkhir, Abdelkader; Bouyakoub, Fayçal M.; Guebli, Wassila: *Smart airport: an IoT-based airport management system.* In: *Proceedings of the International Conference on Future Networks and Distributed Systems*, 2017, pages 1–7

Kourtit et al. 2017
Kourtit, Karima; Nijkamp, Peter; Stough, Roger: Foreword: Digital support tools for smart cities. In: *Socio-Economic Planning Sciences* 100 (2017), Nr. 58, pages 1–2

Neubauer 2011
Neubauer, Regina: *Business models in the area of logistics: in search of hidden champions, their business principles and common industry misperceptions.* Springer Science & Business Media, 2011

Siddiqui 2019
Siddiqui, Fahad M.: *Digital Transformation of Modern Airports by Exploiting Fog as a Service Model.* In: *2019 Integrated Communications, Navigation and Surveillance Conference (ICNS)* IEEE, 2019, pages 1–11

Trindade et al. 2017
Trindade, Evelin P.; Hinnig, Marcus Phoebe F.; Costa, Eduardo Moreira d.; Marques, Jamile S.; Bastos, Rogério Cid; Yigitcanlar, Tan: Sustainable development of smart cities: A systematic review of the literature. In: *Journal of Open Innovation: Technology, Market, and Complexity* 3 (2017), Nr. 3, pages 11

Yuan et al. 2010
Yuan, Xue-Ming; Low, Joyce M.; Tang, Loon C.: Roles of the airport and logistics services on the economic outcomes of an air cargo supply chain. In: *International journal of production economics* 127 (2010), Nr. 2, pages 215–225

9 Report II: Amsterdam International Airport Management

Abstract

With the ongoing technical revolution, new trends and technologies are changing the life and standard of living of people. The aviation industry is also experiencing that more and more people want to travel around the globe and thus airports are trying their level best to meet with the advancement in technical aspects at airports and increase in the quality of services. In this report, the Transport of passengers and Logistics-related activities in Amsterdam airport are discussed. A survey with passengers is done and data analysis on the survey is performed. SWOT analysis and benchmarking on the analyzed data are done. Lastly, recommendations based on the findings were outlined.

10 Introduction

10.1 Smart Airport

Airports always play a major role in region development(Bilotkach 2015). Airports provide facilities to the passengers such that they arrive at the final destination in time while providing them a pleasant experience during their stay.[29] Operation of airports is integrated with many business operations such as baggage handlers, food and beverages, fuel suppliers and many other third-party service providers Airport provides passengers facilities like to get refreshments, food and also different shopping options to utilize the time while waiting.[30] Besides certain facilities, the main thing which matters the most is how much time a passenger has to spend in the airport? Is it still worth spending a huge amount of time in order just to outboard a travel? This research report tries to highlights that how airports can increase smart airports facilities by taking a case study of Amsterdam airport.

The main objective of introducing the smart airport concept is to notify the whereabouts of the passengers in real-time and keep them informed about the activities related to the airport facilities(Bouyakoub et al. 2017)." The future vision of a smart airport can be achieved using by digitizing the whole airport chain. This can be done by using the latest technologies like the Internet of Things (IoT) and Cloud Computing."[31]

Researchers also suggested including Cloud Computing services more efficiently to integrate and increase the efficiency of different services. Siddiqui (Siddiqui 2019) suggested that integrating all the services via cloud formation must be an objective. The Author also suggested "A proper architecture for a smart airport includes a mobile app, self-service kiosks, integration of IoT and RFID to identify the luggage through the t*ag on it, which is sufficient to receive complete information about the passenger. The architecture lies under a single host and accessible to all the employees."[32].

For constant improvement inefficient management of the airport, the smart airport must have long-term strategies and different agendas which are based on key performance indicators. Major KPI's suggested in research are sustainability, security, networking, and punctuality There are also several other indicators such as waiting time for check-in, gate allocations, baggage mishandling (lost, broken), etc. [33]

[29]Bilotkach, Volodymyr. "Are airports engines of economic development? A dynamic panel data approach." Urban Studies 52, no. 9 (2015): 1577-1593.

[30]Mathieu B. Russell Pell, "Airport Digital Transformation," accessed on 28.07.2021 at 22:00 https://amadeus.com/documents/en/airports/research-report/airports-digital-transformation.pdf.

[31]Bouyakoub, Samia, Abdelkader Belkhir, Fayçal M'hamed Bouyakoub, and Wassila Guebli. "Smart airport: an IoT-based airport management system." In Proceedings of the International Conference on Future Networks and Distributed Systems, pp. 1-7. 2017.

[32]Siddiqui, Fahad Masood. "Digital Transformation of Modern Airports by Exploiting Fog as a Service Model." In 2019 Integrated Communications, Navigation and Surveillance Conference (ICNS), pp. 1-11. IEEE, 2019.

[33]Ricondo Associates et al., Strategic Planning in the Airport Industry (Transportation Research Board, 2009).,p.108, accessed on 29.07.2021 at 08:33

In order to make a good experience for passengers, the airport management must analyze and improvise some important factors. For example, the number of passengers travels every day, average waiting time, the number of operating security used in a day,etc.[34]On the other hand Regina B stated that(Neubauer 2011)"Logistics investigate and optimize the processes in individual subsystems of the integrated logistics system of the airport and brings all the operations together."[35] Sharing of information is very essential for effectiveness and efficiency while transferring logistics(Yuan et al. 2010). Therefore, In airport operations, the methods of progressive management and applied logistics must be implemented.[36]

10.2 Amsterdam Smart Airport

Amsterdam airport is the third-busiest airport in the world and hosted around 72 million passengers in 2019. Due to such a large influx, it is also considered the busiest in Europe in terms of aircraft movements. Similarly, in 2019, Amsterdam airport becomes the 4th busiest airport in Europe was With an annual cargo tonnage of 1.74 million respectively. The statistics clearly depict that Amsterdam airport is playing a major role in logistics activities not only in Europe but also in the world[37].

Amsterdam Schiphol or AMS consists of eight piers, where 7 of them are interconnected with 3 halls inside them. Separate sections for Schengen and non-Schengen are made to differentiate between the European passport holders and non- Europeans, which made the process of immigration faster. 15 boarding gates, and 6 runways, make Schiphol airport one of the busiest airports in Europe. With approximately 301 destinations to take off, the flights fly across three continents- North America, Asia, and Europe. Schiphol Plaza is centrally located in between all 3 halls in the airport which is an act of revenue through shopping and attracting tourists in buying the souvenirs of the city.[38]

Schiphol airport provides several facilities for the passengers such as web checking and self-baggage drop counter. It not only saves time for passengers but helps them plan their journey with limited time before the flight. Also, Schiphol is up with the construction of a pier with a total number of 8 gates which was about to be finished by 2020, but due to the Corona pandemic extended for some more time. With such developments, Passengers will feel more comfort-

https://crp.trb.org/acrpwebresource2/wp-content/themes/acrp-child/documents/028/original/$ACRP_20_Strategic_Planning_in_the_Airport_Industry.pdf$

[34]Targit, "6 Most Important KPIs for Airport Operations," accessed on 29.07.2021 at 12:50 https://www.targit.com/en/blog/2017/09/best-airport-kpis.

[35]Neubauer, Regina. Business models in the area of logistics: in search of hidden champions, their business principles, and common industry misconceptions. Springer,2011.

[36]Yuan, Xue-Ming, Joyce MW Low, and Loon Ching Tang. "Roles of the airport and logistics services on the economic outcomes of an air cargo supply chain." International journal of production economics 127, no. 2 (2010): 215-225.

[37]2019, Annual Report. Amsterdam: Schiphol group,accessed on 26.07.2021 at 15:31 https://www.schiphol.nl/en/schiphol-group/page/annual-reports/

[38]Amsterdam Airport- AMS Airport, "Guide to Amsterdam Airport Schiphol," accessed on 29.07.2021 at 12:17, https://www.airport-ams.com/.

able while traveling.[39]

11 Passenger Value Chain at Schiphol

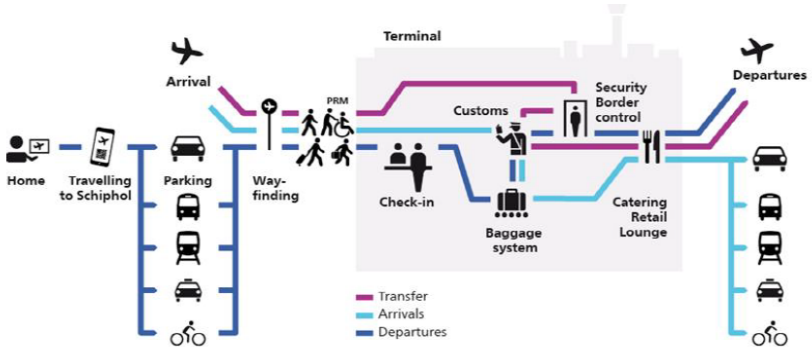


Figure 6: Passenger Value Chain[40]

11.1 Passenger and Security Process

The passenger value chain is shown in figure 6. A passenger can use either the option for web check-in and use the Schiphol app to navigate. The airport can be reached easily and is well connected to various modes of transport. The airport is divided into three parts, passengers, arrivals, and transit passengers. The airport is very well equipped with signs and banners to help passengers in proper navigation. Passengers for departures can go to the airline desk and drop the luggage or drop it at self-checking counters. The luggage went to customs and meanwhile Immigration check is done at security border control. After that passengers have Chanced to dine in or shop at the airport lounge. When boarding begins, usually passengers are carried with minibusses to the aircraft. On the other hand, passengers who are arriving have to pass through Border Security forces, then to customs and after that they can eat at a lounge or exit the airport. Proper services like buses, taxis and private parking are available.

For tracking the tray during the security checks, the "Automatic tray dispenser on the conveyor is embedded with RFID chip so that the tray can be tracked and scanned. Furthermore, the auto clear software enables to detection of items that could be a threat and remove the scanning of safe items. The diverter separates the traced and untraced cabin baggage. The passenger goes through the security scan, and in some cases, re-screening is also executed separately if any suspicious object is identified."[41]

[39]Schiphol Airport - New Projects , Accessed on 29.07.2021 at 13:09 https://www.schiphol.nl/en/projects/page/project-new-pier/

[40]Royal Schiphol Group, "2018 Annual Report",p.20, accessed on 29.07.2021 at 16:06

[41]Louwerse Ron, "Schiphol Security Service the New Approach in Aviation Security," 2014, accessed on 29.07.2021 at 18:24, https://www.icao.int/Meetings/SIAS/Documents/Presentations/.pdf.

11.2 Digitalized services available at Schiphol

There are certain digitalized services available at Schiphol to make passengers' experience more easy and more time-saving. Certain facilities like Online Checking allows passengers to check-in 24 hours prior to the flight. At the airport also passengers can drop the luggage and go directly to the check-in counter.Schiphol also support electric vehicles and certain charging point facility is available at the parking spots, which also encourage passengers to shift more towards EV.

Schiphol also uses the latest techniques for the safety of all traveling passengers.The seamless flow project was launched in Amsterdam in 2019 which helps passengers to save time by not showing their passport and boarding passes at every checkpoint. Biometrics and facial recognition are automatically verified at different checkpoints and thus making seem less, hassle-free and safe experience for passengers.[42]

Schiphol Border control is also well equipped with the latest technology. They use harmless millimeter wave technology to detect all objects with passengers. Lastly, Advanced bird detection is installed by using radar stations and thus ensuring flight safety for passengers.

12 Research Objective

This research report focuses on Smart mobility within the Schiphol Airport of Amsterdam with an analysis on Accessibility, Inter-connectivity & Time Management. The study analyzes the available facilities for people in terms of smooth and fast mobility. This shall further try to figure out the logistics-related activities and local's opinions on the same. Lastly, it provides recommendations with respect to research findings to help the airport develop holistically.

12.1 Research Methodology

The research methodology is developed into three parts. In the first part, an in-depth analysis of smart airports and facilities related to Amsterdam Amsterdam is studied. Here a depth analysis of facilities and technologies already implemented and can be further used were discussed. In the second part, an online survey is conducted with people living or visiting Amsterdam. Both open-ended and close-ended questionnaires would be used. Lastly, in the third part, the evaluation from external sources was discussed. Here a comparison with another European smart airport of Stockholm, Sweden is discussed.

12.2 Data collection

Data collection was obtained using the Facebook users group which includes "Air Bubble Europe " respectively.The questionnaire is made up of a total of 9 questions mainly focus on major aspects of Airport wise activities in Amsterdam includes convenience, accessibility, and sustainability. A total response of

[42]Schiphol launches pilot for boarding by means of facial recognition, accessed on 29.07.2021 at 18:45, https://news.schiphol.com/schiphol-launches-pilot-for-boarding-by-means-of-facial-recognition/

22 people was collected when the survey was left open for 24 hours.

13 Data analysis of the results

22 responses were collected in 24 hours where 88% Residents and 12% were Tourists. The survey was focused on punctuality, information, and experience.

13.1 Check in Service

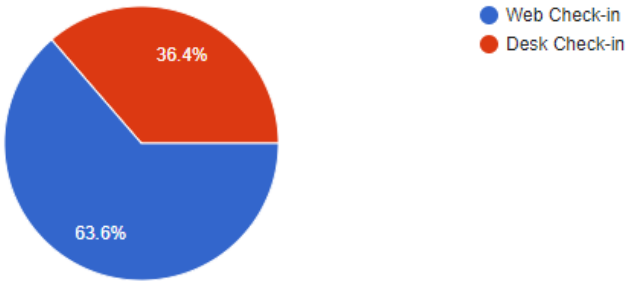


Figure 7: Transport Connectivity in Amsterdam

Figure 7 describes people's choice on choosing web check-in versus desk checking while traveling via Schiphol. among them, 64% of people choose Web check-in and 36% opted for desk check-in. One of the many reasons highlighted in the survey is that web check-in always saves time and is convenient. Also, around 48% of people said they travel at least once from the airport every year. It's also interesting to see that people admit that they usually come to the airport for more than 2 hours time so that they can not miss the flight. Even 31% said that they come to the airport even three hours before.

13.2 Tracking updates

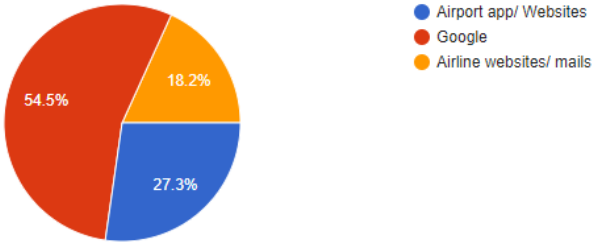


Figure 8: Applications used for tracking flight updates

Regarding updates, Figure 8 shows 54% of people rely on updates on google to track the status of the flight. 27% people rely on Airport apps and websites while 18% still rely on updates from the airline's websites, emails, etc.

13.3 Baggage Experience

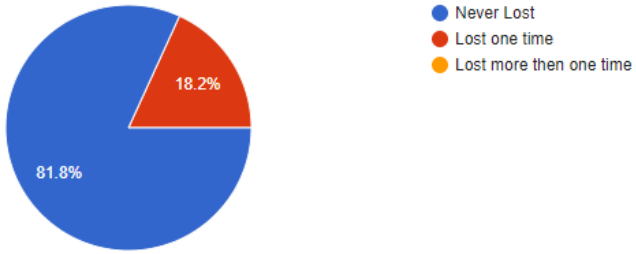


Figure 9: Baggage experience at Amsterdam Airport

Figure 9 shows that 82% people have good experience with the baggage claim and they never lost any of the baggage. On the other hand, there are people who lost their baggage at least once. There were other options like lost baggage more than two times were there which no one has opted for in the survey. Also, the condition of luggage is not discussed in the survey, and only lost or not lost are surveyed.

13.4 Navigation to the Gate

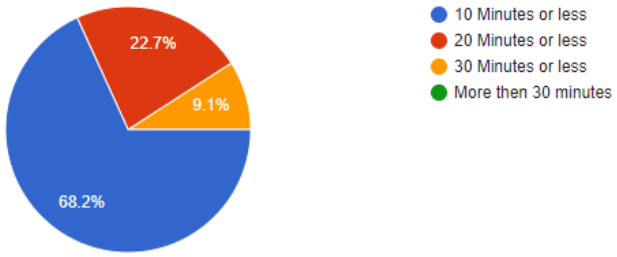


Figure 10: Time needed to locate the gate

Figure 10 describes the time taken by passengers to locate their boarding gate. 68% people take 10 minutes or less to locate their flight gate. 22% says that they need more than 10 minutes but less than or around 20 minutes to find the gate. 9% people say they need more than 20 minutes and 30 minutes or less to find the gate. However, no one says they need more than 30 minutes to find the boarding gate.

14 SWOT Analysis

STRENGTH	OPPORTUNITIES
• Located in the centre of the Amsterdam city. • Aviation & Non-Aviation activities • Well connected to all the European Countries • Perfect integration of latest technologies in the management of transport & logistics.	• Use of AI, Data Engineering, IOT technologies to enhance. • Collaborations & Networking • Connecting International Trains directly to the Airport • Better advanced connectivity between airport and trains
WEAKNESS	**THREATS**
• Under construction projects • Crowded Airport • Old and small infrastructure.	• Proposed transportation cap in tourism might decrease revenue. • Heavy competition from other Smart Airports. • Cyber Attacks

Table 2: SWOT Analysis of Amsterdam Airport

SWOT analysis of Amsterdam Schiphol airport discusses the main points in Strengths, Weaknesses, Opportunities, and Threats. Many recent reports also suggested that "Despite the economic crisis hitting Europe, Amsterdam has recently recorded an increase in tourism. Huge investments have been made in order to obtain more business from the travel industry, but there are still some obstacles Amsterdam must overcome".[43]. This news shows that there are chances of traffic increase at the airport. Amsterdam also needs to enhance its services at the airport. Certain factors added to the strength like adapting new technologies, visionary management, etc., while AI, IoT, etc., latest technologies bring in more opportunities to enhance the technological infrastructure of the airport. While being a crowded airport with old and Small infra, there will always chance of cyberattacks at the airport and thus the management needs to be well prepared for the same.

[43]Eurometer Research Blog: "Amsterdam SWAT Analysis", accessed on 28.07.2021 at 16:46 https://blog.euromonitor.com/amsterdam-swot-analysis/

15 Benchmarking

	CITY	INTERNATIONAL AIRPORT	CONNECTIVITY	FACILITIES	ENTERTAINMENT	STRESS	FINAL SCORE
1	Madrid, ES	Adolfo Suárez Madrid–Barajas Airport (MAD)	89.9	79.95	96.28	63.25	100.00
2	Rome, IT	Leonardo Da Vinci–Fiumicino Airport (FCO)	48.9	83.96	96.27	42.38	93.40
3	Amsterdam, NL	Amsterdam Airport Schiphol (AMS)	68.1	86.22	83.99	41.80	90.40
4	Copenhagen, DK	Copenhagen Airport Kastrup (CPH)	100.0	67.17	81.06	74.55	87.00
5	Moscow, RU	Sheremetyevo Int. Airport (SVO)	44.9	69.92	100.00	33.53	85.70
6	Helsinki, FI	Helsinki Airport (HEL)	60.5	87.97	63.42	80.25	84.00

Table 3: Airports Comparison in Europe[44]

Table 3 shows the bench-marking results of Amsterdam airport with other leading airports in Europe. The table provided by Omio shows the most passenger-friendly airports in Europe. They stated that "A customer-friendly airport can offer great relief for travelers, especially when airports are readily equipped to make the waiting time between flights as enjoyable and comfortable as possible."[45] They opted flight connectivity, punctuality, entertainment, and stress as main factors for the calculation.

Besides, this comparison, this report will benchmark the Amsterdam airport with Changi Airport in Singapore so that few ideas about what other smart airports are doing differently can be observed.

15.1 Changi Airport, Singapore

With 363 thousand flights and 1.97 Million tonnes of air fright movement in 2019, makes Changi Airport is among one of the busiest airports in the world. With a reach to 400 cities and more than 100 countries, the airport is very well connected with the world.

In terms of Smart Airport, Terminal 4 of the Changi Airport is embedded with self-service facilities and thus produces a hassle-free environment. Major services like self-drop luggage, immigration, use of biometrics are mostly automated. The quantity of technological machines includes 18 Immigration gates, & approximately 46 boarding gates. The computed tomography technique made the security check hassle-free with the 3D screening at the security checkpoint. Now the passengers do not need where the items such as laptops, power banks & other electronic devices to be kept out in the tray, and thus saves time and

[44]Omio: "Stress-free Travel: The Most Convenient European Capital Airports", accessed on 29.07.2021 at 15:44
https://www.omio.com/airports

[45]Omio: "Stress-free Travel: The Most Convenient European Capital Airports", accessed on 29.07.2021 at 15:44
https://www.omio.com/airports

energy of passengers and make security check stress free.[46]

The automatic Tray system helps to tackle tact time, the tray system enables two passengers to be checked at the same time, thus speeding up the process.[47] Similarly, The airport shows its efforts for sustainability by implanting more than 26 charging points for the baggage carriers. "These carriers travel in and around the area, as well as load and unload baggage from the airplane. 80 electric baggage carriers use these charging points, saving about 627 tons of carbon dioxide emissions in the atmosphere."[48]

16 Recommendations

Since 2009, the Amsterdam Smart City has facilitated over 80 pilot projects aimed at making the city smarter. In one early program, the Department of Research and Statistics went directly into individual government departments in the capital and access data directly.[49] Based on analysis and research there are certain recommendations that can be useful in the further development of the smart airports. There are:

Focus and Support for digitization: As researched, implementing a highly technical self-service environment can save a lot of time pf passengers. Schiphol must implement high-quality bio-metrics and the latest technologies like Changi Airport can help passengers a hassle-free, time-saving journey.

An Advanced Stress-free user-friendly environment needs to be developed. Developing new gaming zones, indoor gardens, indoor swimming pools, 24-hour cinema, and sleeping pods, etc., will help to make the environment of the airport more relaxed and thus reduce the stress of the passengers.

Advanced application for travelers: Advanced user-Friendly interface must be developed. Easy to navigate application needs to be designed where travellers can enter the PNR and flight number and can get the navigation to follow to reach the fate for the flight will help first time traveler and other passengers too.

Focus on sustainability programs like development in digital services, smart campus mobility, optimizing landside mobility products for end customers, reduction in co2 emissions, and implementing issues related to security.

[46]Changi Airport: "RESILIENCE & ADAPTABILITY", accessed on 29.07.2021 at 20:45, https://www.changiairport.com/content/dam/cacorp/publications/Annualreport.pdf

[47]Changi Airport Group, "Ahead of the Curve: Changi Airport Group Annual Report 17/18," 2018, accessed 29.07.2021 at 20:41.

[48]Changi Airport Group, "Sustainability Report 2017-18," 2018, accessed June 29.07.2021 at 20:43

[49]Towards data science: 8 Years On, Amsterdam is Still Leading the Way as a Smart City, accessed on 28.07.2021 at 10:11
https://towardsdatascience.com/8-years-on-amsterdam-is-still-leading-the-way-as-a-smart-city-79bd91c7ac13

17 Conclusion

Examining the Amsterdam smart airport from a logistics and mobility point of view, it's very clear that the free flow of people, goods, information, and services are major pillars for Logistics and Mobility in the Smart Airport. Our research survey also suggested that currently, Amsterdam is doing great efforts in driving the smart airport in the right direction. After analyzing and researching with other smart airports like Changi, few suggestive measures are also proposed which can help Amsterdam smart airport to improve and grow with their vision and keep improving passenger experience and contribute to the environment more smartly in the future.

References

Batty et al. 2012
Batty, Michael; Axhausen, Kay W.; Giannotti, Fosca; Pozdnoukhov, Alexei; Bazzani, Armando; Wachowicz, Monica; Ouzounis, Georgios; Portugali, Yuval: Smart cities of the future. In: *The European Physical Journal Special Topics* 214 (2012), Nr. 1, pages 481–518

Bilotkach 2015
Bilotkach, Volodymyr: Are airports engines of economic development? A dynamic panel data approach. In: *Urban Studies* 52 (2015), Nr. 9, pages 1577–1593

Bouyakoub et al. 2017
Bouyakoub, Samia; Belkhir, Abdelkader; Bouyakoub, Fayçal M.; Guebli, Wassila: *Smart airport: an IoT-based airport management system.* In: *Proceedings of the International Conference on Future Networks and Distributed Systems*, 2017, pages 1–7

Kourtit et al. 2017
Kourtit, Karima; Nijkamp, Peter; Stough, Roger: Foreword: Digital support tools for smart cities. In: *Socio-Economic Planning Sciences* 100 (2017), Nr. 58, pages 1–2

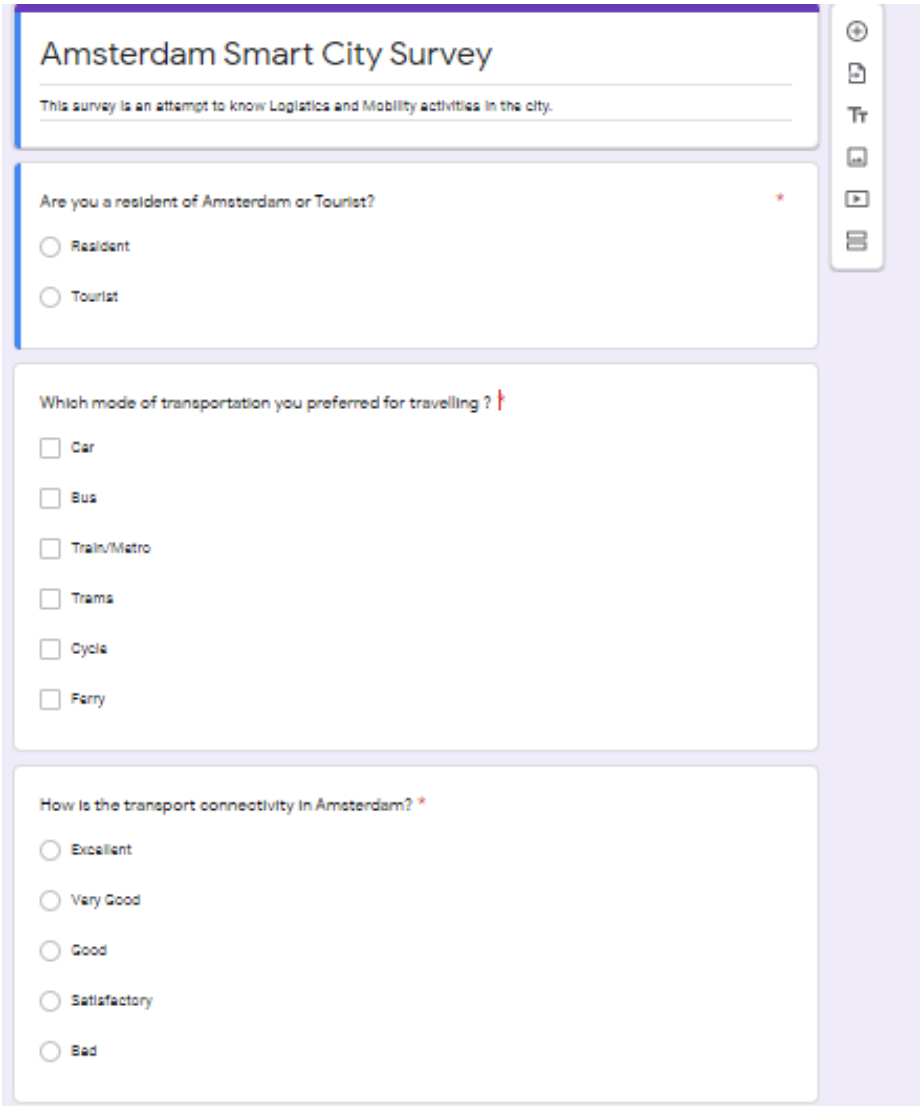
Neubauer 2011
Neubauer, Regina: *Business models in the area of logistics: in search of hidden champions, their business principles and common industry misperceptions.* Springer Science & Business Media, 2011

Siddiqui 2019
Siddiqui, Fahad M.: *Digital Transformation of Modern Airports by Exploiting Fog as a Service Model.* In: *2019 Integrated Communications, Navigation and Surveillance Conference (ICNS)* IEEE, 2019, pages 1–11

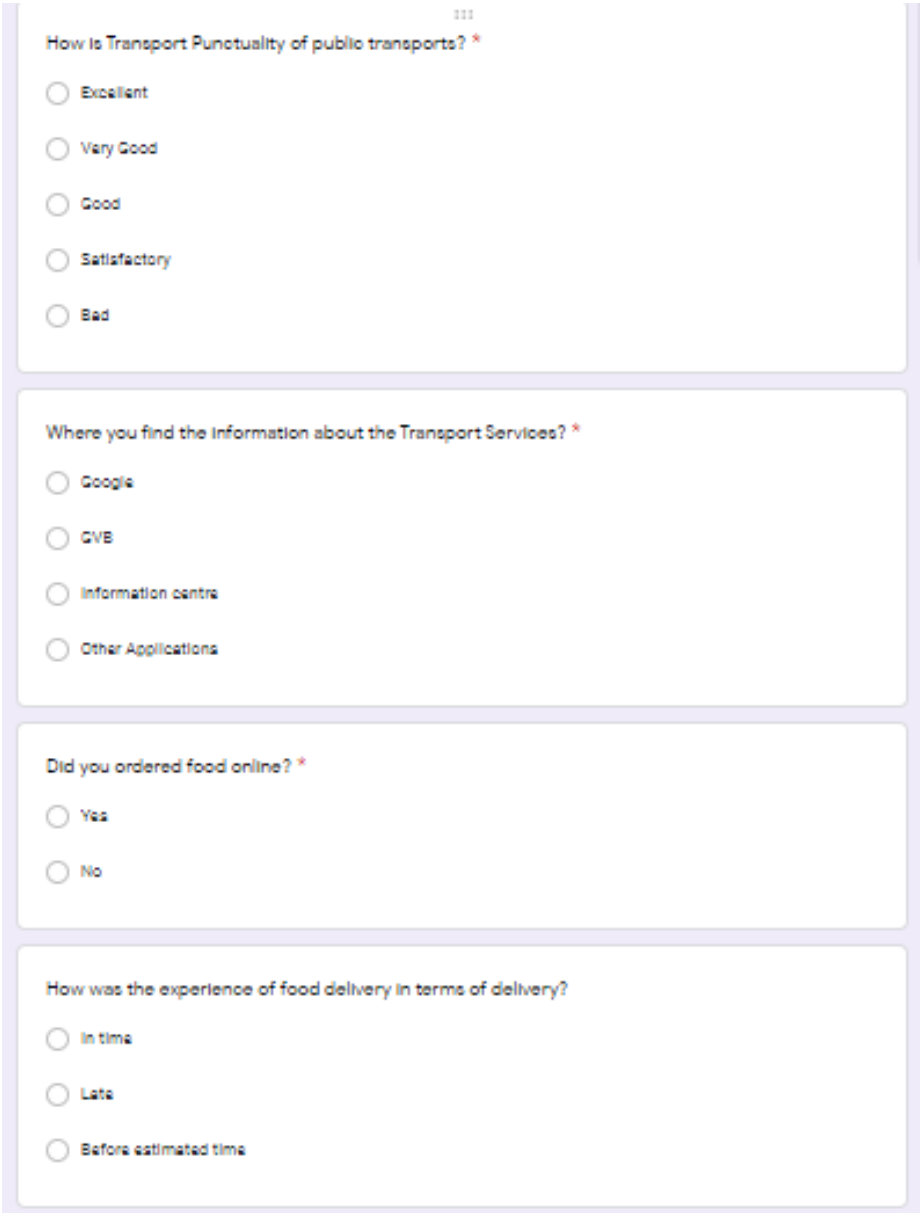
Trindade et al. 2017
Trindade, Evelin P.; Hinnig, Marcus Phoebe F.; Costa, Eduardo Moreira d.; Marques, Jamile S.; Bastos, Rogério Cid; Yigitcanlar, Tan: Sustainable development of smart cities: A systematic review of the literature. In: *Journal of Open Innovation: Technology, Market, and Complexity* 3 (2017), Nr. 3, pages 11

Yuan et al. 2010
Yuan, Xue-Ming; Low, Joyce M.; Tang, Loon C.: Roles of the airport and logistics services on the economic outcomes of an air cargo supply chain. In: *International journal of production economics* 127 (2010), Nr. 2, pages 215–225

A Surveys



Survey 1: Amsterdam Smart city survey part 1



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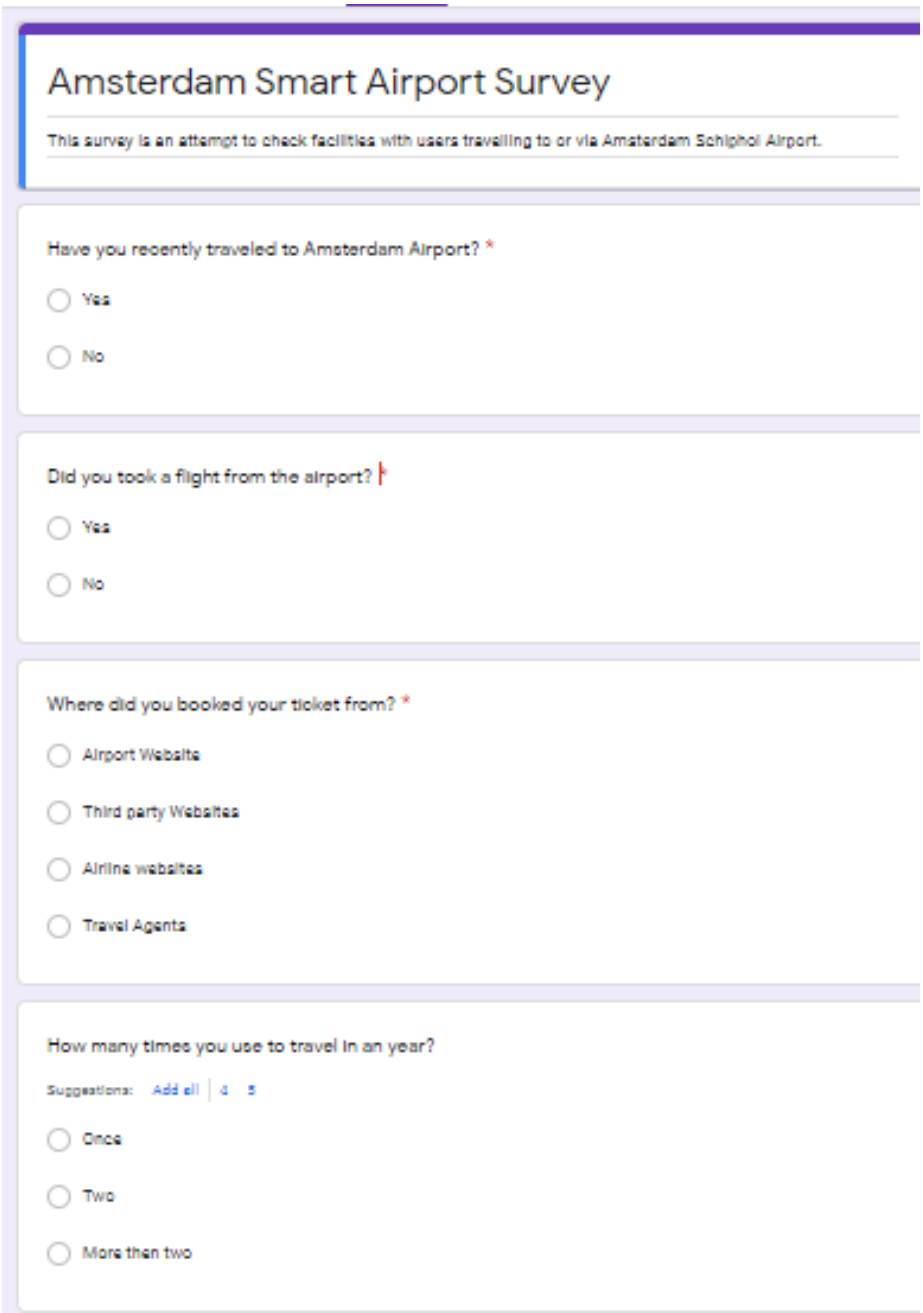
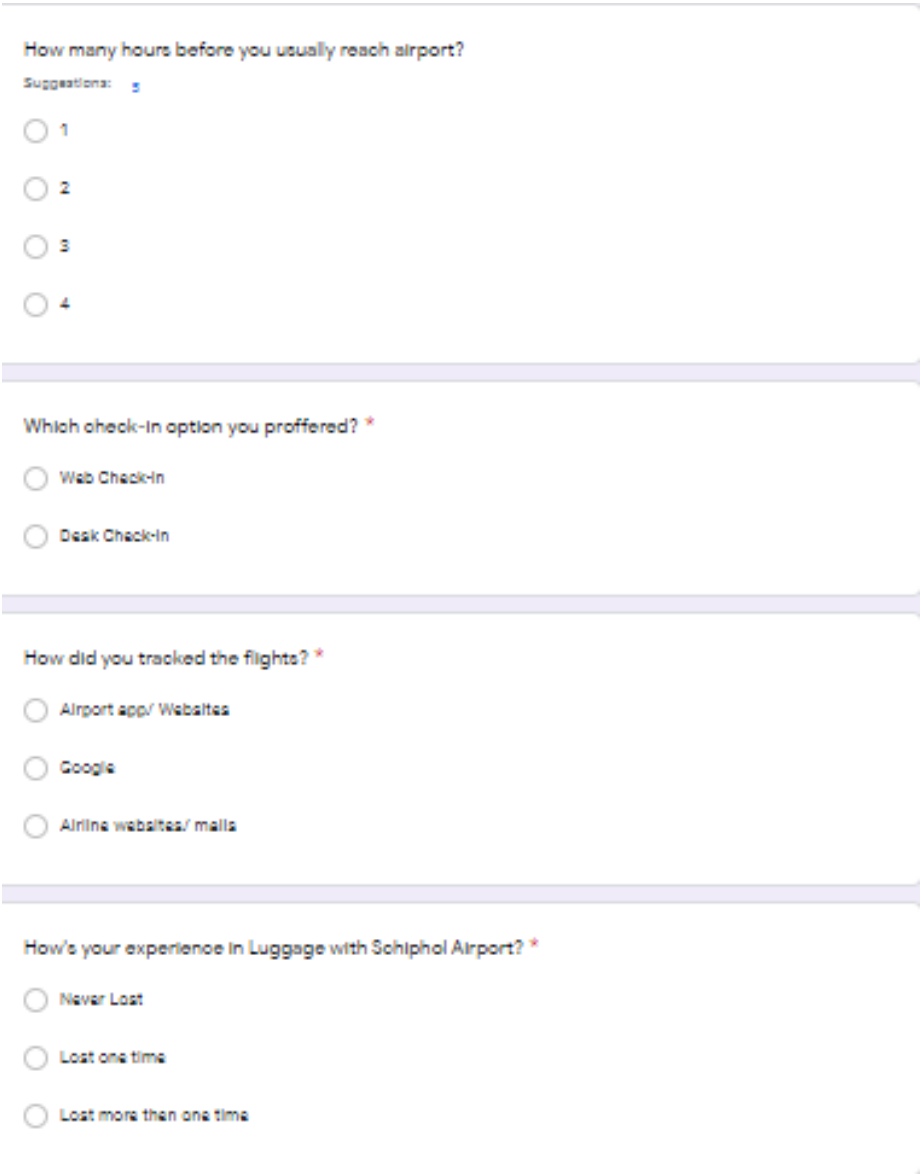


Survey 2: Amsterdam Schiphol Airport survey part 1



Survey 2: Amsterdam Schiphol Airport survey part 2