**Self-Check Questions**

**Unit 1**

Many towns and conurbations around the world are growing *more rapidly* than predicted. People respond to the lack of local public transport by using *private cars*, which only exacerbates the existing problems still further. Alongside the difficult transport situation, people in towns and cities face a range of environmental and *health problems*.

1. Which three actions are recommended by the EU Commission to manage urban growth?
2. *Create alternatives to car ownership*
3. *Improve interconnections between the different (public and private) modes of transport available*
4. *Introduce smart traffic controls to minimize congestion*
5. Which of the following statements about the situation in the Brazilian capital are true? Brasilia …
* *… was planned from scratch, but the urban planners failed to make full use of the opportunities available. One of their biggest mistakes was that they underestimated the role of the car in the late 20th/early 21st century.*
* … is a prime example of modern city planning, in that it separates the different modes of transport from one another and from the people.
* *… practically forces residents to drive their own cars because the roads are far better developed than the pavements, cycle paths or local public transport.*
* *… symbolizes the problems experienced by many major cities and conurbations worldwide. The only difference is that, being a comparatively young city, Brasilia did not face the same legacies as some older cities, but the problems it faces now are the same.*
1. Discuss where in the world transport problems are likely to peak during the next few years.

*The exacerbation of the transport situation in cities is driven by two main factors. Firstly, the negative correlation between the existing public transport capacity and infrastructure: The less well-developed they are, the worse the situation will become. Secondly, the positive correlation with population growth: The more it grows, the worse the situation will become. Consequently, the most problematic development is likely to occur wherever these two factors collide. Newly industrializing and developing countries are in a particularly weak position. Many of them are experiencing strong economic growth which attracts people into the cities to work. Cities in fast-growing developing countries like Accra in Ghana, Abidjan on the Ivory Coast and Dhaka in Bangladesh are therefore prime candidates for a hugely problematic mobility sector.*

The introduction of free local public transport would exacerbate the situation still further. Additionally, taxation could mean that *city dwellers* are subsidized by their *rural counterparts*. The incentive to move *into the city* would become even greater.

1. What are the key problems faced by the German railway (Deutsche Bahn)?
* Insufficient passenger numbers and hence excessive ticket costs.
* *The need to adapt capacity to the surprising upturn in demand.*
* A lack of funding due to low-priced tickets.
* *The complexity of local government and policy requirements, leading to protracted and costly planning and procurement processes.*
* *The risk of competition from self-driving cars while recently purchased locomotives are still in operation.*
1. Can you think of any strategies to keep the railway business attractive in the face of self-driving cars?

*The main weakness of the railway versus self-driving cars is that it can never offer individual point-to-point journeys. It must therefore devise value-added services which offer the same convenience as an uninterrupted door-to-door journey for certain customers. One idea is to offer services which a car cannot provide, such as the option of renting meeting rooms or beds on the train, or sports facilities. The importance of the catering service should not be underestimated either.*

1. What are the four technological dimensions of smart mobility?
2. *New vehicle technologies such as electromobility*
3. *Intelligent transport systems (ITS) for interconnecting road users with one another and with the infrastructure*
4. *Data-based real-time services*
5. *New mobility services*

The success of smart mobility relies on a change in *mobility behavior*, particularly in *large cities and conurbations*. The latest *technological developments* can help achieve a significant change in attitudes.

1. How do the sociological and technical definitions of smart mobility relate to one another?
* They are completely contradictory. Smart mobility is a technology-driven concept; it does not have social objectives.
* They are identical. Without the underlying social objectives, the technology would have no raison d’être.
* *On the surface, they have little in common, but smart mobility combines the technical and sociological level into one overall concept.*
* *They are on different levels. The sociological level defines the general requirements of smart mobility technologies, while the technical level defines their specific dimensions.*
1. Discuss the smart mobility requirements depending on a city’s development status.

*There is usually a correlation between a city’s per capita income and people’s willingness and ability to pay for progressive mobility services. Following Maslow’s hierarchy of needs, the large cities in newly industrializing and developing countries should focus initially on connecting the broader population with very basic transport services. You need to be part of the market before you are open to, and willing to pay for, other services.*

*Many of the services considered niche in newly industrializing and developing countries (such as carsharing and bike sharing) are already widely available in cities in developed countries. Many users are already accustomed to using a smartphone app to access mobility information and book their tickets on the move. This is an attractive target group for the seamless integration of mobility services as the next step toward comprehensive smart mobility.*

1. A smart city ...
* ... is a city with minimal congestion, whose inhabitants have above-average intelligence.
* ... is another word for an interconnected city whose inhabitants are always online. Open wifi access everywhere is a typical indicator of a smart city.
* *... is an umbrella term covering the various levels of digital urban development, from mobility to co-determination.*
* ... is a purely technological phenomenon. It has no social function.
1. Smart mobility is one of seven dimensions of the digital development model for smart cities. What are the other six?

*Smart governance, smart citizen, smart education, smart living, smart environment, and smart economy.*

A smart city uses *new technologies* to ensure the sustainable development of the social end ecological *environment*.

1. Apart from smart mobility, what do you think is the most relevant dimension of the digital development model?

*It's difficult to say. Smart governance is extremely relevant because it regulates the framework for smart mobility. If governments and authorities do not have any direct contact with smartification, it’s difficult to convince them of the correct approach.*

1. From your experience, what are the requirements for smart mobility solutions?

*Smart mobility solutions should create enhanced energy efficiency, fewer emissions, greater convenience and lower costs.*

1. Ultimately, smart mobility solutions may actually lead to increased traffic volumes, but not because of ...
* ... the falling cost of buying an e-car
* ... the possibility of cars driving around empty to avoid paying parking charges
* ... the low variable costs of shared e-cars
* *.... the potential drop in fossil fuel costs.*
1. Tesla has disrupted the car market quite significantly. What exactly is the story here?

Tesla…

* ... managed to secure a two-figure market share in a very short time with affordable electric cars
* *... put electromobility on the map and thereby forced the hands of established manufacturers. Even if Tesla does go bankrupt, it has permanently transformed the market.*
* ... benefited from the falling cost of batteries thanks to research by established car producers.
* ... heavily subsidizes its cars, so one could argue it effectively bought its market share. However, it is only a matter of time until the company runs out of money or the anti-competition authorities intervene.
1. Discuss the automation level at which public resistance to the use of self-driving vehicles in regular traffic is likely to be greatest.

*The transition to the final stage (stage 6 - completely autonomous driving) might seem the obvious answer, but is the leap between the final two stages really that great? Even at levels 4 and 5, the driver has essentially handed over responsibility to the vehicle and no longer continuously controls it. Even with the recent headlines about accidents with self-driving test vehicles, resistance is likely to be greatest at the point where humans regularly hand over control, rather than just occasionally, i.e. between levels 3 and 4.*

**Unit 2**

**2.1**

1. True or false?

Carsharing is…

* *... an umbrella term for a number of different approaches to the sharing of motorized vehicles.*
* ... a concept created at the turn of the millennium which has since really taken off.
* ... most successful on a peer-to-peer basis, rather like Airbnb is for living space.
* ... a concept invented by the leading car manufacturers in Germany.
1. What are the differences between sharing and pooling concepts?

Sharing and pooling…

* ... differ mainly in the use of different modes of transport.
* *... differ according to whether the shared vehicles are used simultaneously or successively and whether they are transporting passengers or goods.*
* … differ in that sharing is always commercially organized, whereas pooling is a private arrangement.
* ... differ in terms of location: Some concepts are only available in cities, and others only in the countryside.
1. Discuss the obstacles faced by peer-to-peer sharing versus sharing 1.0 or 2.0.

*In peer-to-peer sharing, the shared vehicles are privately owned; in the other two sharing concepts, they belong to the service-provider. This leads to two major differences, which also constitute obstacles. Firstly, insurance and liability issues are more complex; and secondly, there is an emotional component: People are reluctant to share their belongings with complete strangers. Particularly with a car, there is no guarantee that someone else will look after it as carefully as you yourself do.*

**2.2**

1. For years, ride-hailing has been the subject of much controversy worldwide. Why is that?

Ride-hailing …

* *... as practiced by Uber has led to price dumping and has undermined safety standards to the detriment of taxi companies.*
* ... has significantly reduced inner-city traffic, and the car park operators are up in arms about it.
* … is basically the same as carsharing, only less regulated. Most of the lobbying organizations are against it.
* *... has prompted a debate about whether the platform operators are mobility service-providers or technology companies.*

Ride-hailing differs from the other sharing concepts because rather than accessing a vehicle, customers are accessing a vehicle *with a driver*. Unlike *pooling* concepts, where you are a passenger on a journey which has already been planned, with ride-hailing you are a *customer*.

1. Discuss the benefits created by liberalization of the intercity bus market.

*It’s a well-known fact that competition stimulates business. To begin with, the newly created bus lines offered very cheap tickets, prompting the German railway to change its pricing model and offer more cheap tickets. In addition, there are now more options for travel in general and for transfers between cities. The opening of the market was a blessing particularly for people with a limited budget but more time.*

Cable cars were once the province of *ski resorts* but *demand* there has dropped off. Meanwhile, demand for cable cars for *inner-city* use has grown in newly industrializing and developing countries, especially in South America and Asia, prompted by the rapid, unchecked growth of their inner cities.

1. What is situation with cable cars versus buses and inner-city railways?

Cable cars ...

* ... could replace buses and trains altogether in the medium term.
* … *are particularly useful in densely built-up agglomerations with difficult geographical conditions.*
* *... could play an important role in helping to solve typical inner-city problems partly caused by buses and trains.*
* *are particularly ideal for point-to-point journeys and for connecting new districts to the bus and metro network.*
* ... can transport more passengers than an efficient metro network.
1. List the main advantages of cable cars compared with conventional modes of transport and transport infrastructure projects in cities and conurbations.

*Short planning times, minimal space requirements, low operating costs, minimal harmful emissions, low planning and construction costs, direct connections.*

1. In Hamburg in 2014, a planned cable car project over the River Elbe was reversed following a referendum. Discuss the possible reasons behind this.

*Many residents feared that the cable car station would create additional traffic rather than reducing conventional traffic flows. In an echo of the protests against wind turbines and the Elbschlösschen Bridge in Dresden, they were also critical of the potential adverse impacts on the cityscape. In this instance, the original (commercial) reason for the project also came under fire. The operators of a musical theater on the south side of the River Elbe wanted to be able to transport visitors faster and more conveniently to performances.*

**2.4**

1. Air taxis are ...
* *... electrically powered aircraft for the transportation of passengers which take off vertically.*
* ... any aircraft which take off vertically.
* ... the helicopter shuttles used in cities like New York and Monaco.
* ... electrically powered aircraft for the transportation of at least ten passengers which take off vertically.
1. Discuss the new challenges posed by the widespread use of air taxis.

*With large numbers of air taxis, airspace monitoring would need to be significantly expanded. This is an impossibility with current funding levels and the current number of pilots. One alternative could be to introduce traffic regulations similar to the highway code. However, it should not be forgotten that air taxis can move freely within space, unlike cars which are bound by roads. Safety is another topic requiring intensive debate, along with issues such as shadow strike, noise pollution and encroachments of privacy for residents around popular routes.*

1. Which two technologies is the Hyperloop concept based on?

*It is a combination between a magnetic levitation train (like the Transrapid) and a vacuum tube.*

1. The Hyperloop ...
* ... is technically mature. It is now just a race for which company will build it first.
* ... is not yet technically mature, but the test speeds achieved are so high that it already outperforms conventional high-speed trains.
* ... was announced by Elon Musk in his 2013 White Paper. However, his rival Richard Branson was faster to implement the concept and is now mass-producing the first Hyperloop.
* *... is not yet technically mature; current speeds are roughly on a par with those of high-speed trains like the ICE.*
1. What do you think are the pros and cons of the Hyperloop being developed in multiple locations by competing teams, rather than centrally in one location?

*One clear downside is the fact that the available resources are not being pooled. On the other hand, the technology is not yet sufficiently mature to be able to identify whose approach is the best. With different teams working on different approaches at the same time, there is less risk of spending too much time betting on the wrong horse. Also, it is a well-known fact that competition stimulates business.*

**Unit 3**

1. Why does car ownership decrease the likelihood of switching to alternative mobility offerings?

*Once you own your own car, you always have running costs, so the cost calculation is less favorable for alternatives like public local transport or carsharing.*

1. Average spending on mobility…
* … is marginal. People are increasingly less willing to spend money on mobility services.
* *.... is greater than on food, drinks and tobacco. It accounts for around 14 percent of people’s disposable income.*
* ... is of little interest to most people.
* ... is increasingly irrelevant in a globalized world, because with fast Internet access you can get all the information you need, so therefore there is less incentive to travel.
1. Outline your own ideas of how to persuade people to make more rational decisions when selecting a mode of transport.

*One key issue when selecting the correct combination or mode of transport is the lack of comparability between different options. Increased transparency would be a useful first step. Another option would be to make it easier to purchase tickets and incorporate real-time data for a smoother, more predictable journey.*

1. What are the key features of MaaS solutions?

*Purchasing and paying for integrated tickets which are valid for multiple modes of transport and mobility packages tailored to individual usage platforms, combined in a single platform or app with all the necessary information.*

1. One potential side-effect of Mobility-as-a-Service solutions is that…
* ... people buy second cars so they can earn extra money by offering mobility services.
* ... transport intersections become overloaded.
* ... additional ticket checks and additional software for checking tickets from different modes of transport are required.
* *... people become more likely to sell their cars.*
1. Can you think of any disadvantages associated with the widespread implementation of MaaS solutions?

*There are some disadvantages, particularly in the longer term. Entry barriers to the transport service-providers market have always been high, partly due to the level of capital needed to invest in cars, buses and trains, but also because people become accustomed to using certain mobility services and it is difficult to persuade them to switch. In a market dominated by MaaS solutions, it will become even more difficult to develop new transport services which are considered attractive alternatives from day one. It is therefore perfectly conceivable that the MaaS solutions currently disrupting the market will ultimately contribute to its paralysis in the longer term.*

1. The implementation of Mobility-as-a-Service projects ...
* ... is purely a technical problem relating to the difficulty of integrating data from different sources.
* ... is purely a market issue. It is irrelevant on a political level.
* *... is highly complex. It entails technical challenges as well as conflicting interests.*
* ... generates great mistrust, particularly among potential clients regarding the use of their personal data.
1. What role do you think is played by politics when implementing MaaS projects? Which factors should be considered?

*Given that MaaS projects usually involve numerous partners and stakeholders, politicians should avoid getting involved. Should conflicts of interests arise within a project, or between multiple concepts, they may act as arbitrators.*

1. How are the problems in road and rail construction linked to the challenges of creating a smart mobility infrastructure?

*Road and rail construction have been grossly underfunded for many years, even to the level needed to maintain the existing network. It is therefore difficult to imagine where the funds for an even more expensive nationwide smartification of the transport routes could be found.*

1. Funding of the smartification of the German infrastructure...
* *... is still completely unclear at present. The current funds available are insufficient.*
* ... has been secured, unlike the maintenance of the road and rail infrastructure.
* ... will continue to be subsidized by revenues e. g. from vehicle taxes and fuel taxes.
* ... will need to be topped up. In future, the required funds can easily be generated from taxes on e-mobility.
1. Which priorities should be set when expanding the smart infrastructure over the next few years?

*Priorities should focus on the fastest-growing cities where solutions are most urgently needed, but at the same time, solutions which work well in densely populated areas should be rolled out to less problematic environments in due course.*

**Unit 4**

1. In which key aspects does Greenwheels differ from its competitors car2go and DriveNow?

*No registration fee, optional monthly contributions, reservation in advance for a specific period, no minute-by-minute charges, offer of hourly, daily and weekly rates, vehicle is returned to the point of collection.*

1. Carsharing providers…
* ... are very customer-centric as far as payment is concerned and offer numerous different payment methods.
* … are so similar in their business models as to be virtually indistinguishable.
* *... offer very different pricing policies. There are differences in the registration fee, monthly subscription charges and variable (time-based) costs.*
* ... must offer maximum flexibility. There is no longer any market for chargeable memberships and fixed collection and return points.
1. Develop two user profiles which would be attractive for Greenwheels and car2go respectively.

*Greenwheels: The user does not have his own car but needs a vehicle for four hours a week to visit his family for lunch and go to the market in his old home town. He knows precisely in advance how long he will need the car for and also that he will return the vehicle to the original location close to his apartment.*

*Car2go: The user may already own her own car but she likes to use carsharing spontaneously to avoid paying for parking, or in other cities to get quickly from one appointment to the next. She can usually only plan at very short notice and price is less of an issue.*

1. Which type of information could persuade people to use alternatives to their own cars?

*Information about congestion en route and limited parking spaces at their destination might persuade people to leave their cars at home. References to more environmentally friendly alternatives will also have an effect, albeit less pronounced.*

1. In the competition between private cars and other modes of transport…
* *… many routes (such as the journey to work) are routinely traveled by car, even if alternatives would be cheaper.*
* ... public local transport is always the winner, because it is cheaper.
* ... as the purchase costs for cars become more expensive, the choice is leveraged in favor of the alternatives
* … transparency is an important criterion.
1. Deutsche Bahn is planning to offer integrated mobility services with its “Deutschland-Ticket”. Discuss whether Deutsche Bahn is the right company to do this or whether another operator would be better-placed to address this topic.

*One positive aspect is that the German railway network already has large numbers of regular passengers and it therefore has access to a large pool of potential customers for the “Deutschland-Ticket”. In 2017 alone, 15 million rail tickets were sold via the app, so the basis is available. However, the railways compete with many other providers of mobility services, who many not want to grant them access to their booking systems. A neutral app provider may therefore have greater success.*

1. Allocating cars and bicycles in sharing models according to the “first come, first served” principle ...
* ... is fair and unproblematic. It is clear from the start that only a limited number of vehicles are available.
* ... is basically wrong. Allocation should be regulated via auction models. Whoever pays the most gets the car.
* ... is not a problem, given that users have the option of reserving cars 15 to 20 minutes prior to use.
* *... makes sharing as an alternative to car ownership unattractive for certain target groups.*
1. What might be the pros and cons of a potential merger between car2go and DriveNow with regard to vehicle availability?

*One potential benefit is that users who were not previously customers of either service would gain access to cars from both providers, increasing the likelihood of a car always being available nearby. Customers who were already members of both services would no longer need to maintain two subscriptions, hold two membership cards and check two invoices. One potential disadvantage would be if the merger led to a reduction of the fleet.*

**Unit 5**

**5.1**

1. Indoor and outdoor navigation…
* ... have differing levels of importance for smart mobility. Outdoor navigation using GPS is more important.
* ... can coexist. There is no need for interconnection.
* *... must be interconnected because seamless positioning at the transition points is important.*
* ... must only operate in network mode.
1. Discuss why dependency on GPS is seen as a problem which led to the development of alternative positioning systems like Galileo.

*GPS technology is owned by the US military. There are currently no problems with it being used by military and private institutions in other countries, but there is no guarantee that this will always be the case. This realization prompted several key nations and the EU to launch their own systems.*

**5.2**

1. Explain what is meant by the “green wave”, giving an example.

*The speed limit on a road is 50 km/h. However, there are numerous access and exit roads between traffic lights, usually making it impossible to drive at a steady 50 km/h. When the traffic lights are set up to allow drivers to pass multiple traffic lights in succession without stopping, despite these interruptions, this is known as the green wave.*

1. The main objective of efficiency-based traffic control is to *minimize* stopping and waiting times. As well as costing road users valuable *time*, it also has an adverse effect on energy consumption and *emissions*.
2. The new approaches to traffic management are different because…
* *... they exploit new technologies. Some things that are possible today would have been inconceivable in the past.*
* ... they can adapt the traffic lights to the traffic situation in real time. For example, traffic light phases may be adapted to the number of cars turning off a certain section of road.
* ... they already know which car will take which route thanks to the navigation systems installed in modern cars, and can respond on an individual basis.
* *... they no longer try to control the traffic lights based purely on the traffic situation but instead attempt to influence the behavior of individual road users via the growing number of on-board computers installed in modern vehicles.*

**5.3**

1. It is particularly relevant to develop approaches such as floating car data and floating car observer because ...
* *... this reduces dependency on purely stationary systems with their related weaknesses.*
* ... it makes navigation more accurate by incorporating real-time data.
* ... this is the only way of preventing serious accidents almost entirely.
* ... it creates a new business model for car manufacturers.
1. Describe the differences between Floating Car Data (FCD) and Floating Car Observer (FCO).

*The main difference is that FCD only allows positioning of cars equipped with the relevant technology, whereas FCO allows the positions of other road users to be identified.*

**Unit 6**

**6.1**

1. Car2X communication ...
* ... means that in future, the sensors in cars will no longer be needed. This will save customers money.
* *... represents communication with the entire environment. The X may represent other vehicles or parts of the smart infrastructure as well as people’s smartphones.*
* *... is primarily aimed at improving road traffic safety.*
* ... is just an interim stage. Self-driving cars don’t need it.
1. Discuss the accident with the self-driving Uber car. Should test drives with self-driving cars be shelved for the time being?

*Even before the accident, it was clear that self-driving cars are still prone to errors. For this reason, there was a responsible person traveling in the affected vehicle, but their attention lapsed at the time of the accident. This is one of the main reasons for accidents even in non-self-driving cars. If Uber can draw conclusions from the accident and prove that everything is being done to avoid these types of incidents in future, I see no reason why the test runs should not resume*.

**6.2**

1. Why has the development of car safety systems changed so radically in recent decades?

The development of car safety systems…

* ... focused solely on costs for many years. This has changed as the laws have been tightened up.
* *... benefits from the opportunities afforded by new technology.*
* … is an area where car manufacturers need to make money. This is the only reason.
* *... focused for many years on minimizing the consequences of accidents. Today, the focus is more on actively preventing accidents.*
1. What are the options for equipping vehicles with Car2X communications?

*With Car2X communications, the vehicle obtains information about the surrounding area which could be used to design value-added services. Real-time information about available parking spaces at the destination and improved navigation based on the current volume of traffic are two conceivable options. However, there are virtually no limits to the designer’s imagination.*

**6.3**

1. The development of a standard for Car2X communication…
* ... is being implemented in close collaboration with locomotive manufacturers and railway operators under the name Rail2X at the same time.
* … has not yet been finalized in every detail. However, car and telecommunications companies favor the standard proposed by the CAR 2 CAR Communication Consortium.
* *... could be based on the 5th generation mobile communications standard because on-board emergency call systems are already being developed on this basis.*
* ... is not strictly necessary.
1. Which potential problems do you foresee when using the 3GPP standard in Germany?

*There are still quite a few dead spots in Germany’s mobile phone networks. 4th generation mobile communications do not yet offer nationwide coverage. The question is therefore whether, or when, the mobile phone network will be available with an adequate range and quality to enable error-free Car2X communications.*

**Unit 7**

**7.1**

1. UbiGo…
* ... failed due to a lack of acceptance among the general public.
* ... was simply too expensive.
* *…failed due to a combination of technical problems that could have been avoided.*
* ... would have opened up a lucrative new business model for taxi companies.
1. What would you do differently if you were a UbiGo project manager in a different city? Draw on the findings from the Göteborg project.

*The key here would be to ensure clear agreement in advance between all players about the next steps if the project is successful. This applies both to follow-on financing and the main legal aspects. What is more, the interests of the privately organized partners must be given proper consideration from day one. They will not be willing to get onboard unless they feel that this offers a valid business model for them as part of the longer-lasting implementation of smart mobility projects.*

**7.2**

1. Moovel has developed a range of new offerings in collaboration with SSB in Stuttgart. What are the partners’ objectives with this collaboration?

The partnership between moovel and SSB in Stuttgart…

* ... aims to give local residents a daily choice between their own cars and alternative services.
* ... aims to reduce the market shares of taxi companies, because many people find them too expensive.
* ... is designed to give people the same door-to-door service as taxis, but cheaper.
* *… is aimed at minimizing the incentives to use your own car.*
1. In your view, which services are lacking from the current SSB Flex solution?

*SSB Flex is limited to its own shuttle services and public local transport options. Carsharing and bike-sharing are not currently included in the scheme. The app could also depict the traffic and parking situation in the inner-city, offering an additional incentive to leave the car at home if it reaches or exceeds capacity.*