K2 - Sweden's national centre for research and education on public transport

Research Agenda 2020 - 2024

Contents

1. Introduction

K2 is Sweden's national centre for research and education on public transport. Academia, public sector actors and the business community all meet here to discuss and develop the role of public transport in Sweden. We research how public transport can contribute to attractive and sustainable metropolitan areas for the future. We train public transport actors and disseminate knowledge to decision-makers, so that the debate on public transport is conducted on a scientific basis.

Public transport as a research field contains a number of possible aspects and perspectives. A certain breadth is required, but also prioritization and focus, in order for K2 to be able to make a difference. This document is intended to clarify K2's research focus for the period 2020-2024. The focus is also based on the research agenda for K2 that applied during the years 2015-2019 and which was developed in collaboration with public transport actors during K2's start-up phase in 2013-2014. External and internal researchers, international advisers, K2's partners and other relevant organisations have been involved in the work to develop the research focus. The direction has been decided by K2's board. The agenda has been updated in December 2021 due to Corona pandemic's impact on society and public transport.

The document starts with the overall bases for K2's research, followed by a review of prioritised research areas and perspectives. The appendix describes how the focus is translated into practical research, including the forms of collaboration between research and practice.

2. Basis for K2's research

K2's ambition is to be an internationally leading centre that utilises research and education to improve and renew public transport as a means of achieving sustainable cities and regions. By developing new and applicable knowledge about public transport and its role in society, K2 contributes to agenda 2030 and the global targets for sustainable development.

Our research focuses particularly on the challenges faced by metropolitan areas, and on the links between the city and its surrounding area. The research is conducted in a collaboration of research and practice. This entails adopting an approach in which public transport actors contribute in various ways to developing the research issues, conducting the research and disseminating the results.

As a whole, K2 is a multidisciplinary research environment. The research is intended to explore issues that transverse different research areas and perspectives. This does not preclude individual research projects from taking a more focused or mono-disciplinary approach when warranted.

Our research is characterised of a high scientific quality, and its purpose is to advance the cutting edge of new research. We contribute to increased understanding and innovation and we ensure that knowledge is put into practice by organisations who, in various ways, work with or are affected by, public transport. Results from K2's research projects are generally published in scientific articles or reports, as well as in popular science format.

Research projects are carried out with internal and external funding within the framework of K2. This line of research is the primary focus for K2's internal resources. Externally funded projects can complement this research focus by investigating different, but related issues. In this way, K2 takes more comprehensive responsibility for knowledge development regarding public transport as a means of achieving sustainable cities and regions.

3. Five research areas, three perspectives

K2's research for the period 2020-2024 will focus on five areas. These address key challenges for public transport's ability to contribute to sustainable cities and regions:

- Future mobility
- Market and financing
- Decisions and effects
- Integrated planning
- Public transport for all

Future mobility deals with public transport's opportunities and challenges with regard to new digital technologies, as well as traditional public transport's interface with new mobility services. The area of *Market and financing* focuses on governance, agreements, pricing and forms of funding for resource-efficient and attractive public transport. *Decisions and effects* focuses on the social effects of public transport and on increased knowledge of analytical methods and the role of the analysis results in actual decision-making processes. *Integrated planning* deals with the design of public transport and its integration with land use and other local, regional and national spatial planning. *Public transport for all* focuses on how public transport and access to mobility contribute to and affect accessibility, democracy processes, inclusion and exclusion.

Research within these five areas is based on three perspectives, all of which are necessary in order to understand the role and importance of public transport in society, and to contribute to its renewal. The perspectives attach importance to different analysis units or study objects within the research areas. The three perspectives are:

- Individuals and groups
- Organisation and cooperation
- Transport systems and information

Individuals and groups focuses on existing and potential passengers, as well as other individuals and groups in and around public transport. These can also be studied aggregated at a community level. This perspective includes, for example, a behavioural science and a social science approach. *Organisation and cooperation*

focuses on the governance of public transport, its institutional framework and the mutual dependence between actors in and around public transport. Social science and economic research, for example, play an important role in this perspective. *Transport systems and information* focuses on public transport's digital and spatial infrastructure and design. This perspective includes, inter alia, traffic engineering and computer science approaches. All of these perspectives require research using both quantitative and qualitative methods, as well as combinations thereof. Case studies and comparative studies of cities and countries, e.g. in a Nordic context, can contribute to increased understanding and new approaches.

During 2020 and 2021, Covid-19 has meant changes in society and in public transport. This has not changed the overall relevance of the research agenda but has given certain issues increased relevance. Still, more general trends such as demographic change and demands for sustainability, urbanization, digitalisation and changing lifestyles mean that people's demands and expectations for transport and public transport are changing.

Public transport as a means for more sustainable cities and regions

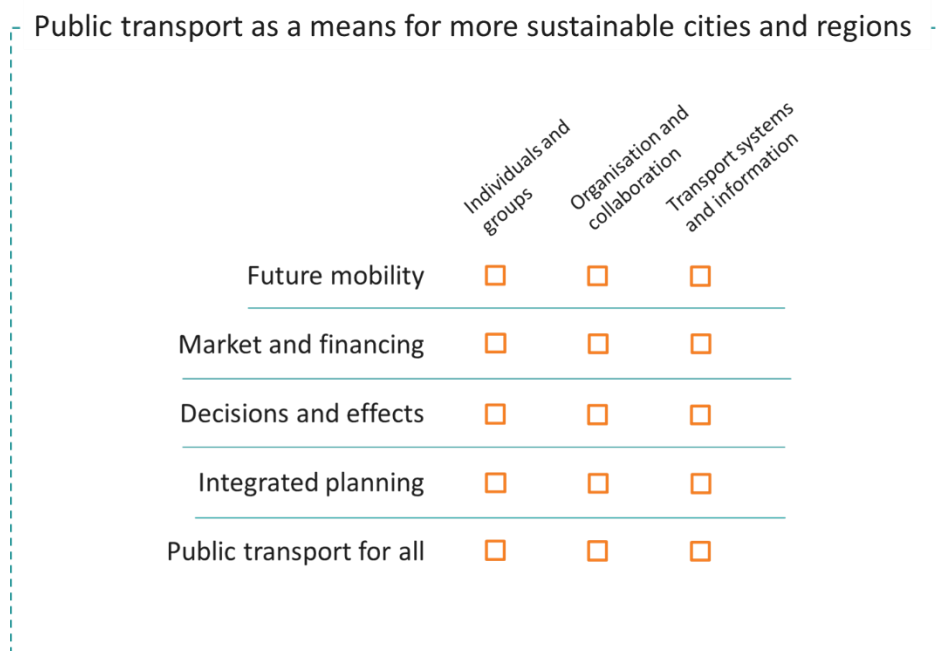|	Individuals and groups	Organisation and collaboration	Transport systems and information
Future mobility	☐	☐	☐
Market and financing	☐	☐	☐
Decisions and effects	☐	☐	☐
Integrated planning	☐	☐	☐
Public transport for all	☐	☐	☐

Figure 1. K2's five areas of research and three perspectives on public transport as a means of achieving sustainable cities and regions. The research is, to a large extent,

intended to explore issues that transverse different research areas and perspectives. This does not preclude individual research projects from taking a more focused or mono-disciplinary approach when warranted.

Future mobility

Opportunities and challenges of new digital technologies and the traditional public transport's interface with new mobility services

Digitisation involves a significant restructuring that affects all parts of society. In regard to public transport, it offers new information opportunities for passengers, operators and organisations that plan or order transport services. Increased access to data from e.g. sensors and ticketing systems, combined with new opportunities to process the information with elements of artificial intelligence and machine learning, create the conditions for energy efficiency, better resource utilisation and increased individualisation of public transport. Digitisation will facilitate the emergence of new demand-driven or shared mobility services and new business models for combined-service passengers that can compete with or complement today's public transport services. The introduction of autonomous and connected vehicles can accelerate and reinforce the effects of such a trend. Impacts on autonomous and connected vehicles can accelerate and amplify the effects of such a development. Changed behaviours as a result of increased opportunities for digital accessibility and digital services to avoid congestion and spread travel have become increasingly important. Digitalisation creates opportunities, but also challenges, for example, for personal privacy, for various individuals' access to a changed mobility landscape, for costs and for the ability to achieve climate targets and environmental goals.

Overall research issues

Although most public transport will be provided by existing services for the foreseeable future, digitisation and new mobility services will entail a major change for passengers and commercial operators in and around public transport. This trend also affects the way in which public transport is organised, which actors are involved, and their different strategies. New solutions also affect the conditions and requirements for the physical design of the transport system and the public transport services offered. Research is needed on the following, broadly formulated issues:

- How can *behaviour* be changed as a result of digitisation generally, such as changes to the organisation of working life, and to new mobility services in particular? What do such behavioural changes mean for passengers and for the

demand for public transport at different times and places in the city or the surrounding area? How does it affect public transport costs and socio-economic efficiency?

- What kind of individualised and context-conscious *information* can support combined-service travel from a passenger's perspective? How can this be adapted for passengers with different circumstances and requirements?
- How can resilient *collaboration and business models*, including information sharing, be designed for different types of combined-service traveller, which include both traditional public transport, new mobility services, walking and cycling, in ways that lead to more sustainable travel in cities and regions?
- How can public transport services, including special passenger transport, be affected by new mobility services, e.g. in a city's suburbs or periphery, or where there are few passengers? How does this affect *society's responsibility* to provide and finance public transport, and how can public transport authorities and other societal actors take advantage of the opportunities provided by new solutions?
- How is the *physical environment* impacted by digitisation and the new mobility services, e.g. the location and design of interchanges? What does this mean for urban and infrastructure planning locally, regionally and nationally?

Expected results

The research is expected to contribute to an increased understanding of how new technology and new services can affect public transport. It includes increased knowledge about how people with different needs and circumstances choose to travel when new opportunities for mobility and information are offered. This knowledge helps to make the regional public transport authorities, municipalities and other relevant actors better equipped to handle opportunities and risks in the mobility landscape of the future and increases their strategic ability to influence trends in a direction that leads to more sustainable travel.

Market and financing

Management, agreements, pricing and forms of funding for resource-efficient and attractive public transport

The public transport market is characterised by a dynamic relationship between supply and demand, and the fact that a significant part of the supply is funded by taxes. Most of the local and regional public transport in Sweden is operated as procured transport services. This means that the conditions for public transport are largely determined within the framework of a scheme involving public clients and private contractors. For several years and in different ways, it has been an ambition of regional public transport authorities to influence the costs, quality, environmental performance, supply and demand by means of new contractual models, such as through incentives for the operators. These models have consequences for passengers and for the design of the transport system. In addition to the procured transportation, there are public transport services provided on commercial terms, as well as public transport in its own right. Regional public transport is financed partly through taxes and partly through ticket revenues. The future investment needs and operating costs of public transport and how these are to be financed is a growing challenge, especially in light of ambitions to achieve an increased share of motorised travellers for public transport. The issue of financing has become more topical due to the loss of income caused by reduced travel. Changed travel demand can also force changes in the supply. Different price strategies can increase or reduce passenger numbers, and lead to increased or reduced operating costs.

Overall research issues

Understanding passengers' circumstances, preferences and experiences is fundamental to developing public transport in the desired direction. Knowledge is also needed about how organisational reforms affect the market in ways that create increased public benefits. Such reforms generate effects that may be intentional or unintentional and unforeseen. The following overall issues are emphasised within the area:

- How do different *supply and price strategies* effect passengers using public transport, e.g. differentiated pricing and free public transport, and how does it affect different groups of passengers with regard to e.g. availability and

distribution? How can such strategies be implemented in ways that achieve policy goals regarding e.g. socio-economic efficiency, and which are also acceptable to citizens and the various social actors?

- How do different *contract and business models* affect the market and how do they contribute to achieving politically determined goals, including how those goals are translated and interpreted, for example in contracts? How do requirements in the contracts affect the preconditions and expectations of those who provide public transport?

- Which *factors* affects the conditions for public transport authorities and public transport companies within the existing procurement system, e.g. technology development, competition levels, standardisation of contracts? Which factors influence the choice of regime, e.g. the presence of commercial traffic and traffic operated independently? How can knowledge of these factors be used to develop the organisation of public transport?

- What preconditions exist to change the *funding* of the operation of and new investments in public transport, e.g. in ways that more clearly link the funding to those who benefit from such measures? How does it affect the incentives of different administrative levels to implement measures?

- In what way and with what result can *value-creating partnerships* between regional public transport authorities, transport companies and municipalities etc. help to develop the public transport market, including the ability to develop innovate solutions?

Expected result

The research is expected to lead to an increased understanding of the public transport sector's market conditions, how different strategies and business models affect the ability to achieve predetermined public transport objectives, including targets for increased passenger numbers and increased cost efficiency. The research also helps highlight and analyse new approaches to the funding of public transport in the future. The research will provide public transport authorities, public transport companies and other relevant actors with insights on the market's current organisation and how it can be developed in the future.

Decisions and effects

Public transport's social effects and increased knowledge of the role of analysis results and analysis methods in decision-making processes for improved goal achievement.

Public transport is increasingly viewed as a tool for the development of cities and regions, based on a broad sustainability agenda that includes economic, social and environmental aspects. Knowledge of the effects of public transport for individuals and for society as a whole is of crucial importance for decisions on traffic supply programmes, investments and other measures that lead to increased target achievement. In order to contribute to strategic decision-making, the effects of public transport must be understood in a context that includes overall demographic and technological changes in society. A more systematic use of analysis methods, both before and after the fact, can contribute to increased knowledge and learning that will strengthen strategic capabilities in the long term. It is enormously important to also increase our knowledge of how analyses and their results are used and negotiated in practical planning and decision-making processes.

Overall research issues

A key aspect of the research area is to describe the effects of public transport on individuals and society, and to critically analyse how individuals and groups are described in analysis models. Previous assumptions about people's behaviours and travel habits may need to be reviewed. Impact analyses not only play an instrumental role in decision-making but are often used conceptually or symbolically. Knowledge of effects must also, therefore, be analysed and understood on the basis of how decision-making processes work in practice. The following research issues have high priority in this area:

- How does public transport contribute to achieving local, regional and national *policy objectives* for sustainable cities and regions, e.g. regarding employment targets and reduced climate emissions?
- What effects do *different types of actions* have on travel and on passengers' experiences, e.g. accessibility measures for public transport? How can knowledge of such effects be used to guide the measures taken by

municipalities and regions so that they can be expected to achieve the greatest benefit in terms of more sustainable travel?

- What are the *system effects* of actions in the public transport system and its components, e.g. new conceptual solutions, vehicle electrification, changes to infrastructure and the services offered? How can this knowledge be used to contribute to decisions that lead to the attainment of established objectives?

- How can citizens and passengers become more *involved* in analysis and decision processes? How can participation contribute to a better understanding of how public transport is perceived, how it functions and how it can be improved, and at the same time increase legitimacy with citizens for decisions on public transport development?

- How are analyses used in actual decision processes? How can analyses e.g. evaluations after the fact, be systematized in order to contribute to *long-term learning* within the public transport sector?

- Which new or developed *models for impact assessments* before the fact (e.g. simulation models) or after the fact, can support decision-making, in which the rate of change is high and uncertainty is high, for example, the use of new technology and new services? Which existing and future data sources can be used to support both operational and more strategic decision-making? Who has access to such data and with what consequences?

Expected results

The research is expected to contribute to new knowledge on the effects of public transport and to further develop methods for evaluating these effects. New insights on how decision-making processes work and what role analyses and methods of analysis play in these will be presented. The knowledge will contribute to more informed decision-making processes, to increased learning among public transport actors and greater participation by citizens. Overall, this will contribute to an increased ability to make decisions that lead to the attainment of established goals, e.g. regarding the transition required to achieve the climate goals.

Integrated planning

Public transport design and its integration with land use and other local and regional planning

Public transport both affects, and is affected by, complex relationships with other functions and events in major cities and their surrounding areas. The planning, implementation and operation of public transport therefore needs to be more integrated with other spatial planning. This particularly applies in relation to issues concerning strategies and plans for urban land use and planning, but also in relation to other social functions at local, regional and national level, such as healthcare, education, environment and regional development. Public transport must also be planned in an integrated manner with other types of traffic, e.g. to better integrate cycling and public transport. Integrated planning must be done on the basis of changing societal needs due to an ageing population and technological developments, and on the basis of demands for a transition in order to achieve climate targets and accessibility goals.

Overall research issues

Public transport and buildings are fundamental structures in a city, and how well they are integrated into the urban landscape plays a crucial role in the living and provisioning conditions of individuals and groups, as well as their options for sustainable travel. The design of public transport is influenced by and affects other functions in cities and regions and affects the land values of cities, often in ways that have a structuring role. Integrated spatial planning places great demands on coordination and cooperation between organisations, which can be difficult due to different goals, interests, professions, organisational cultures and divisions between different administrative levels. Collaboration is often time consuming and can contribute to unclear divisions of responsibilities. Research is required on the following issues:

- How and with what consequences can the planning of public transport be *integrated with other urban and regional planning*? How can the integration be improved between different types of traffic, e.g. public transport and cycling? What formal and informal obstacles exist for this to happen?

- In what way can the preconditions for public transport be developed through *cooperation* between private actors, municipalities, regional and state authorities, e.g. through financial incentives or more coherent processes for infrastructure investments and accessibility measures? How is the interaction between actors' different goals, interests and practices affected? In what situations and in what way can collaboration be difficult, for example, by creating an unclear allocation of responsibilities?
- In what way and with what result can *planning be broadened* so that public transport is handled in a more integrated way with other areas, e.g. the healthcare sector? What requirements does it impose on organisation and the ability to collaborate between different actors?
- How can we get a better understanding of the *structuring effect* of public transport on urban land use, including different types of public transport, e.g. track-bound traffic and electrified bus traffic? In what way is this affected by new concepts and new mobility services, within cities and between cities and their surrounding areas?
- In what way can cities and regions be developed through *densification* around public transport hubs, and how can bus stops, stations and hubs be designed as meeting places in the city?
- How, and with what effects, can municipalities and regions work to *disperse the demand* for public transport over larger parts of the day, e.g. through dynamic opening hours of social functions such as schools and childcare, increased opportunities for distance working etc.? This issue has become more topical in recent times.

Expected results

The research is expected to highlight how different goals, interests, professions and organisational cultures have an impact on the way in which planning is conducted and the effects that this has on the physical design. This knowledge will contribute to exploring the preconditions for, and opportunities associated with, more integrated social planning. The research offers public transport actors a better understanding of how coordination and collaboration with other important areas can and should be conducted in order to achieve good results.

Public transport for all

Public transport's contribution to, and impact on, accessibility, democratic processes, inclusion and exclusion.

Public transport investments can play an important role in social and economic inclusion in cities and their surroundings. Urbanization, an ageing population and migration represent major challenges, not least in terms of how society's resources are made available through the transport system. The design and availability of public transport play an important role with respect to this challenge, for the individual and for different social groups. Within the cities, the question is how the requirements of companies and enterprises for establishment locations, demand for centralised housing and proximity to high-quality public transport can be balanced against the needs of other groups for accessibility in ways that create well-being and quality of life for all residents. Previous urban planning, with the ideal of functional division, has contributed to social exclusion in some cases. In large cities, therefore, there are problems with socially segregated environments, with residents who cannot afford a car and where access to public transport is therefore essential. At the same time, public transport does not always satisfy the needs of these areas, where the environment in and around public transport is perceived as unsafe or transport is perceived as too expensive.

Overall research issues

A public transport system suitable for everyone requires knowledge on how the accessibility, mobility and quality of life of different individuals and groups are impacted by the public transport system. A society that satisfies all its citizens' needs and ensures that all citizens can have influence, imposes demands on planning processes with democratic participation, and pays attention to which groups in society (based on e.g. age, income, ethnicity, disability, type of residence) benefit from new public transport solutions and mobility services. Changed conditions for teleworking can further affect the accessibility of different groups. The transport system, including public transport, plays an important role with respect to the ambitions to reduce social gaps and improve economic development, job creation and housing supply. The following research issues are prioritised in the research area:

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- which groups in society are *benefited or disadvantaged* by public transport investments, changed services and pricing, and in what way the public transport system can support more equal and egalitarian access to society's resources?
- What account do authorities take of citizens' *different needs and perceptions* when designing public transport, e.g. children, people with disabilities and different socio-economic groups?
- How, and with what results, does collaboration between public transport actors and residents, including new, digital methods for *dialogue and feedback* increase the participation of different groups in planning and decision-making?
- How is public transport planned and designed so that it is, and is perceived to be, *safe and secure*, for both passengers and employees? How can it be designed to minimise noise and barrier effects?

Expected results

The research is expected to contribute to an increased understanding of public transport as a means of increasing social sustainability. The special needs of different groups in public transport are made visible, and concepts such as social benefit, quality of life, health and accessibility are developed in relation to public transport. In regard to public transport actors, such as regional public transport authorities and municipalities, the research will lead to an increased understanding of how to better include different groups in the planning process. The research also contributes to an increased understanding of how public transport, in combination with new mobility solutions, can be designed to offer solutions to those who currently have limited mobility.

4. Conclusion

The transport system must be reorganised to meet the overall societal challenges of environmentally, economically and socially sustainable development in cities and regions. There are high expectations for public transport as a fundamental component in such a transition. While traditional public transport must be further developed and improved, more radical changes are also required, including digitisation, new mobility services, new organisational and business models and society's changing needs and expectations.

Through research in the five research areas and from the three perspectives presented here, K2 contributes to new knowledge of public transport as a means for achieving sustainable cities and regions. In order for this knowledge to lead to changes and renewal in practice, research and extensive and persistent efforts are required to communicate and discuss research results with those who work with, or are affected by, public transport in various ways. Knowledge compilations and training aimed at professionals are important forms of increased learning that can bolster the strategic and operational capacity of public transport actors.

Through new knowledge, combined with high ambitions for knowledge sharing and collaboration between research and practice, K2 facilitates joint efforts to achieve global sustainability goals.

5. Appendix - implementation

K2's research focus for 2020-2024 is translated into actual activities through research projects of varying scope. These are developed and implemented in collaboration between research and practice. The forms and degree of collaboration can vary between different projects.
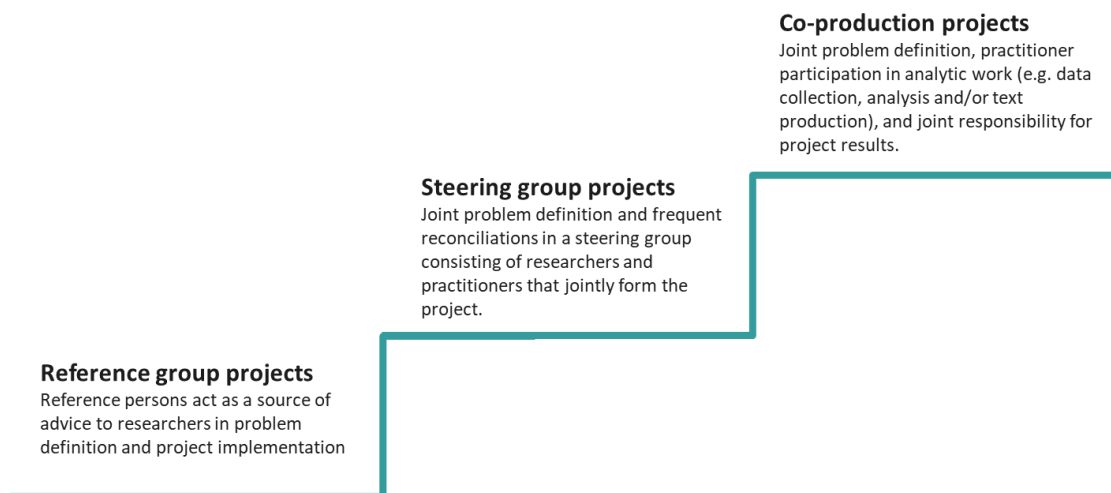
Large research projects

The larger research projects have a timeframe of up to three years, and an economic scope of SEK 2-6 million. The projects are led by one of K2's research partners (Lund University, Malmö University, the Swedish National Road and Transport Research Institute) but may also include researchers from other organisations in Sweden and internationally. During the five-year period, at least two decision-making points will be established for larger projects. The first of these will take place in 2019 and concerns projects to be implemented during the period 2020-2022. The process takes place in two steps, where the first step relates to outlines. The outlines that are considered to have the greatest potential will have the opportunity to submit a complete project description. Decisions on major research projects are made by K2's board.

Smaller research projects

Smaller research projects are projects with an economic scope that does not exceed SEK 500,000. These projects are also led by one of K2's research partners, but can also include researchers from other organisations. The invitation to submit proposals for smaller research projects usually takes place twice a year, in the spring and autumn. The first round of decisions will take place in October 2019. Decisions on smaller research projects are made by K2's board.

Collaboration between research and practice

Research projects within K2 are developed in collaboration between research and practice. This means that dialogue between researchers and the actors relevant to the project takes place when research issues and problems are defined. For larger projects, requirements are also set for collaboration in the implementation of the projects. Such collaboration is also desirable in smaller research projects. Collaboration can be designed in different ways depending on what is appropriate, based on the project's specific conditions. Collaboration can take place at different levels, as illustrated by K2's collaboration steps (see Figure 2 below).

Co-production projects
Joint problem definition, practitioner participation in analytic work (e.g. data collection, analysis and/or text production), and joint responsibility for project results.

Steering group projects
Joint problem definition and frequent reconciliations in a steering group consisting of researchers and practitioners that jointly form the project.

Reference group projects
Reference persons act as a source of advice to researchers in problem definition and project implementation

Figure 2. The collaboration steps provide a schematic picture of different levels of collaboration between research and practice in K2 projects. The level of collaboration is determined by the specific project's conditions and needs. In specific research projects, this can be designed in many different ways, where the forms of collaboration can also differ in the various phases of the project. One basic requirement in all K2 projects is that problems and research issues are formulated in dialogue between research and practice. Large research projects also have requirements for collaboration concerning project implementation.