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Sustainable mobility and logistics for Central Asia Research perspectives for a climate center

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ABSTRACT

Urban transportation is on the one hand a vital component of a city and on the other a major factor of concern. The latter is due to the high impact on air pollution, carbon dioxide emissions, and fatalities. This is not just caused by the mobility of people but also, and increasingly, by the need to transport goods. Cities in Central Asia are often associated with strong air pollution and rising greenhouse gas emissions from urban transport contradicting the global strive for a carbon-neutral world by 2050. In the light of sustainable development, it is, therefore, the objective to reduce the externalities of urban mobility and urban logistics jointly.

The German-Kazakh University in Almaty envisions fostering the transformation to sustainability in Central Asia by setting up a climate center. One pillar will be urban transport. In this working paper, an interdisciplinary team of experts from Kazakhstan and Germany investigates fields of action and research for this center. The team describes stakeholders to involve, potential funding opportunities, and first actions for each of the identified fields. The working paper provides a fruitful basis for academics and partners to set up the center and to involve new partners.

KEYWORDS

urban mobility, urban logistics, sustainability, climate change, urban transport, climate center

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1. Introduction

"The Asia-Pacific region is not on track to achieve any of the 17 SDGs by 2030." (ESCAP, 2021). In North and Central Asia, all of the SDGs in regression are environment-related; including, "sustainable cities and communities" (Goal 11), "climate action" (Goal 13), and "life below water" (Goal 14). (Bi Yi, 2021) The same holds for the North and Central Asian region. Just two targets are on track, reduced inequalities (Goal 10) and peace (Goal 16). However, the data quality of both is marked insufficient. Whereas the target "affordable and clean energy" (Goal 7) shows progression, the targets "sustainable cities and communities" (Goal 11) and "climate action" (Goal 13) show regression. Although during the lockdown, cities in North and Central Asia enjoyed a brief period of improved air quality, it is worrying that 85 percent of countries in Asia and the Pacific have little to no environmental considerations in their recovery plans. Urgent action is required to reverse these regressing trends. Transport, energy, and agriculture are among the sectors that should be prioritized for the development of low-carbon systems and infrastructure in the subregion. (Bi Yi, 2021)

In the light of global objectives to fight climate change, fostered by the COP 26 conference, this trend clearly demonstrates an urgent need for action. This may be a solid and promising starting point for the research perspectives of a climate center at DKU. In this working paper, we will therefore examine the current status of sustainable cities, especially their traffic, logistics, and the means to power them. We will do that by concentrating on Kazakhstan as a prospective driver of change in the region. The contribution of the working paper will be a description of the status quo and an extensive portrayal of prospective research fields as methods for the DKU climate center and corresponding initiatives.

1.1. Climate change - the current situation in Kazakhstan

Kazakhstan outnumbers the other countries in Central Asia in terms of GHG emissions. Uzbekistan, scoring second, is not even causing half of the emissions (World Bank, 2021). GHG-Emissions in Kazakhstan were inclining over the last years. Based on data from 2016 approx. 16 Mio. T GHG out of nearly 300 Mio. t GHG in total is caused by the transport sector. Nearly half of the emissions are due to electricity production and heating. Manufacturing and Construction are responsible for another 55 Mio. t GHG. Coal is by far the most important fuel, representing more than 150 Mio t of GHG emissions (Ritchie & Roser, 2020).

The dominant driver of transport-related GHG emissions is road transportation (OECD, 2017). Railways are scoring the second. Unfortunately, we could not find sophisticated data for GHG emission sources fur urban mobility. Such data is not

available at the city level too, forming a barrier to analyzing and evaluating the effectiveness of urban transport policies and according to measures.

More than 4.5 million of all types of cars are registered in the country. Approximately 3.7 million of them are passenger cars. Those cars are comparably old. Nearly two-thirds (63,7 %) of them are older than 10 years, 7,9% are between 7 and 10 years, 13,5% are 3 to 7 years old and the remaining fraction can be considered as new cars until the age of three (Bureau of National Statistics 2021). This age distribution comes along with old engines and exhaust treatment conditions fueling air pollution.

The National statistical agency reported that gasoline is the most widely used fuel in the Republic of Kazakhstan. It ensures the movement of 88,1% of passenger cars. 7.8% ride on mixed fuel and 2% on diesel fuel. The share of electric cars is negligible. In numbers, it is around 1.000 pieces (Scheel et al., 2020). The statistic committee (1st Oct 2021) even reports just about 504 electric cars in Kazakhstan. The electrification of urban transport is part of the country's vision to become carbon neutral by 2060. Another means is smart cities, helping to cut emissions and air pollution.

Kazakhstan is the largest land-bound country and the 9th largest in the world. Roughly 20% of the inhabitants are living in the three largest cities Nur-Sultan, Almaty, and Shymkent. Almaty is the largest city in Kazakhstan, the major commercial and cultural center, as well as its most cosmopolitan city. The population of the city is about 2 million people. The area of the city is 630 square kilometers and it is located in a mountainous area. According to the Kazakhstan Air Quality Index, in 2020 Almaty was named the most polluted city in the country.

1.2. Main challenges

1.2.1. Urban transport:

Cities as complex, dynamic systems are shaped by the ongoing processes of urbanization, agglomeration, and decentralization (Batty, 2013). Traffic problems accumulate in the inner cities resulting in high congestion, an unreliable and inefficient transport system, and high amounts of air pollution and GHG emissions. Therefore, greening urban transportation is a vital contribution to sustainable urbanization (Rockström et al., 2017). A trend is to end automobile dependency (Newman & Kenworthy, 2015), creating more livable cities for people (Gehl, 2010). Municipalities rediscover active modes of transport, transit-orientated development, and redistribute urban space from cars to bicycles, pedestrians, and public transport. Forerunner cities like Groningen or Copenhagen and also recent metropolises like Madrid, Oslo, or Paris clearly demonstrate this shift and corresponding gains in urban quality. The reduction of car traffic decreases air and noise pollution, greenhouse gas

emissions (GHG), urban space allocated to traffic, and fatalities and so contributes towards the rediscovery of a street as a public and multifunctional place to live, relax and move. Fundamentally, streets need to be well-built for walking, sitting, standing, and communication for children and the elderly on equal terms (Gehl, 2015). The dominant planning object is the enjoying pedestrian instead of the speed-seeking car driver. (Assmann et al., 2019)

The cities in central Asia experienced and are still experiencing a rapid process of urbanization with more and more people moving to cities. What is, even more, is that those cities were hit by very strong motorization in a short period. Whereas in western societies the incline of car usage came to a hold, partially showing a trend to decline, in Central Asia cars are still seen, for a good reason, as a symbol of wealth and modernism leading to car-centric urban planning. The result of it is a high level of air pollution, heavy transport inequalities, a high level of congestion, steadily inclining carbon dioxide emissions in transport, and high numbers of traffic fatalities.

The logistics sector, in urban areas and also in long-haul traffic, shows a similar pattern. During the last years, the transport of goods via streets and lorries was supported by building roads and neglecting railway systems. The railway, the best inland mode of transport for long distances, is slower and sometimes tracks are even deconstructed making the network less and less attractive. Within urban areas, this strongly affects air pollution, since goods are mainly transported by old and dirty lorries and more environmentally friendly means of transport are overseen.

Active and sustainable modes of transport in Kazak cities are scarce. As the examples in figure 1 highlight, public transport is partly well established as bus services. Tramways are not existing or were deconstructed, case of Almaty. Metro lines and commuter rails are very seldom, as cycling paths are. However, Almaty shows strong efforts to improve the situation by establishing a Sustainable Urban Mobility Plan (SUMP) and by extending the cycling network, bike-sharing, bus lanes, and the metro system. Nevertheless, Key barriers to clean public transport are still (OECD, 2017):

- Lax diesel engine emission norms
- Low diesel fuel standards
- Weak technical inspection standards
- Inadequate pricing signals
- Insufficient support to producers for clean buses

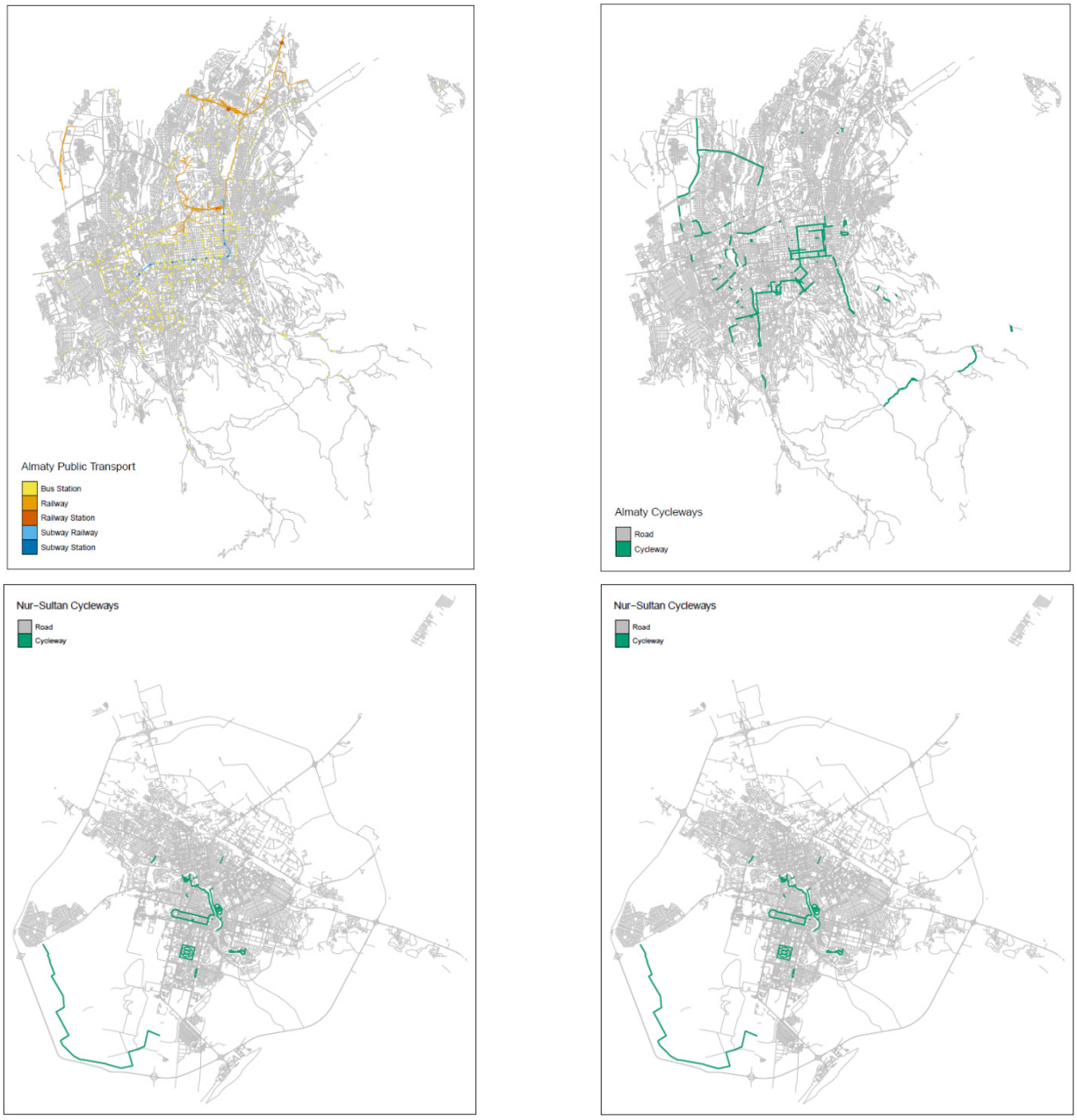

Figure 1. Transport network of Nur-Sultan and Almaty, Own analysis based on OpenStreetMap

One current attempt is to electrify bus fleets and to start using green hydrogen for public transport. In October 2021, KazMunayGas announced the construction of the first hydrogen refueling station in Atyrau in Kazakhstan. Hydrogen will be supplied from the existing installations of Er Liquid Munai Tech Gases LLP at the Atyrau Oil Refinery (ANPZ). This forms the starting point for hydrogen for bus fleets in the country. The first consumer, in this case, will also be ANPZ, because refueling is necessary for buses and passenger vehicles powered by hydrogen engines, which will be purchased by ANPZ for the transportation of workers.

The number of registered cars in Almaty and Almaty region achieved almost 532 000 cars – it's the largest number of registered cars among other regions of the

country. The vehicles generated around 44 845 tons of pollutants (Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan 2020). In the year 2017 the UNDP City Almaty sustainable transport project calculated a mode share of 41% cars, 39% public transport, 19% walking, and just 1% cycling (Damenova & Yerzakovich 2017).

Currently, 21 carriers are operating in Almaty to service 151 city routes. The number of buses plying the routes is 2,441 mobile units. Of these, 515 gas buses, 196 trolleybuses, 15 electric buses, and 1715 diesel buses. The Deputy Akim of Almaty stressed that in 2021 and 2022, the municipal bus fleet of Almatyelectrotrans LLP plans to purchase 300 gas buses. In addition, a private investor is considering the construction of a new bus fleet in 2022 with the purchase of up to 200 gas buses to service urban routes with an increase to 500 mobile units by 2025. This work is carried out on a systematic basis. The passenger traffic in Almaty is about 1.2 million passengers per day.

1.2.2. Green hydrogen - Clean energy for transport

The urgency of decarbonizing energy systems has grown since the entry into force of the Paris Climate Agreement in 2016. In 2020, 126 countries have set goals for decarbonizing the economy. On July 14, 2021, the EU announced a plan to reduce emissions by 55% by 2030. The transition to carbon neutrality through alternative energy and the production of “green” hydrogen is one of the objectives of many national strategies. Kazakhstan, in order to maintain the competitiveness of the economy, also needs to be part of the green transformation. On September 1, 2021, the President of Kazakhstan K.K. Tokayev delivered a Message to the people of Kazakhstan “The unity of the people and systemic reforms are a solid foundation for the prosperity of the country”. The President outlined the problem of a shortage of balancing capacities to regulate unstable electricity from renewable energy sources, as well as the projected deficit in the country by 2030, due to the expected economic growth. Hydrogen will play a crucial role in that.

The forecast of the International Renewable Energy Agency (Irena) suggests that by 2050, 8% of the global gross energy consumption will be provided by “green hydrogen”, and 16% of all electricity generated will be used for its production (IRENA, 2020). In December 2020, the list of world-scale projects included 13 projects with a capacity of up to 50 GW. In mid-2021, the number of megaprojects has grown to 26, with a capacity of about 260 GW. Renewable energy sources and hydrogen technologies are the most important driver of the global decarbonization of the world economy.

The project of the company “Svevind Group” in the Mangystau region of the Republic of Kazakhstan will be one of that megaprojects. The project of the company

"Svevind Group" in the Mangystau region of the Republic of Kazakhstan is planning to produce 2 million tons of "green" hydrogen per year that need to be transported to the importing markets. The production will be possible through the construction of wind and solar power plants, meaning that the production will not leave a carbon footprint. Kazakhstan is a landlocked state, therefore, large volumes of hydrogen will need to be transported by land transport and/or pipeline transport. However, there are no studies in the country on the possibilities of transporting "green" hydrogen by land transport over distances of more than 100 km, as well as an assessment of the transportation of "green" hydrogen by the capacities of existing gas pipelines.

At the same time, there are no standards of production, testing, standards of transportation, storage, and even the use of "green" hydrogen in Kazakhstan. It is necessary to determine in which areas there is the greatest demand in modern standards. Otherwise, for example, the use of passenger cars and municipal transport may be delayed due to the lack of standards for hydrogen gas stations. Everything rests on the absence of modern regulatory requirements for the placement of infrastructure facilities, storage of hydrogen, refueling, and corresponding equipment. Today there are only two standards in Kazakhstan: ISO/TS 20100:2008 "Gaseous hydrogen. Refueling stations" and GOST 3022-80 "Technical hydrogen. Technical conditions".

2. Methodology

The task to identify and describe prospective fields of research for the DKU climate center in the field of logistics and urban demands an interdisciplinary approach. Urban mobility is where the disciplines of transport planning, logistics engineering, social sciences, and energy meet, and novel and effective approaches are brought to life through an interdisciplinary approach. In order to set up a team of experts, who are the same as the authors, we had to fulfill three requirements

- Equal mix of experts from Central Asia and Europe
- Representation of experts from the different fields of expertise on urban mobility
- Good mix between practitioners and scientists.

After setting up the core team we started the interdisciplinary work and followed a three-step approach:

1. Situation analysis based on an extensive literature study and regional expert involvement
2. Large stakeholder workshop with other regional and scientific experts to firstly present the situation analysis, secondly define relevant actors and thirdly start a creative discussion on possible research approaches and necessary

stakeholders

3. Consolidation and formalization of the workshop results and composition of the working paper.

The outline of the working paper follows the methodology by providing the situation analysis in section 1, naming relevant actors in section 3, and consecutively describing the identified and consolidated research approaches and other activities of the climate center in section 4.

3. Actors for transformation in mobility and logistics

In the course of our work, we identified a set of relevant actors and stakeholders who are very likely to be relevant for the DKU climate center and research in logistics and urban mobility. Those actors can be relevant in one or several roles, either as a funding agency, legislator, regulator, user, applied research partner, consultancy partner, or multiplicator. We are aware, that our list just provides an overview of relevant actors and by nature is not complete.

3.1. Public actors

3.1.1. National

On the national level, here in Kazakhstan, we identified the following actors and stakeholders:

- National government and parliament: Legislation and financial means
- Ministry of Energy: Electric power industry, renewable energies, and investment programs
- Ministry of Industry and Infrastructural development: Transport and roads, investment programs
- Other ministries and institutions will be relevant for certain projects and initiatives and shall be approached case by case.

On the regional level or the city level of high importance is the involvement of:

- Akimat, the local administration, especially the departments for urban planning and transport planning: Those are needed for open data initiatives, citizen involvement, SUMPs, transport, and urban planning projects.
- Public institutions (like Akimat, Universities, schools, etc.) by implementing internal sustainable mobility measures and corresponding management.

3.1.2. International

Although Logistics and urban mobility are a national or regional field of action, international actors are active in this field by providing funding for research or deployment projects as by providing consultancy on policy developments and

implementations, Guidance on new technologies and modes of transport or monitoring of sustainability efforts. Relevant actors are:

- United States Agency for International Development, funding and guidance
- The World Bank, funding and guidance
- OECD (OECD Environment), funding and guidance.
- EU and UNDPs SDG Knowledge Hub for Central Asia countries to promote the regional SDG agenda. (https://www1.undp.org/content/brussels/en/home/presscenter/pressreleases/2021/a-knowledge-sharing-platform-to-help-central-asian-countries-to-.html)
- European Union: Research funding through Horizon and knowledge transfer as people exchange through the Erasmus program.
- Transformative Urban Mobility Initiative (TUMI, https://www.transformative-mobility.org). Off interest here can be the 200k TUMI Challenges which fund a mobility project in a city very easily.

3.2. Civil Society

Civil society is vital for research on the deployment of sustainable means of transport and mobility. Since most urban transport is in general caused by the private movement of people, this group is essential when it comes to achieving an urban transformation of the transport system. Civil society needs to accept it as practicable and fitting to social norms and values. Civil society can take several roles:

- Influencer on local and national legislators through elections and participatory processes
- Stakeholder involvement in urban planning and transport planning, like with SUMPs.
- User and buyer of mobility offers, vehicles and services.
- Receiver, and sometimes sender, of goods
- Research object, individuum or society, to investigate social norms and values guiding mobility and mobility patterns

3.3. Industry partners

Setting up research on sustainable logistics and urban mobility requires a strong involvement of regional and national actors from different industry sectors. These are namely:

- Electricity and energy companies deploying renewable energies and setting up applied projects and renewable energy technology, storage technologies, sector coupling, etc.
- Public transport agencies and other mobility companies through providing data, digitalization, deploying new offers, and being an application partner

- Logistics companies by providing data and testing new approaches, processes, and vehicles for sustainable operations.
- Map- and communication companies: Providing data and maps for different traffic flow and mobility pattern analyses.
- Vehicle OEMs and technology suppliers: Development and prototyping of more sustainable vehicles (including drive trains), deployment of new vehicles, and standard committees and industry associations for standards on hydrogen and emissions.
- Small and medium-sized businesses as senders and receivers of goods by demanding sustainable forms of transport
- Small and medium-sized businesses and large companies by implementing internal sustainable mobility measures and corresponding mobility management.

3.4.Funding agencies

A special group of actors is funding agencies. We already named large-sized international actors focusing on development projects in the subsection international actors. Here, in this section, we want to highlight some German actors and specific programs which can suitable to support the following research agenda.

- BMU: Exportinitiative Umwelttechnologien (call march 2022 and march 2023): https://www.exportinitiative-umweltschutz.de/de/exportinitiative-umwelttechnologien
- CASIB https://www.bmbf-client.de/projektbueros/kasachstan
- BMBF: Travelling Conferences (no current call)
- BMBF: „Partnerschaften für nachhaltige Problemlösungen in Entwicklungsländern – Forschung für Entwicklung“
- BMBF: Internationale Kooperationen Grüner Wasserstoff; https://www.bmbf.de/bmbf/de/home/_documents/internationale-kooperationen-gruener-wasserstoff.html
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

4. Approaches for sustainable urban mobility and logistics

In the course of our work, it became clear, that the DKU climate center needs more scientific formats and activities than pure research. We identified many relevant activities which will contribute to the establishment of the center itself as to foster sustainable development in the field of logistics and urban mobility. We clustered the activities in research, knowledge transfer, and standard development. We will describe prospective approaches in each corresponding subsection.

4.1. Research

The research cluster is the dominant cluster with a broad range of topics of interest. We, therefore, decided to group this a second time in thematic fields. For each research field, we also highlight one possible first action/project theme for the DKU climate center.

4.1.1. Urban transport

Urban transportation is one major field of concern and a possible starting point for a sustainable transformation. Research approaches are:

Smart maps and open data: Transportation is temporal and spatial. The configuration of the urban form and the transport networks strongly determines how people and goods will move through a city or region. Maps of the transport network and data on the location and activities of people and businesses form the information basis to better understand when which mode of transport is used for which purpose. From figure 1 it becomes obvious that for instance, the cycling network of Almaty is pretty limited whereas every part of the city can be reached on roads by cars. Those inequalities determine mode uses, relevant research here can investigate the accessibility of a city by different modes of transport, travel time differences between them, and bottlenecks as holes in the network. Despite cars, the route choice of people and goods is not well understood yet. The corresponding visualization of the results can help citizens and urban planners to understand mode choices and guide better-informed planning of settlements and active modes of transport. (Huber et al., 2021) demonstrate the power of map-based route choice analysis via crowed sourced open data for better planning of a cycling network.

Facing upcoming automated and autonomous vehicles maps become of even more importance as an enabler for those vehicles and as means to assess the viability of a city's networks. As (Plank et al., n.d.) are pointing out, especially micro-vehicles driving on cycling paths and sidewalks for urban deliveries are likely to hit the streets soon but are strongly dependent on the network configuration. In order to make a city ready for such new services, more detailed maps are needed.

First action:

- Evaluation of map quality of active mobility representation
- Accessibility and transport injustice analysis for certain cities
- Travel-time difference analysis between modes for certain cities.

Social norms and urban mobility: The car is not just a vehicle, it is not just a means to go from A to B. The car is coined over the last decades to be a symbol of freedom. An expansive and mostly heavy, strongly motorized car demonstrates wealth. An SUV promises security whereas public transport nowadays stands for the risk of infection and users of it, as with bicycles, are seen as being too poor to use a

car. Promoting active and sustainable modes of transport can therefore not just be a task of engineering but a task of investigating lifestyles, social norms, and drivers of innovation and social changes. From the perspective of research for a sustainable transformation, it opens many avenues like:

- the investigation of social groups which can be innovators and early adopters to promote certain innovations like electric cars or cargo bikes,
- Investigating social norms in the benefit of active mobility and how they can be effectively addressed.
- The modification of mobility innovations from outside central Asia to meet the regional cultural needs to reach better acceptability.
- Investigation ways to raise consciousness for sustainability and social lifestyles
- Understanding the needs of minorities to create a more inclusive transport system.

First action: Field trial and evaluation – Can cargo bikes be a sustainable SUV (and make people start using bicycles for everyday commutes)?

Citizen involvement: The active involvement and participation of citizens and other stakeholders can strongly increase the acceptability of urban transport innovations on certain infrastructure or settlement developments. In European countries, a huge body of different formats and methodologies of participation and involvement exists but is strongly shaped by the cultural background. In this respect, it is worth investigating the suitability of different types of participation in the Central Asian background and how they need to be modified to be effectively applied.

First action: Citizen reports in Kazakhstan or a city in the country

4.1.2. Logistics

The logistics research falls into urban logistics and long-distance transport

Urban Logistics: The movement of goods is currently done by trucks, many of them are old and with high emission levels. Data about logistics in cities, the flows, volumes, and corresponding shares of logistics sectors, are basically unknown. Systematically assessing and modeling goods flows to understand the specific local situation can be one first starting point for research. Another stream of research can be the applied investigation of new logistics concepts like micro-consolidation, urban fulfillment, pick-up points, and often about that the deployment of light electric vehicles or cargo bikes.

First action:

- Extending the cargo bike trial, an open trial scheme for commercial cargo bikes
- conducting systematic simulation studies on the viability for certain logistics sectors and city areas.

- Assessment of freight flows and modeling freight flows

Green long-distance transport: Road transport of goods is dominated by gasoline trucks. First electric trucks are internationally available, but their range is still limited and not competitive for classic long-haul. At this stage, it is worth investigating their application potential in logistics sectors and for certain tasks like collection and distribution and how a policy to promote their needs to be designed. In addition, it could be worth investigating the potential of synthetic fuels, hydrogen, overhead lines for trucks to power long-distance transport, or the potential to shift to rail to guide policymakers.

First action:

- Study on the potential applications of e-trucks
- Investigating certain scenarios for the diffusion and promotion of low emission vehicles
- Impact assessment of different emissions standards

Green hydrogen transportation: Kazakhstan has the economic potential to produce relevant amounts of green hydrogen needed by international partners like Germany. As it is unclear now how it will be exported, models and simulations of different alternatives for transporting hydrogen can be a strong benefit for the economic development of the region. Their contribution would be strategic and assist the infrastructural planning. The topic cannot be more actual than today, given the latest political developments.

First action: **Green hydrogen production and delivery challenges**

The urgency of decarbonizing energy systems has grown since the entry into force of the Paris Climate Agreement in 2016. In 2020, 126 countries have set goals for decarbonizing the economy. On July 14, 2021, the EU announced a plan to reduce emissions by 55% by 2030, followed by a transition to a zero balance of greenhouse gas emissions by 2050 – the "Green Deal" - the European economy decarbonization program. Environmental restoration programs and the promotion of "green" strategies in the economy are not just a trend, but also a factor of economic competitiveness. The transition to carbon neutrality through alternative energy and the production of "green" hydrogen is one of the objectives of many national strategies.

In order to maintain the competitiveness of the economy, Kazakhstan also needs to be in this "green" wave. On September 1, 2021, President of Kazakhstan K.K. Tokayev delivered a Message to the people of Kazakhstan "The unity of the people and systemic reforms are a solid foundation for the prosperity of the country". The President outlined the problem of a shortage of balancing capacities to regulate unstable electricity from renewable energy sources, as well as the projected deficit in the country by 2030, due to the expected economic growth.

Renewable energy sources and hydrogen technologies are the most important

driver of the global decarbonization of the world economy. The forecast of the International Renewable Energy Agency (Irena) suggests that by 2050, 8% of the global gross energy consumption will be provided by “green hydrogen”, and 16% of all electricity generated will be used for its production. In December 2020, the list of world-scale projects included 13 projects with a capacity of up to 50 GW. In mid-2021, the number of megaprojects has grown to 26, with a capacity of about 260 GW.

One of these megaprojects is the project of the company “Svevind Group”, implemented in the Mangystau region of the Republic of Kazakhstan. It is planned to implement the largest and most ambitious project for the construction of wind and solar power plants with the subsequent allocation of resources for the production of 2 million tons of “green” hydrogen per year, i.e. production will not leave a carbon footprint.

Kazakhstan is a landlocked state, therefore, large volumes of hydrogen will need to be transported by land transport and/or pipeline transport. However, there are no studies in the country on the possibilities of transporting “green” hydrogen by land transport over distances of more than 100 km, as well as an assessment of the transportation of “green” hydrogen by the capacities of existing gas pipelines.

At the same time, there are no standards of production, testing, standards of transportation, storage, and even the use of “green” hydrogen in Kazakhstan. It is necessary to determine in which areas there is the greatest demand in modern standards. In fact, here we are talking about technologies that should be developed in Kazakhstan first of all. For example, standardization of technologies related to the use of “green” hydrogen in the energy sector or as fuel for public transport and cars is very relevant. However, the commissioning of such transport may be delayed due to the lack of standards for hydrogen gas stations intended for passenger and municipal transport. Everything rests on the absence of modern regulatory requirements for the placement of such infrastructure facilities, storage of hydrogen on them, and refueling of equipment.

However, today there are only two standards in Kazakhstan: ISO/TS 20100:2008 “Gaseous hydrogen. Refueling stations” and GOST 3022-80 “Technical hydrogen. Technical conditions”. If Kazakhstan wants to become a world leader in the export of “green” hydrogen, it is necessary to develop its own standards today and harmonize them with international ones. Also, national standards do not yet regulate the operation of pressurized gas compression and storage systems, which are used in the world, and allow the use of the most advanced hydrogen energy technologies.

The standards are necessary for the development of an action plan for the introduction of hydrogen filling stations in the urban environment, as well as the development of the most optimal supply chain, i.e. the application of methods of analysis of urban logistics. The development of the layout of such filling stations is

especially important for megacities like Almaty and Nur-Sultan, where population growth due to the influx of population from rural areas has averaged 4% over the past 10 years. At the same time, there is a high level of gas pollution in urban areas, in particular in the city of Almaty, which is associated with a high number of cars. At this stage, it is enough to say that within the portfolio of available options for solving environmental and energy security problems, hydrogen is considered one of the main alternative fuels for future road transport.

Regarding the ubiquitous trend of decarbonization, Kazakhstan is required to reconsider ways to "green" economy including logistics:

- The "green" hydrogen development strategy or road map needs to be established including logistics and transportation questions;
- The volume of produced "green" hydrogen would be three mln tonnes per year, therefore, the transportation facilities and logistics of export need to be evaluated;
- The standards of new technologies implementation and application required the use of "green" hydrogen in the energy sector or as fuel for public transport and cars;
- Implementation of the "Resource Efficient Production Logistics" as a new training program for students and professionals for improving their skills;
- The comprehensive information about the "green" hydrogen production project and its impact on the economy and society must be provided through conferences and presentations of the project to the public.

4.1.3. Sector coupling and clean energy for transport

Greening transport requires the transformation from combustion engines to electric engines (let it be battery vehicles or hydrogen vehicles). The electricity needs to come from green sources and not coal plants. It will be produced by volatile renewable energies, which will not secure that electricity is produced exactly at the moment when it is needed by the transport sector. In order to overcome this, smart grid approaches are needed and the grid itself should be fitted to new requirements. Many options like using vehicles as temporary storage capacity, using hydrogen for storing electricity, implementing flexible pricing at charging points, etc. are thinkable and will need further investigation and field trials.

First action: Green hydrogen from renewable energies to power public transport busses.

4.1.4. Impact assessment

Emission data: Air pollution is a strong concern in most cities. To improve the situation, it is first necessary to understand where the pollution comes from.

In Almaty for instance it is a public discussion whether the air pollution is mainly caused by coal firing or (old) combustion engines of cars. Since regional emission factors for sources are not available to investigate that soundly, one path of research can be to develop a methodology to assess emissions under the special conditions of Kazakhstan / Central Asia. Another valuable contribution would be the improvements of air pollution maps by adding more sensors to the systems and by improving the modeling methodology. The former can easily be done by citizen engagement as demonstrated by the OK lab Stuttgart (https://luftdaten.info/).

First action: **The Impact of Urban logistics development in Almaty**

Many researchers considered different ways of decreasing pollution levels. One of the solutions was the optimization of the urban public transport routes and cargo delivery – last-mile delivery. Even the development of applications for monitoring the location of busses was established by scientists of two universities: Central Asian University and Kazakh academy of transport and communication. Moreover, the Kazakh Academy of transport and communication presented several research outcomes regarding the evaluation of current routes of urban public transport, the number of buses, and the most crowded hours. However, there is a small number of research that include data about suburban routes, and bus station loading since today many people live in the suburban areas of the city. Linking rural areas to urban centers ensures mobility in the countryside. In addition, there is a lag in research on creating a single network that connects all types of public transport.

Integrating public transport into a single network will allow increasing its efficiency so people would prefer to use public transport rather than individual cars. The best example is the transportation system of Berlin that allows using one type of ticket for all public transport, moreover, passengers can use the public-transit network for moving through different travel zones by buying the tickets in advance. The system was developed under:

- the Act on Federal Government Financial Aid to Improve Transport at the Local Authority Level,
- the Carriage of Passengers Act,
- the Construction and Operation of Railways Regulations,
- the Civil Aviation Act,
- and the Federal Trunk Roads Act.

For Almaty, it is necessary to develop a single integrated system for all types of public transport and connect it with rural areas in the first stage. Further, this system can be used as a base for connecting the whole transportation system of the republic.

Impact assessment & evaluation: The evaluation of certain policy or transport measures is a standard field of science. Within the transport planning or urban planning

domain, a sound evaluation of a certain measure is often neglected. The problem arising from that is that it remains unclear whether the targets are reached and public money is well-spent or not. In other words, missing or bad evaluations can hide that certain transport measures promise to contribute to sustainable development, but actually are not doing so. Here research activities can firstly investigate the impact of a measure prior to the deployment and also after it and by doing so improve the methodologies and processes of the evaluation. An applied stream of research can be the assessment of stronger standards and regulations on fuel, emissions, drivetrains, and vehicles in logistics and urban mobility.

First action: Setting up some impact models for above mentioned first actions, like the cargo bike simulation.

The true cost of transport: It is well known in the scientific sphere, that car traffic is by far the most expensive mode when it comes to total social costs, including external costs. The letter is costs that are not directly paid by the user but by the society in general like air pollution, GHG emissions, infrastructure, etc. Between policymakers and everyday people, this is often unknown or not well understood. To overcome this, it is worth investigating new ways of green budgeting, assessing total costs, communicating external costs, or internalizing them.

First action: Applying the CostTool for total costs of urban transport systems: https://www.uni-kassel.de/fb14bau/institute/institut-fuer-verkehrswesen-ifv/verkehrsplanung-und-verkehrssysteme/forschung/it-gestuetzte-tools/costtool

Monitoring: Sustainable development is a process with targets set for the future. Data for sustainable cities and other SGD indicators is not sophisticated for the region. Also, the impact of sustainable transport measures on target fulfillment is not transparent right now. One attempt for the DKU climate center can be the setup of a monitoring approach for sustainable cities and mobility in Central Asia. Here research is especially needed to address issues of different or lacking data quality and common indicators for mobility and logistics.

4.2. Knowledge transfer

Another valuable task of the DKU climate center can be the transfer of knowledge between Europe and Central Asia (in both directions) and the transfer of knowledge between the countries and institutions in the region. In other terms, the DKU can become a kind of center of knowledge. To foster knowledge transfer, we propose the six following activities

- Creation of reform support teams of European experts which assist local policymakers for a short and given period.
- Short term executive programs on new topics on logistics and urban mobility as to improve the network of executives.

- Consultancy projects
- Knowledge transfer and common projects for stakeholder engagement
- Setting up a best practice map in Central Asia for executives, policymakers, planners, and the general public.
- Study tours to German sites and Institutions for executives and experts

4.3. Standards

Standards are a crucial means to shape the industry and interaction between businesses and people, nationally and internationally. Setting standards correctly can propel sustainable technologies, and means of production or ease communication and digital services. The DKU Climate center is by nature a neutral actor and therefore in a good position to motivate and moderate standard development processes. It can play an essential role in investigating the impact of certain standards on climate, see section 4.1.4.

First action: If Kazakhstan wants to become a world leader in the export of “green” hydrogen, it is necessary to develop its own standards today and harmonize them with international ones. Also, national standards do not yet regulate the operation of pressurized gas compression and storage systems, which are used in the world, and allow the use of the most advanced hydrogen energy technologies.

5. Summary and outlook

The scope of this working paper is to investigate potential research fields and approaches for a climate center at the German-Kazakh University. This shall help to connect actors in Central Asia and stimulate environmentally friendly and carbon-neutral innovations and growth. We conducted the work with an interdisciplinary team through literature reviews and workshops.

In our working paper, we present the first outline of possible fields of action and approaches for research. We name actors to involve those in research and transformation processes and mention possible sources for funding. This work was meant to provide an overview of promising and helpful attempts. In the upcoming work, we will further define and detail the research approaches, analyze more data and identify special actors to involve. Since fighting climate change is of vital importance for the world society we will keep active with this work. For instance, the cargo bike project at DKU is prolonged through DAAD funding, and local businesses, students, and the civil bike community will be strongly invited and approached to test and use the cargo bike in order to spread the word about the novel means of transport in spring and summer 2022. First trials and data show a promising potential for greening urban logistics and mobility.

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