

Visualizing Data for Systemic Approach & Governance Decisions

CASE STUDY – SWEDEN

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Contents

Summary.....	4
Main key findings	4
Introduction	5
Organization overview: SALAR	7
Analytical framework of the case study	8
Operationalizing the Agile EDU analytical framework	8
Background	10
Municipality background statistics	11
The incentive to “No vulnerable areas 2030”	15
The agreement	15
Initiative - “No vulnerable areas 2030”	16
Vulnerable areas	17
Living condition index	18
Vulnerable living condition areas	19
Synergies on the education area	19
Data informed governance as a tool	20
The tool - visualizing data on a map	21
Key findings master thesis	23
Method	24
Result and analysis	25
Regulations, rights and privacy	26
Conclusion	30
Recommendations	32
Meso perspective - municipal level	32

Meso and micro perspectives	34
Equity and inclusion considerations	34
Final words	35
References	36

Summary

Research shows that pupils who live in areas with lower socioeconomic standards and higher exposure to criminal activity perform worse in school than pupils from areas with higher socioeconomic standards. This case study presents how a Swedish municipality uses data and visualization to address the challenge of educational inequality among students from different socio-economic backgrounds. The municipality uses official statistics on school results, collected by Statistics Sweden and the Swedish National Agency for Education, to identify and monitor the students who are at risk of dropping out of upper secondary school. The municipality also uses GIS maps to visualize the spatial distribution of school performance and socio-economic factors across different areas of the city.

The case study is based on the Agile EDU analytical framework, which views data use and datafication as an ecosystem of various education stakeholders, each with their own priorities and perspective on tackling the challenges of education through the use of data. The framework includes three pillars of which this study focuses on pillar 3 (data governance), but also touches on pillar 1 (regulation, rights & privacy) and pillar 2 (data in use for teaching and learning).

Main key findings

Regulations, rights and privacy

- Challenges and limitations in a data-driven approach concern:
- Addressing ethical concerns is crucial to avoid stigmatization and reinforcing stereotypes.
- Relevant data collection and safe integration are essential for comprehensive and responsible analysis.
- Using access-controlled login in the visualization tool is crucial for protecting the privacy of data subjects.
- Fostering a culture of trust, transparency and empowerment are essential in data-driven approaches.
- The use of a visualization tool can help to reveal spatial patterns and relationships.
- Data visualization tools should aim to understand underlying factors affecting school performance rather than ranking schools, areas or specific groups

Data in the use for teaching/learning

- A new way of using and analysing already existing data has shown that switching to a school in a less vulnerable area does not necessarily lead to improved academic performance for students from vulnerable areas.
- The use of GIS-maps can help to generate hypotheses and questions for further research and exploration

- Data and visualizations can be utilized to plan, monitor, and evaluate interventions effectively.

Data governance

- The municipality has discovered that a data-driven strategy, which involves the collection, analysis, and visualization of data on school performance and socio-economic backgrounds at various levels, can effectively identify students in vulnerable areas who are at risk of not achieving eligibility for upper secondary school.
- The use of GIS maps has helped to unveil and illuminate data and facts that were not visible earlier, e.g. through:
 - Revealing patterns and correlations in school performance and socio-economic factors, enabling the comparison of schools and identification of best practices and areas for improvement.
 - Showing that there are significant variations in school performance and socio-economic conditions within the same area or even within the same school.
 - Revealing that some schools have more students from outside their catchment area than others, which may indicate a lack of attractiveness or quality of some schools.
 - Demonstrating that some areas have a high concentration of students who are at risk of dropping out of upper secondary school, which calls for targeted interventions and support.
- Data and visualizations can be utilized to inform and communicate with various stakeholders, e.g. political boards, school principals and teachers to increase awareness and advocacy to make well-founded decisions.
- Data and visualizations can effectively be used to improve and justify resource allocation decisions by identifying schools and areas with the highest proportion of students at risk of not achieving eligibility for upper secondary school. This targeted approach allows for efficient and effective support, tailored interventions, and better monitoring and evaluation of resource impact over time.

Introduction

Education is one of the most important factors that determine an individual's future prospects. An incomplete education can give rise to costs both for the individual and for society as a whole. For example, it can lead to reduced lifetime income, increased risk of addiction problems, crime and ill health, and the risk is even higher if situated in a vulnerable area (Grönkvist, Niknami and Santavirta, 2023). Also, the value of education varies between different levels and there are certain thresholds that are of particular importance to overcome. In Sweden, two such thresholds are to

meet the entry requirements for upper secondary school and to obtain an upper secondary school diploma.

Approximately 98 per cent of all young people in Sweden begin an education in upper secondary school. But after five years, just over a quarter of these have still not graduated. Young people who leave upper secondary school without a diploma have fewer opportunities to establish themselves in the labour market, and with this comes for example an increased risk of lower income and poorer health. This means a deterioration in the quality of life for the individual and costs for society. It is therefore important that both school principals and the rest of society work together consciously and strategically to prevent dropouts (SALAR).

The Swedish school system is structured to provide comprehensive education from preschool through upper secondary school. Compulsory education lasts for nine years, encompassing primary and lower secondary education, which aims to ensure that all students acquire fundamental skills and knowledge. Following this, students typically proceed to upper secondary school, which offers a variety of programs tailored to both academic and vocational interests. The system is designed to be inclusive and equitable, with the intent of fostering a supportive environment for all students to achieve their full potential. Additionally, there is a shared responsibility between the state and the municipality, with the state setting national educational standards and the municipalities managing the day-to-day operations of schools.

There is convincing evidence in the literature that early investment in pupils' human capital and skill formation provides better conditions for success later in life (Cunha and Heckman, 2007). The data of pupil results by school and residential area used by the municipality in this study supports analysis that principals can be used to give the best possible support to the students who have the most challenges/needs. This way, the chance increases that relevant actions can be taken as early as possible, and the school gets a broader analysis basis to work with to improve equality and inclusion.

Research by Schildkamp, Kim, and Datnow (2016) indicates that data-driven decision-making in education significantly gains from a collaborative setting. Additionally, Schildkamp and colleagues highlight the necessity of structured interactions within these collaborations to enhance informed and effective decision-making.

However, the success of these data-driven strategies heavily relies on the accuracy and reliability of the data being utilized. Accurate and reliable data are crucial for making well-founded decisions that can genuinely benefit students. Inaccurate data, on the other hand, can lead to misguided policies and interventions, potentially exacerbating existing issues rather than resolving them. Therefore, ensuring the integrity of data collection, analysis, and visualization processes is paramount to achieving the desired outcomes in educational settings.

Furthermore, in order to give each student, the conditions to cope with their education, it is of great importance to identify the students who are in need of extra support at an early stage. Students who live in areas with lower socioeconomic standards and higher exposure to criminal

activity are at greater risk of failure in school than pupils from areas with higher socioeconomic standards (Holmlund, Sjögren and Ockert, 2020). Since learning is a cumulative process where the ability to absorb new knowledge is often based on having completed the previous steps, it is especially important to detect the students who are starting to fall behind at an early stage.

This study aims to examine how school results affect the prospects of students in terms of further studies, health, and overall living conditions. Therefore, this study considers not only school-specific context factors but also a broader perspective of the quality of life for the individual and the costs for society.

The main challenge addressed by this case study is that despite generally good school results, the municipality fails in providing all pupils from socio-economically disadvantaged areas with sufficient knowledge to qualify for upper secondary studies.

Additionally, this case study incorporates two learning stories that provide further practical insights into the utilization and management of data. These stories offer detailed examples of effective data-driven strategies in educational settings, highlighting the importance of accurate data and analytical knowledge.

Challenge	Context	Issue	Goal
School results	Municipality	Failure to provide sufficient knowledge for pupils from disadvantaged areas	Qualify for upper secondary studies

Table 1 Challenge and Goal

Organization overview: SALAR

The Swedish Association of Local Authorities and Regions (SALAR), known in Swedish as Sveriges Kommuner och Regioner (SKR), is a crucial organization representing the governmental bodies of municipalities and regions across Sweden. SALAR's primary mission is to safeguard the interests of its members by advocating for their needs and providing support and advisory services within various domains including education, healthcare, and public administration.

SALAR facilitates collaboration and knowledge-sharing among municipalities and regions, thereby fostering an environment conducive to innovation and improvement in public services. The organization plays a vital role in promoting policies and practices that enhance the quality and efficiency of public administration.

In the context of education, SALAR actively engages in initiatives aimed at improving educational outcomes and ensuring equity and inclusion in schools. By leveraging data and evidence-based practices, SALAR helps municipalities identify challenges, implement effective strategies, and monitor progress. This is particularly significant for addressing disparities in educational attainment and ensuring that all students, regardless of their socio-economic background, have access to quality education and opportunities for further studies.

Additionally, SALAR collaborates with national and international bodies to align local educational policies with broader regulatory frameworks and global best practices. This ensures a cohesive approach to managing and utilizing educational data, safeguarding privacy, and enhancing the overall governance of the educational system.

Analytical framework of the case study

This case study is based on the analytical framework developed by the (Agile EDU literature review on datafication in and of education, 2023) (fig.1). The analytical framework views data use and datafication as an ecosystem of various education stakeholders, each with their own priorities and perspective on tackling the challenges of education through the use of data. This ecosystem is based on the interrelationship between three pillars: (1) regulations, rights and privacy (national, international level); (2) data in the use for teaching/learning (classroom and individual level); and (3) data governance. At the core of these three pillars is the data generated by students and teachers.

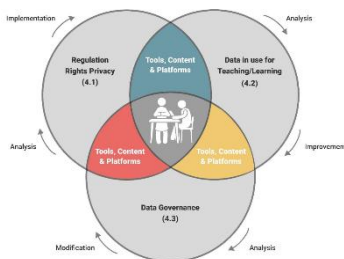


Figure 1 Agile EDU analytical framework (2023)

The municipality in this case study (hereafter referred to as “the municipality”) describes a project which is largely about data-driven development where data and statistics are made visible at a more granular level than the municipality's average. The data can be visualized in a clearer way, for example with the help of the municipality's GIS maps. The project, which is run by the municipality, enters the Agile EDU project based on the pillar of “Data governance” but also touches on the areas of regulation, rights and privacy and data in use for teaching and learning, all of which constitute pillars of the Agile EDU analytical framework (fig 1).

Operationalizing the Agile EDU analytical framework

An illustration of this study’s operationalization of the Agile EDU analytical framework is shown in figure 2. A short summary of this study's practical operationalization of the Agile EDU analytical framework is:

- The study focuses on the pillar of data governance, which examines how data is collected, managed, shared, and used for decision-making and improvement in education.

- The study aims to answer the research question of how the use of available data concerning upper-secondary eligibility among students from vulnerable areas can lead to informed governance decisions at a municipal level.
- The study also explores the possibilities of using data to reveal other patterns related to life chances and opportunities/prospects for higher/greater equity and inclusion in education.
- The study applies the Agile EDU analytical framework to the context of a Swedish municipality that is exploring new methods to discover, highlight, and visualize data to promote equity and inclusion.
- Furthermore, the study considers the interrelationship between the data governance pillar and the other two pillars of the Agile EDU analytical framework: regulations, rights and privacy, and data in use for teaching and learning.
- In this case study the pillar of "Data in use for teaching and learning" has been interpreted in the context of how school leaders, politicians and other decision makers at different levels of governance use the visualized data from the municipality to improve equity and inclusion (challenges and opportunities).

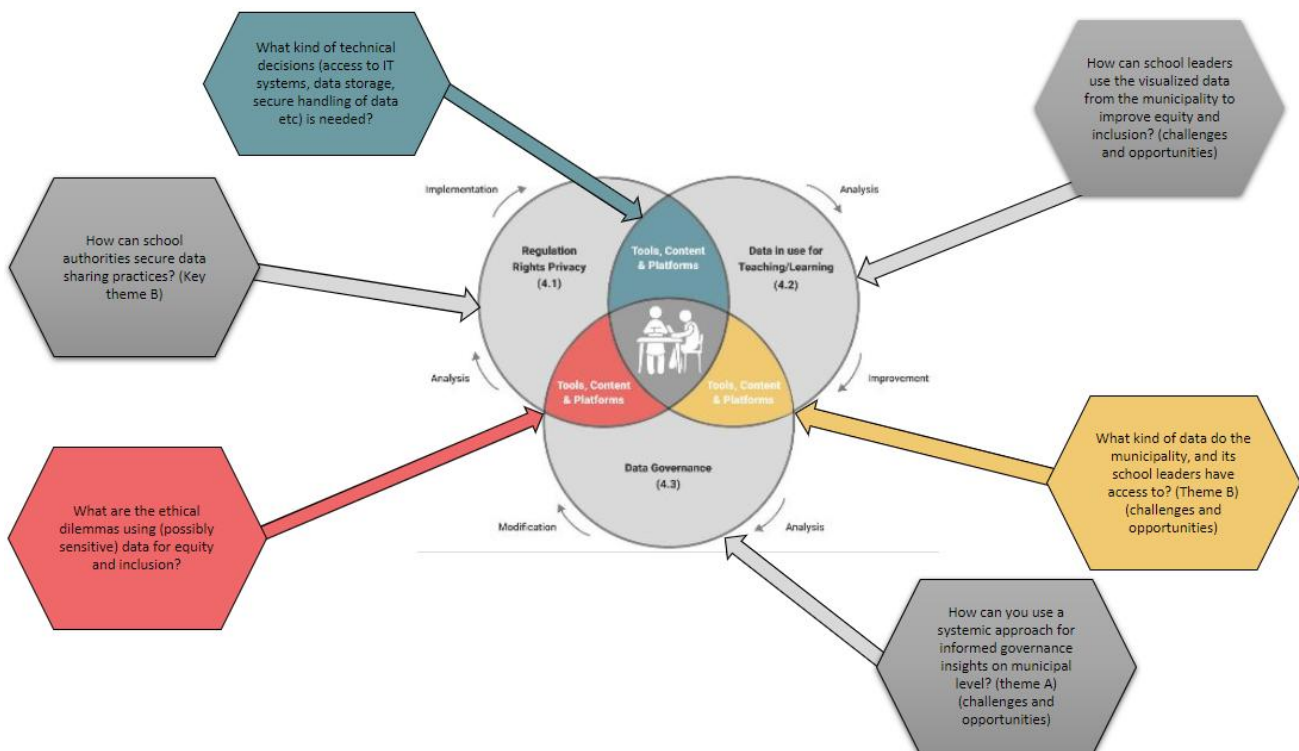


Figure 2 Operationalization of the Agile EDU analytical framework (2023)

Research question

How can the use of available data concerning upper-secondary eligibility for students from vulnerable areas lead to better informed governance decisions at a municipal level?

Background

The use of data is rapidly increasing in society overall as well as in the school sector. Still, from what we know generally the school sector suffers from e.g. lack of knowledge concerning what type of existing data appropriate to use, how it can be visualized, competence of how to analyse the data as well as jurisdictional, legal and ethical aspects. This case study examines a Swedish municipality that is exploring new methods to discover, highlight, and visualize data to be able to make informed decisions that promote equity and inclusion.

The overall goal in the municipality is to reverse the negative trend within the vulnerable areas in the municipality and to create better living conditions as well as security for residents. According to the municipality, it is particularly important to strengthen residents' self-efficacy, civil society and collective capacity, as well as the institutional capacity of authorities and companies. Included in the overall goal, and of specific interest for this study, is for the municipality to increase the number of students from vulnerable areas eligible for upper secondary school.

One of the sources of data that the municipality uses in its project is the official statistics of school results collected by Statistics Sweden (SCB). Statistics Sweden is a government agency that produces and distributes official statistics, as well as coordinates and supports the Swedish system for official statistics. The system consists of about 30 agencies that produce statistics within their respective fields of responsibility.

The statistics of school results are based on the mandatory reporting of grades and other information from schools to SCB and the Swedish National Agency for Education (Skolverket). This reporting covers all students in compulsory and upper secondary education, both in public and independent schools. The data includes information on students' grades, eligibility for upper secondary school, educational programs, completed courses, diplomas, and national tests. The data also contains background variables such as gender, age, residence, migration background, parental education, and income.

This information is then used to produce different statistics, evaluate education and allocate state grants. The reporting obligation is regulated by the Education Act (2010:800), the Education Ordinance (2011:185) and the Ordinance (1993:1153) on situation reports on the education system. The principals must also comply with the General Data Protection Regulation (GDPR) when they handle personal data within the education system.

Municipality background statistics

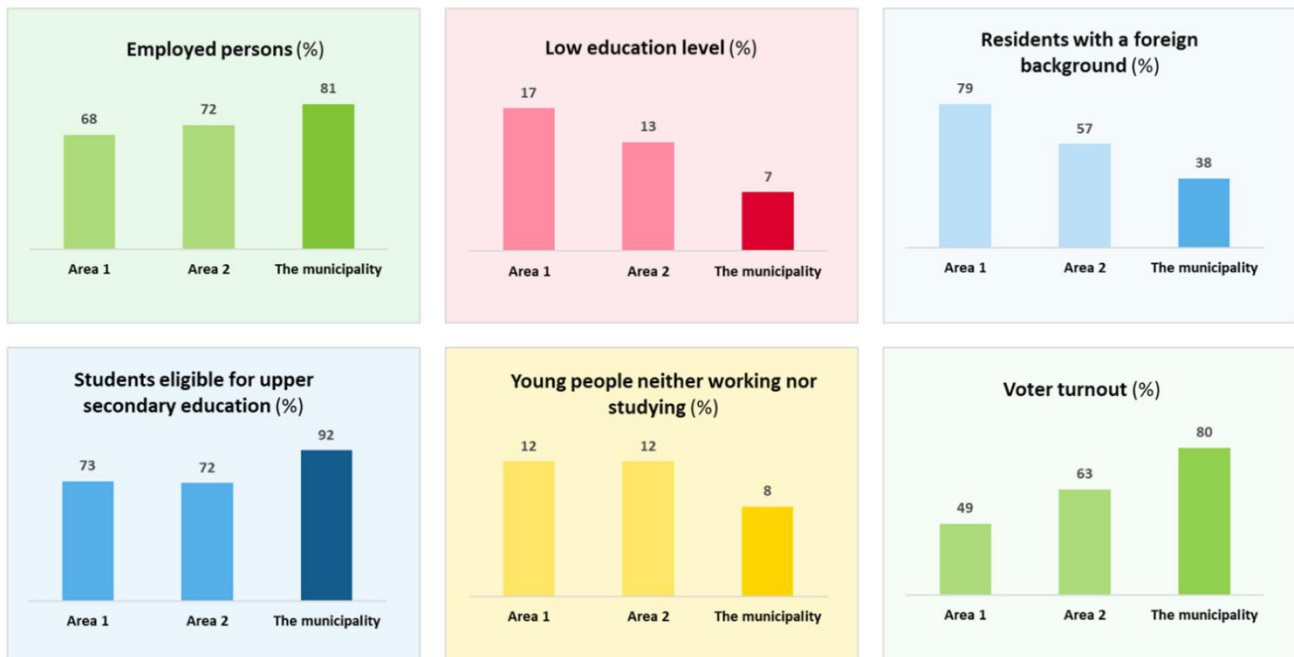


Figure 3 Educational level, voter turnout, number of residents with foreign background

The diagrams in Figure 3 provide an overview of various aspects of the municipality, such as employment rates, educational level, number of residents with foreign background, students eligible for upper secondary education, and voter turnout. Comparisons are made between the average for the entire municipality and two specific areas, area 1 and area 2, within the municipality.

There are noticeable differences between the overall average for the municipality and the specific results from the two areas across all diagrams. For instance, the proportion of young people who are neither working nor studying is higher in area A and B compared to the municipality as a whole. Similarly, the data shows that the share of students eligible for upper secondary school is lower in these areas than the municipal average. These patterns are observed consistently throughout all the diagrams.

The municipality

The residents of this municipality benefit from some of the highest incomes and best educational outcomes nationwide. The data below highlights key metrics such as median net income and academic accomplishments. While the municipality demonstrates robust socio-economic and educational performance overall, it faces challenges related to income disparity, academic results in certain subjects, and vulnerable regions that it plans to address by 2030.

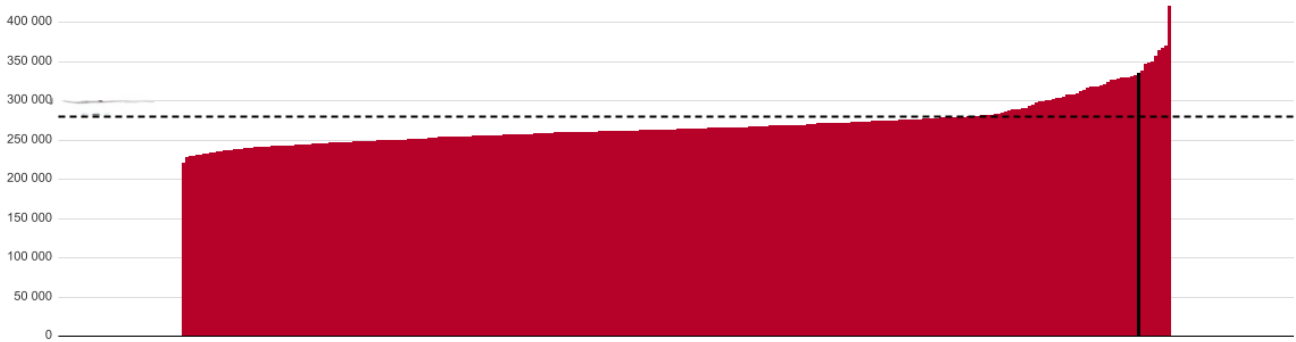


Figure 4 Median income - This figure shows the median net income for all municipalities in Sweden, where the sharp black vertical line represents the municipality, and the dashed line represents the national average. (Kolada, (SALAR), 2024).

Simultaneously, the municipality experiences significant income disparities, and in 2020, it had two areas included on the police's list of vulnerable regions. In that year, local politicians decided that by 2030, there should be no vulnerable areas left. To meet this goal, the municipality works collaboratively across its departments and with external civil organizations. Regarding student performance, data indicates high overall eligibility rates within the municipality. This is illustrated in Figure 5, where the bar on the right represents the municipality. It shows that the proportion of students qualifying for upper secondary school in the municipality is greater than the national average.

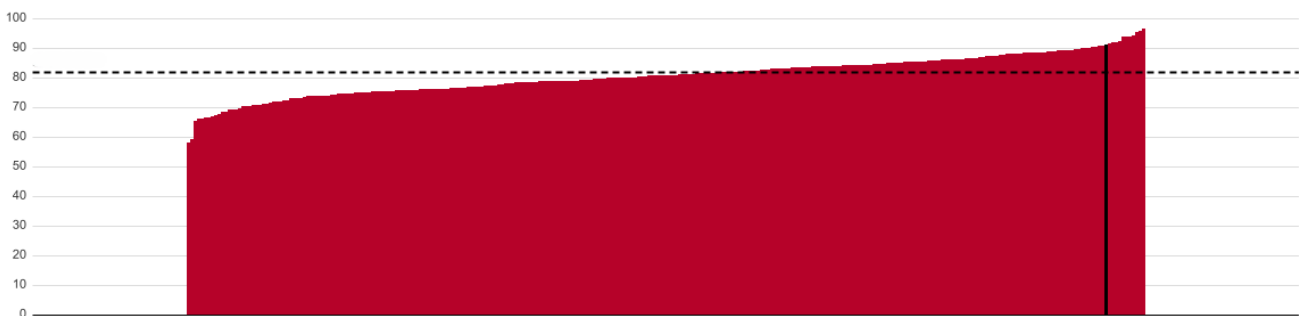


Figure 5 National pupil eligibility for upper secondary vocational programs. This figure shows the national eligibility for Sweden (%). The black vertical line represents the municipality, and the dotted line represents the average in Sweden, the red area represents the spread between all municipalities. (Kolada, (SALAR), 2024)

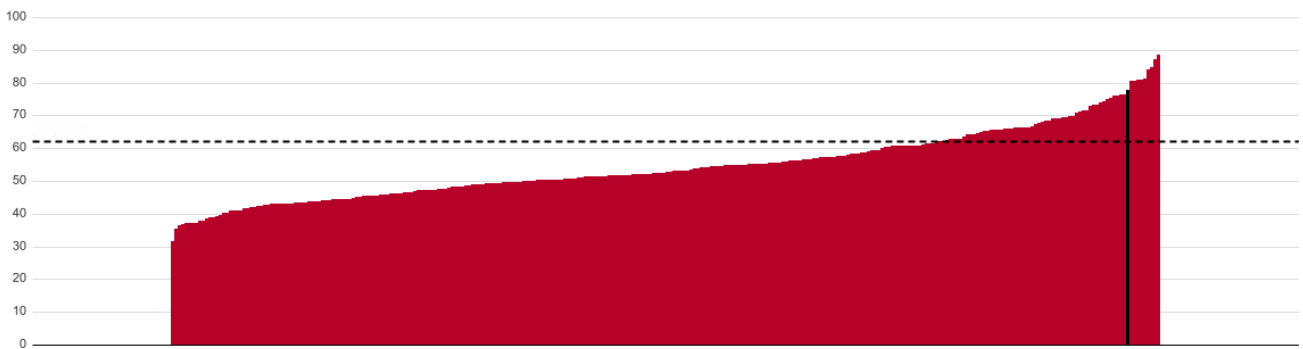


Figure 6 Post secondary education. Students whose parents have post-secondary education, grades 1-9 in municipal primary school, percentage (%). The black vertical line represents the municipality, and the dotted line represents the average, the red area represents the spread between municipalities in Sweden. (Kolada, (SALAR), 2024)

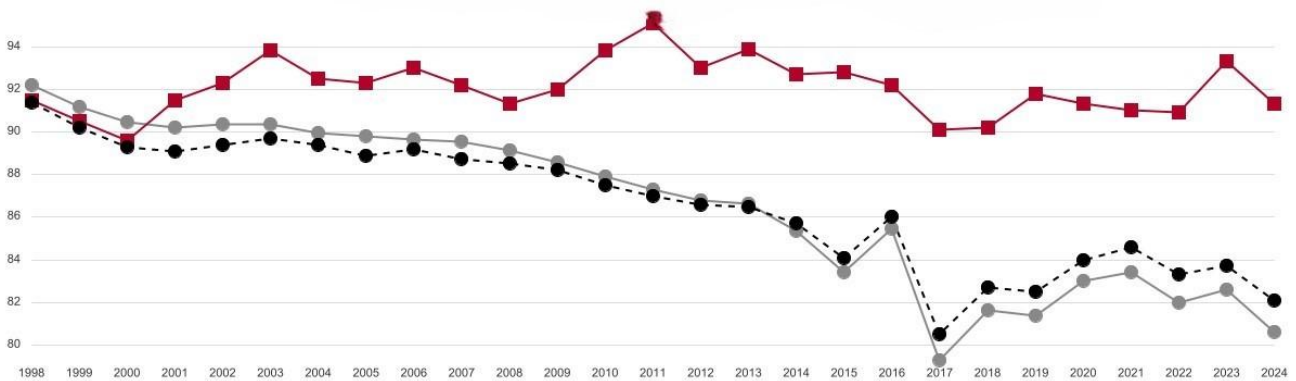


Figure 7 Academic result students' year 9, students' eligibility for upper secondary vocational programs (%).

The figure above (fig.7) depicts the changes in results over time, contrasting the municipalities' outcomes (illustrated by the red line) with those of similar municipalities (shown by the grey line) as well as the national average (represented by the black line). From the illustration, it is evident that the results for the municipalities remain fairly stable over time, consistently exceeding both the average for comparable municipalities and the national average.

Big differences between different areas in the municipality

Figures (8A+B) below depict the upper secondary school eligibility of students across different municipality areas. While most areas show high eligibility, some range between 68% to 79%. Figures 9 (A+B) indicate that vulnerable areas correlate with lower student eligibility rates, highlighting disparities when comparing figures 8 (A+B) and 9 (A+B).

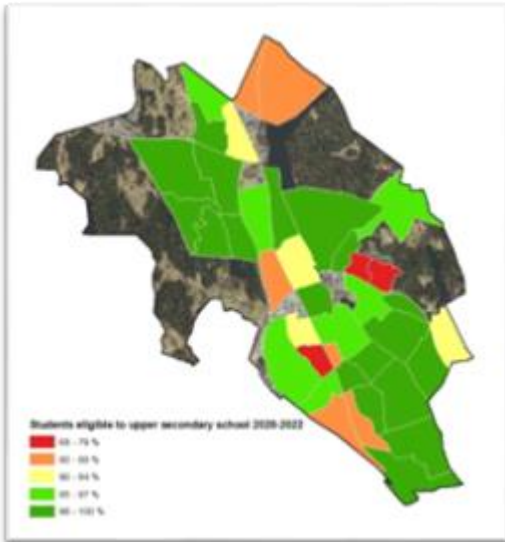


Figure 8A

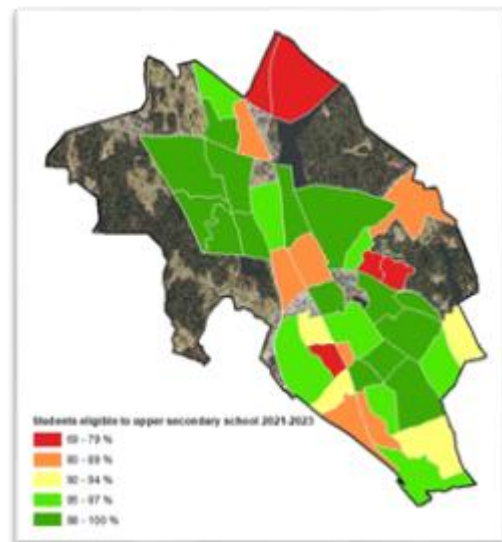


Figure 8B

Figure 8 Maps showing students eligible to upper secondary school. Green areas indicate high socioeconomic standards, while red areas show lower standards.

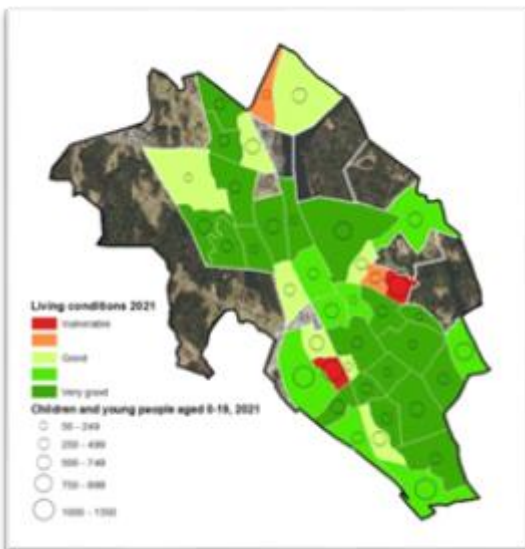


Figure 9A

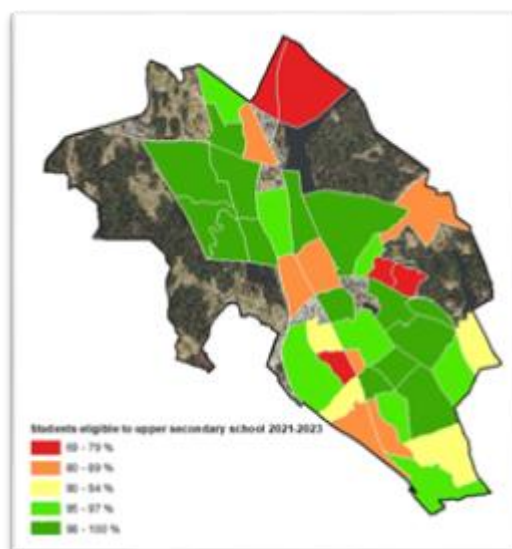


Figure 9B

Figure 9 Maps showing living conditions and pupil population density. Green areas indicate high socioeconomic standards, while red areas show lower standards. Larger circles denote higher pupil density.

The incentive to "No vulnerable areas 2030"

The municipality has a strong motivation to engage in the agreement "No vulnerable areas 2030" as it sees the negative consequences of the socio-economic segregation and criminal influence in its territory. The municipality acknowledges that the situation in the vulnerable areas affects the whole city and that it is necessary to address the root causes of the problems, such as poverty, exclusion, discrimination, lack of education in different areas within the municipality, and lack of opportunities. The municipality also recognizes that it cannot solve these complex challenges alone and that it needs to collaborate with other actors, such as civil society, business sector, academia, and the residents themselves. By strengthening the social capital and the institutional capacity in the vulnerable areas, the municipality believes it can create more equal and sustainable living conditions for all its citizens.

The agreement

Within the agreement called "No vulnerable areas 2030" different levels of governance in the municipality are involved at different phases of the process (fig.10). The Municipal Executive Board leads the work; the Education Committee, the Health and Social Care Committee, the Social Welfare Committee, the Culture and Leisure Committee, the Community Planning Committee, the Nature and Technology Committee, the Environment and Building Committee, the Knowledge and Labour Market Committee shall all contribute to the implementation.

The municipal police are integral to this initiative, significantly contributing to addressing crime and insecurity in vulnerable areas. Their active and continuous participation is crucial for collaborating with the municipality and other stakeholders to foster a safer environment for all residents. This cooperative approach ensures that efforts to enhance living conditions are both effective and sustainable.

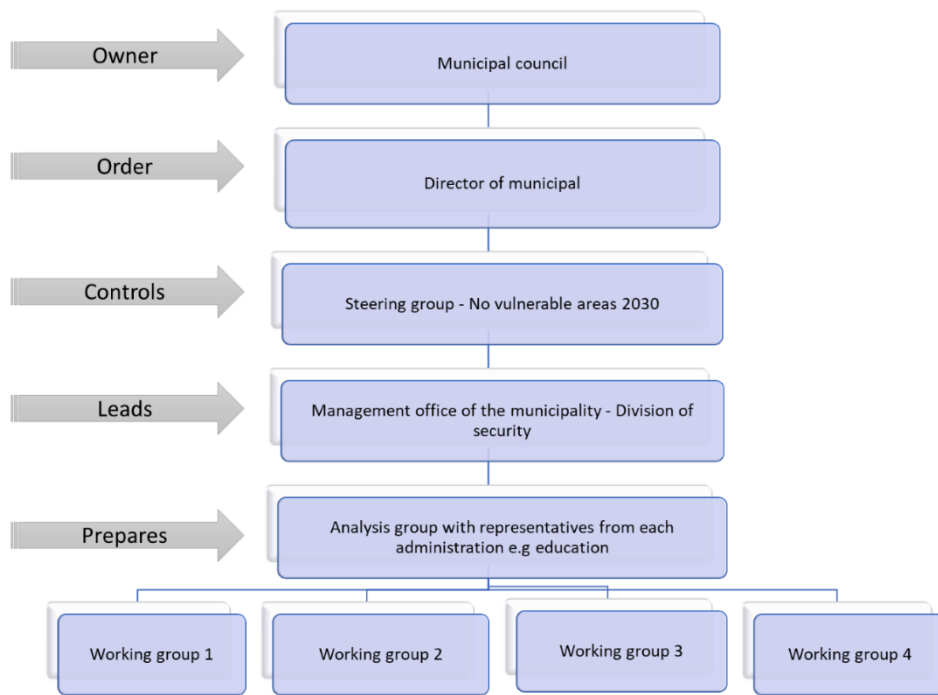


Figure 10 The central organization for "No vulnerable areas 2030"

The development initiative, which aims to reverse the negative trend within the vulnerable areas in the municipality, is a long-term effort and necessary to create better living conditions as well as security for residents in the vulnerable areas.

Initiative - "No vulnerable areas 2030"

What is the best way to evaluate a residential area in terms of the residents' living conditions and the potential impact of crime on their daily lives? What can a municipality do to keep track of how a specific area is changing, and see if the situation is getting better or worse? On behalf of the municipality, Malmö University has created an analysis model to examine what the situation may be like in a residential area in terms of living conditions and criminal influence. The model includes indicators that measure institutional capacity, collective capacity, self-efficacy and the local problems related to crime and insecurity.

The aim of the analysis model is to identify factors that the municipality's activities can affect and that need to be improved to change the direction of the development in the vulnerable areas. It enhances our understanding of the underlying factors behind the development of vulnerable areas and what the municipality's activities need to focus on to create a positive development. The factors are measured in different ways but can be done through statistical data from Statistics Sweden or internal statistics within the municipality, crime statistics etc. The statistics are broken down at the statistical area level to show more clearly the area that is defined as vulnerable. Offices and companies produce business-related indicators to monitor relevant statistics for their respective activities. For example, the education office looks at things like

eligibility for vocational programs and enrolment in preschool, the social welfare office looks at long-term financial assistance and updates for children and young people, etc.

The initiative includes cooperation with researchers from Lund and Malmö Universities who have created the socio-economic index that the model uses. Also, the municipality has requested statistics so that they can see results by school and also by residential area. This data can then be connected to a socio-economic index (living conditions). The data produced is shown in a map tool to display school results based on geographical area along with different areas socioeconomic index. This gives a different picture than what is usually seen by only looking at the municipality's average results or the results of specific schools. Here, the municipality can track individual pupils based on their area of residence and see where they go to school.

Vulnerable areas

A vulnerable area is a neighbourhood or district where people face many difficulties and challenges in their daily lives. These difficulties can include low income, high unemployment, poor education, health problems, social exclusion, and exposure to crime and violence. People who live in vulnerable areas often have less opportunities and resources to improve their situation and participate in society.

The municipality and the police use a specific definition of a vulnerable area to identify where they need to focus their efforts and resources to improve the living conditions and security of the residents. The definition is based on two main concepts: living conditions and criminal influence. Living conditions refer to the resources, relationships and conditions that affect the ability of individuals and groups to fully develop their abilities and potential. Criminal influence refers to the extent to which criminals have an impact on the local community, such as by creating fear, intimidation, or parallel structures.

Using these two concepts, the municipality and the police classify the areas into three categories: risk areas, vulnerable areas, and particularly vulnerable areas. The categories reflect the level of problems and challenges that the areas face, as well as the degree of collaboration and trust between the residents, the authorities, and civil society.

Term	Definition
Living conditions	Resources, relationships and conditions that affect the ability of individuals (and groups) to fully develop their abilities (capacities).
Vulnerable living conditions	Lack of resources, relationships and conditions that decisively limit individuals' ability to fully develop their abilities (capacities). Vulnerable living conditions are affected by individual characteristics, social and structural conditions such as class, gender and ethnicity.

Table 2 Definitions of living conditions and vulnerable living conditions (PO Hallin, 2020).

Living condition index

According to (Datafication in and of education – a literature review, 2023) there is a need for a systematic approach (eco-system) when aiming towards datafication. Aiming towards a systematic approach of analysing data, the municipality uses a living condition index. The Living Condition Index chosen has been developed by Lund University and Malmö University. Three basic factors containing six social indicators determine three life indices: economic conditions, family and housing conditions, and segregation (fig.11).

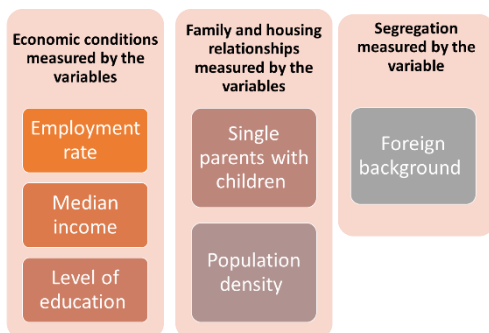


Figure 11 Living condition index – basic factors

The living condition index shows that the socio-economic status is low in two areas of the municipality. Indicators in these areas, such as the level of education, the proportion of gainfully employed people and earned income are lower than the average levels for the municipality as a whole. This is illustrated on the maps (Fig 9A+B), where the different colour schemes of the residential areas highlight differences in living conditions between different areas and the areas that can be classified as vulnerable areas.

One way to understand the connection between living conditions and vulnerable living conditions is to see them as opposite ends of a continuum, where living conditions refer to the positive aspects of people's lives and vulnerable living conditions refer to the negative aspects that limit their potential. The living condition index is a tool that measures and compares the living conditions of different areas based on various indicators, such as income, education, employment, housing, and segregation. By using the living condition index, the municipality can identify the areas that have low socioeconomic status and face more challenges and thus can be classified as vulnerable areas. The living condition index also helps the municipality to design and implement policies and interventions that aim to improve the living conditions and prevent the development of more risk factors in these areas.

Vulnerable living condition areas

Presented below (figure 12) is a map of the municipality, illustrating the living conditions across various subdivisions in 2021, with a focus on the population distribution of young people and students. The map clearly displays the municipality's diversity, indicating that a substantial proportion of the districts boast highly favourable living conditions, while two regions are particularly noteworthy. The data also reveals a concentration of children and young students within these notable areas. This visual evidence supports further exploration into the educational outcomes of students residing in areas that are considered vulnerable or at risk, especially given the high youth demographic in those regions.

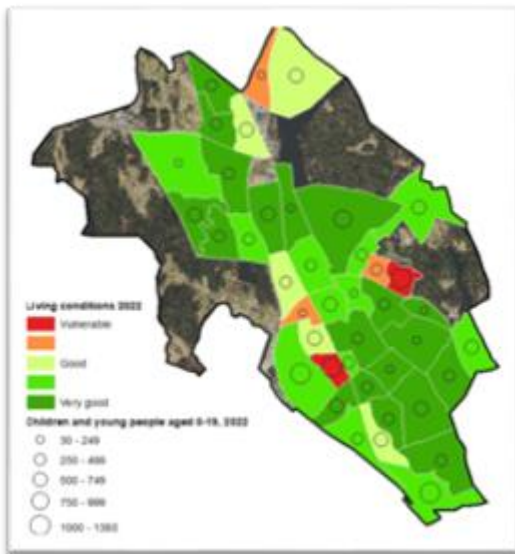


Figure 12 Vulnerable areas - This figure shows a map of the municipality divided into smaller areas. The colours indicate the socioeconomic living conditions, and the circles indicate the population density of young people.

Synergies on the education area

The focus for education within "No vulnerable areas 2030" is to use existing data for new types of analysis. The core of the focus for education is the early identification of pupils who need specific intervention and more support. The main challenges that have been identified during the process especially concerns low enrolment rate in preschool and high proportion of children who are not eligible for vocational programs in upper secondary school.

The municipality's operational plan for 2024 indicates, among other things, that children and pupils generally achieve good results in the municipality's preschools and schools, however there are variations in results within and between the municipality's preschools and schools. The variations in results in preschools and schools exist between different groups of pupils and in some cases also

between girls and boys. For example, there are variations in results related to safety, study environment and the quality of teaching. There are also variations in academic results.

A specific example of academic results is the variation in upper secondary school eligibility based on the pupil's registered address. The share of pupils who reach upper secondary school eligibility is lower among pupils registered in the municipality's socio-economically vulnerable areas than in other residential areas within the municipality. Other examples of variations in academic results are that the share of pupils who achieve passing grades in all subjects differs between different schools and variations in the level of knowledge in, for example, mathematics, mainly in the younger ages.

According to a report by the Swedish National Agency for Education, students who do not complete upper secondary school have lower incomes, higher unemployment rates, and higher dependence on social benefits than those who do. The report also estimates that the total cost of not completing upper secondary school for the cohort of students who started grade one in 2002 was about 17 billion SEK (about 1.65 billion EUR) per year. This includes the direct costs of public spending on education, social welfare, and health care, as well as the indirect costs of lost tax revenues and reduced GDP growth.

| Data informed governance as a tool

To help all children and students achieve educational goals as much as possible, focused actions are needed that address, balance out and, as far as possible, keep avoiding, the differences mentioned above. To do this, the board and its activities need to analyse the differences in outcomes that have appeared in the monitoring, as well as the needs and circumstances of students and schools that relate to the same outcomes.

No Vulnerable Areas 2030, initiative work is being done at several levels to map, monitor and analyse data in order to take precise actions and to be able to systematically work to improve the conditions for children and students in the areas that are on the police's list of vulnerable areas. Until December 2023, the municipality had two areas on the police's list, since December 2023, only one of these areas remains on the list. However, work on these two areas will continue.

In the initiative the Board of Education aims to increase the eligibility for upper secondary school for students registered in these areas and to similarly increase the participation rate in preschool. The work regarding upper secondary school eligibility is now in a stage where the focus is to find the causes - of lower academic results - that the Municipality in different ways has the ability to address and balance out, and to take suitable actions based on identified causes.

The tool - visualizing data on a map

Data visualization involves displaying information and data graphically through various charts, graphs, and maps. The primary objective is to simplify the identification and comprehension of trends, anomalies, and patterns within the data.

When dealing with large volumes of complex data at different levels, ranging from micro to macro, mapping data can reveal patterns and trends connected to specific geographic areas, such as neighborhoods. For instance, visualizing data related to a municipality's school sector on a geographical map can uncover new insights that can inform decisions and initiatives. However, this approach can also present certain challenges.

In this case study, the focus is on a municipality's initiative to create maps using Geographical Information System (GIS) technology. These maps aim to illustrate patterns for specific themes or attributes, such as school performance, population density, or quality of life indices. It is crucial to develop a research-based method to analyze these visualizations and understand how they enhance the usability and comprehension of the displayed results. To ensure the effectiveness of the visualization tool, a user evaluation will be conducted by the municipality during its development.

From an overall operational perspective, a broad use of the GIS tool and its resources can provide benefits such as:

- **Better analysis and decision-making:** Genuine access to data-driven maps and views offers a new type of decision support for the organization.
- **Continuity and flexibility:** Access to a current situational picture strengthens the organization's common ability to analyze and make both short- and long-term decisions
- **Reduced time wastage:** Significantly improved conditions for sharing and finding data allow employees to spend time and effort on more directly value-creating tasks rather than searching for and compiling the information they need.

The visualization tool (Fig. 14) provides an overall view of various indicators, including students' academic achievements. This tool can highlight students who are at risk of not being eligible for upper secondary school, thereby offering valuable insights for educational planning and intervention.

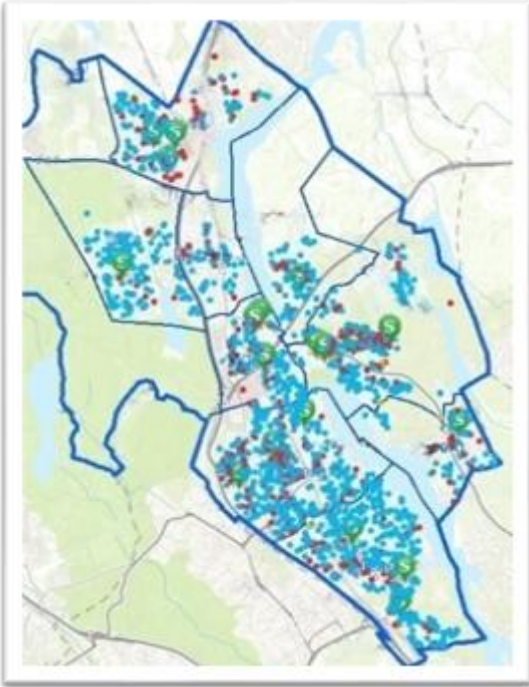


Figure 14 The visualization tool

Key findings master thesis

A master student in economics, Genlott (2024), has focused on analysing school results within the municipality. The study delves into the effects of relocating students from schools in one area to those in another, providing valuable insights into neighbourhood influences, socioeconomic factors, and the broader educational environment. This comprehensive research is instrumental in shaping the GIS-based visualization tool, as it highlights the multifaceted elements that impact educational outcomes.

The study examined the impact of moving students from schools in vulnerable areas to those in non-vulnerable areas. The findings align with previous research (Gruman et.al 2008), indicating no significant effect on academic outcomes for pupils who switch schools. While there are no clear Tiebout effects, there is a short-term disruptive effect.

The Tiebout effect refers to the idea that people will "vote with their feet" by moving to communities that best satisfy their preferences for public goods and services, such as quality education, public safety, and amenities. Essentially, it posits that individuals choose their residential locations based on the mix of taxes and public services offered by different municipalities. When people relocate to an area that matches their preferences, it can lead to a more efficient allocation of resources and services. However, the effect assumes that there are no obstacles to moving and that people have full information about the different communities' offerings.

The key findings from the master thesis are of importance for the development of the GIS-based visualization tool. These findings shed light on the intricate factors influencing student performance, such as neighbourhood effects, socioeconomic background, school and teacher quality, staff turnover, and school funding. By understanding these variables, the visualization tool can be designed to highlight the significant patterns and trends that impact educational outcomes.

Moreover, the thesis emphasizes the limited effect of transferring students from vulnerable to non-vulnerable areas, aligning with previous research such as Deluca, S., & Rosenblatt, P. (2010). This insight is crucial for the visualization tool, as it suggests focusing on systemic factors within each neighbourhood rather than merely geographic relocations. The absence of Tiebout effects and the short-term disruptions observed reinforce the need for a stable and context-aware approach in the tool's design (Genlott, 2024).

Method

This study case was presented at the first Country Dialogue Lab in Sweden, where the municipality in focus talked about their “No vulnerable areas 2030” initiative. The study is a qualitative case study based on research from (Hallin 2023), carried out through semi-structured interviews of the chain of command within the municipality.

Within the case study, SALAR has received information from the Municipality that includes information from project and operational plans as well as project descriptions. In addition to this material, SALAR has conducted 6 interviews with different roles within the chain of command in the municipality (fig 15).

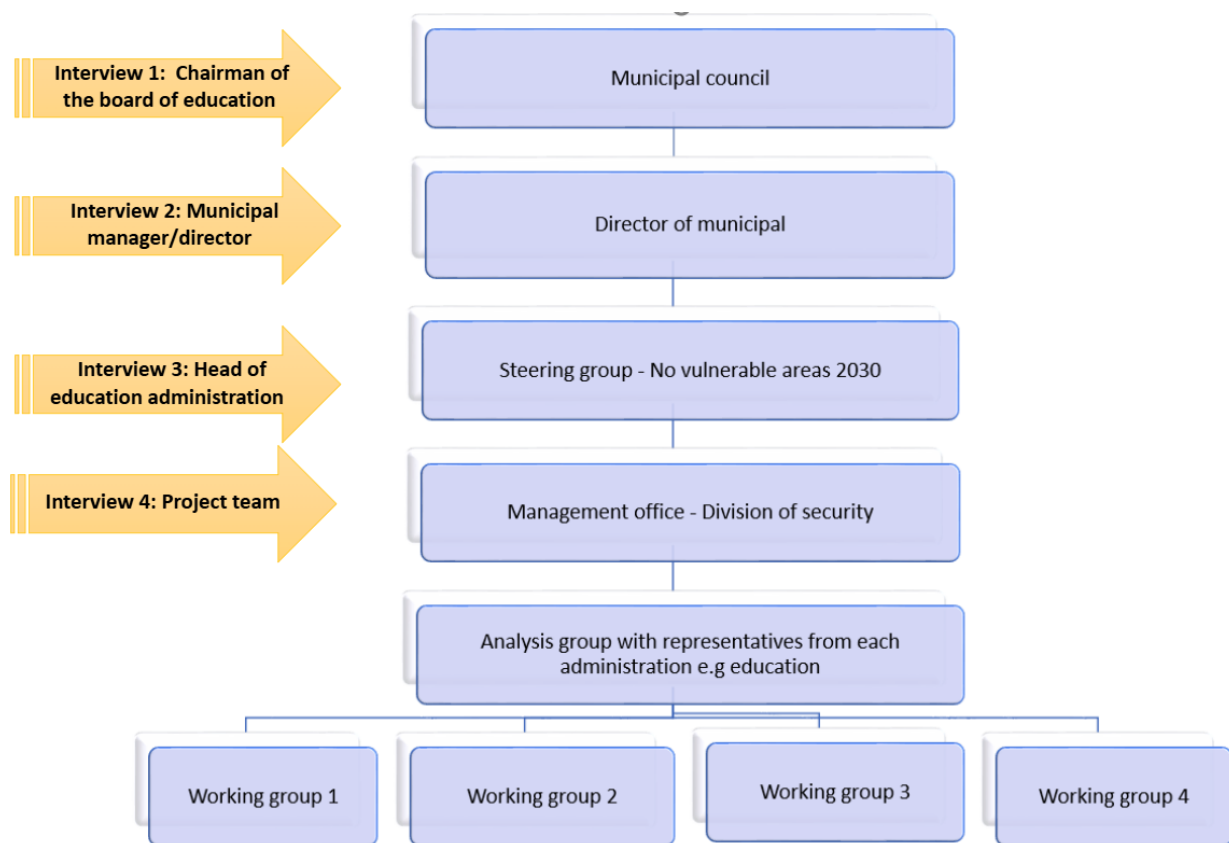


Figure 15 Organization and chain of command in the Municipality

Semi-structured interviews

Before each interview, a consent form and a number of general questions that the conversation/interview was to be about has been sent to the interviewee. The semi-structured interview itself, based on a few open-ended questions was conducted by two people from SALAR as an open conversation, based on the questions that were sent out in advance.

Below is a summary table where information about the interviews performed, including the name of the interviewee, organization, date of interview, and method used.

Informant	Organization/title	Date of Interview/interviews	Method
M1	Charman of the board of education	2024-01-07	Semi-structured interview Digital interview in Teams
M2	Municipal manager	2024-01-10	Semi-structured interview On site interview
M3	Head of education administration	2024-01-12	Semi-structured interview On site interview
M4	Head of administration	2024-09-20	Semi-structured interview On site interview
M5	Member of project team	2024-10-29	Semi-structured interview Digital interview Teams
U1	Professor emeritus university of Malmo	2024-02-08	Semi-structured interview Digital interview Teams

Result and analysis

The study has adopted the Agile EDU analytical framework, which is a comprehensive and flexible approach for using data to support educational improvement and innovation. The framework consists of three interrelated and iterative pillars: "*Regulations, rights and privacy*", "*Data in use for teaching and learning*" and "*Data governance*". Each pillar involves a set of activities, skills and tools that are essential for effective and ethical data use.

The following sections will describe the results and analysis connected to each pillar of the Agile EDU analytical framework. These pillars are interrelated and iterative, contributing to a

comprehensive and flexible approach for using data to support educational improvement and innovation.

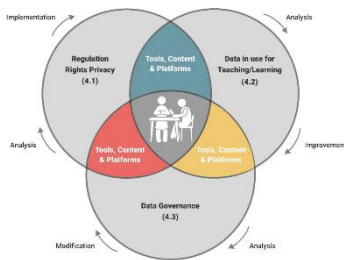


Figure 16 Agile EDU framework

Regulations, rights and privacy

The pillar refers to the process of collecting, integrating and preparing data for analysis in accordance with GDPR. In our case this involves identifying the data sources and types, defining the data quality and security criteria, and transforming the data into a suitable format for analysis. This also requires developing client competence, which is the ability to formulate clear and relevant questions and requests for data analysis, based on the needs and objectives of the data users. In this study, this pillar involved collecting and integrating data from different sources, such as the municipality's database, the national statistics agency and the national education agency.

The municipality faces both challenges and limitations in its data-driven approach, such as questions concerning data quality, data protection, data literacy, data interpretation, data ethics and data politics. The municipality addresses these issues by adhering to the relevant laws and regulations, ensuring the accuracy and reliability of the data, also providing training and guidance for the data users. All together creating a culture of trust and transparency and empowerment in the organization around data use and datafication.

All the collected and relevant data, such as information on grades, eligibility, programs, courses, diplomas and national tests is used and visualized in a map (GIS-tool). This includes information about the location, characteristics and performance of schools and pupils in the municipality, as well as the socio-economic and demographic indicators of the neighbourhoods where they live. The data quality and security were ensured by following the legal and ethical regulations for handling personal and sensitive data (GDPR) and according to Swedish law, as well as by anonymizing and aggregating the data to protect the identity and privacy of the data subjects. The municipality has established a dedicated project team to ensure secure data management, and to offer expertise when it comes to developing data on maps and relevant visualizations.

The use of data and visualization to address the challenge of educational inequality has evolved a discussion concerning the risk of stigmatization or pinpointing specific groups or areas with weak socio-economic performance. The municipality recognizes that the data and visualization can have negative effects on the self-esteem, motivation and expectations of the students and teachers in

the low-performing schools or areas, as well as on the public perception and reputation of these schools or areas. The municipality also acknowledges that the data and visualization can create or reinforce stereotypes and prejudices about certain groups or areas, based on their socio-economic background, ethnicity, gender or other characteristics. The municipality mitigates these risks by being aware of the sensitivity in the data as well as using the data and visualization in a legal, ethical and responsible way. The municipality also stresses that the data and visualization is not used to rank or compare schools or areas, but to identify and understand underlying factors that affect school performance and educational outcomes.

Key findings

- Addressing ethical concerns is crucial and involves using data carefully and respectfully to avoid stigmatization and reinforcing stereotypes.
- Relevant data collection and safe integration from different sources, including databases and national statistics agencies, are essential for comprehensive and responsible analysis.
- Ensuring data accuracy and security by adhering to GDPR, national laws, careful selection of quality assured data and anonymizing data e.g. by using access-controlled login in the visualization tool is crucial for protecting the privacy of data subjects.

Data in use for teaching and learning

This pillar refers to the process of exploring, interpreting and communicating data for action at different levels of governance. This involves applying different methods and tools for analysing and visualizing the data, such as descriptive, inferential and predictive statistics, maps, charts, tables and dashboards. Here we have seen that it's required to develop the analytical skills, which are the ability to understand, interpret and communicate the results of data analysis, as well as the critical thinking and reflexivity skills, which are the ability to question and evaluate the assumptions, biases and implications of data analysis.

In this case study the pillar of "*Data in use for teaching and learning*" has been interpreted in the context of how a municipality learns how to use visualized data to improve equity and inclusion.

The teaching- and learning pillar involved using different methods and tools for exploring and visualizing data, such as spatial analysis, cluster analysis, correlation analysis and regression analysis. The methods and tools were used to examine the spatial patterns and relationships between segregation and pupil achievement in the municipality, as well as to identify the factors and variables that influence them.

The municipality discovered that a data-driven approach to identify and support students, specifically in vulnerable areas, who are in need of extra support to complete their upper secondary education is possible. However, the municipality recognizes that employing and displaying data can reinforce or amplify stereotypes and biases about particular groups or regions based on their socio-economic background, ethnicity, gender, or other traits.

This pillar also involved interpreting and communicating the results of the data analysis, using maps, charts, tables and dashboards, as well as reports and presentations. The analytical skills were developed by engaging the municipality's staff and managers in discussing and understanding the findings and conclusions of the data analysis, as well as the limitations and uncertainties associated with them. The critical thinking and reflexivity skills were developed by encouraging the municipality's staff and managers to reflect on the assumptions, biases and implications of the data analysis, as well as to consider alternative perspectives and explanations.

Using and analysing already existing data showed that students from vulnerable areas switching/attending to a school in a non-vulnerable area has little or no positive effects on the average academic outcomes for the students. This implies that early skill formation is of great importance and that only the quality of the school may not be as influential as previously thought. These results might also indicate that resource allocation should be changed to handle differences between vulnerable and non-vulnerable areas within the municipality.

Considering the observations mentioned above it is crucial to hypothesize potential explanations for the noted lack of significant improvement when students from vulnerable areas move to schools in non-vulnerable areas. One possible explanation could be linked to structural factors at the societal level that go beyond the school's mandate. Even the best educational institutions may struggle to compensate for factors surrounding vulnerable areas and socio-economic challenges faced by students. By generating hypotheses and questions, these insights can pave the way for deeper exploration and cooperation, common understanding and innovative solutions in an organization.

The municipality also learned that the use of a visualization tool can enhance the understanding of spatial patterns and relationships affecting educational outcomes. By generating hypotheses and questions, these tools can pave the way for deeper exploration and innovative solutions. This approach has shown to be instrumental in addressing complex educational disparities, fostering a more data-driven and inclusive strategy for supporting students across different areas in the municipality.

Key findings

- The use of a visualization tool can help a municipality to reveal spatial patterns and relationships affecting educational outcomes.
- Data visualization should aim to understand underlying factors affecting school performance rather than ranking schools, areas or specific groups
- Fostering a culture of trust, transparency, and empowerment, through training and guidance are essential for addressing data quality, protection and data literacy, interpretation, and ethical concerns in data-driven approaches.
- The use of a visualization tool can help to generate hypotheses and questions for further research and exploration.

Data governance

This pillar refers to the process of using data to inform and support decision-making and action. This involves identifying the data users and stakeholders, defining the goals and strategies for action, and evaluating the outcomes and impacts of action. It also requires developing a systematic approach and a supportive culture, which are the ability to plan, implement and evaluate actions based on data analysis, as well as to foster collaboration and dialogue among different stakeholders.

The data governance pillar, as well as the pillar concerning rights and regulations, also requires developing ethical awareness and responsibility, which are the ability to respect and protect the rights and interests of the data subjects and users, as well as to avoid or mitigate any negative or unintended consequences of data use.

This study involves the development and use of a visualization tool to inform and support decision making and action at different levels of the educational system within a municipality, such as policy, governance, management and practice. The goals and strategies for action included developing and implementing policies and programs to address segregation and improve pupil achievement, as well as monitoring and evaluating the effectiveness and impact of initiatives.

The development of a visualization tool also facilitates the exchange of experiences, insights and feedback among the data users and producers, as well as promoting cross-sectoral collaboration and coordination for addressing complex and multifaceted issues, such as segregation and pupil achievement. The ethical awareness and responsibility were developed by following the legal and ethical regulations and guidelines for using data, as well as by considering the potential benefits and risks of data use for the data subjects and users, and avoiding or mitigating any oversimplification, stigmatization or discrimination.

Data and visualizations can be utilized to evaluate the effects of different interventions on educational outcomes. For example, by analysing GIS maps, the municipality can observe how various initiatives, such as targeted support programs or new policies, influence student performance across areas. This approach allows for a clear comparison of areas before and after interventions, highlighting any improvements or persistent issues. It also enables stakeholders to identify which strategies are most effective in promoting equity and inclusion. Furthermore, visual data can be instrumental in communicating these findings to a wider audience, ensuring transparency and fostering a collaborative effort to address educational disparities.

Key findings

- Employing a data-driven approach, encompassing the collection, analysis, and visualization of data on school performance and socio-economic backgrounds across different levels in a municipality can efficiently support the governance of initiatives to students in vulnerable areas who are at risk of not qualifying for upper secondary education.
- Data and visualizations can be used to inform and communicate with various stakeholders, such as school principals, teachers, students, parents, politicians and researchers.

- The data and visualization tool can be used to improve the resource allocation to support students in possible need of extra support to complete their upper secondary education.
- The use of a visualization tool allows for efficient and effective support, tailored interventions, and better monitoring and evaluation of resource impact over time.

Conclusion

This study has explored the development and use of an artifact for analysing and visualizing the relationship between segregation and pupil achievement in a Swedish municipality. The study has applied the Agile EDU analytical framework, which consists of three pillars: data, analysis and action. The main findings and implications of the study can be summarized as follows:

- **Data:** The study has demonstrated the potential of using already existing data for providing a spatial perspective on educational issues, such as segregation and pupil achievement. However, the study has also highlighted the challenges and risks associated with the collection, quality, integration and ethics of GIS data. The study has shown the need for clear protocols and guidelines for handling sensitive and personal data, as well as ensuring the validity and reliability of the data sources. Moreover, the study has emphasized the importance of client competence, i.e., the ability to formulate relevant and meaningful questions and requests for data analysis.
- **Analysis:** The study has illustrated the use of different methods and development of a tool for analysing and visualizing GIS data, such as maps, charts, tables and dashboards. The study has also discussed the advantages, limitations and potential risks of using the methods and tools, as well as the skills and knowledge required for using them effectively. The study has pointed out the need for analytical skills, i.e., the ability to understand, interpret and communicate the results of data analysis. Furthermore, the study has stressed the need for critical thinking and reflexivity, i.e., the ability to question and evaluate the assumptions, biases and implications of data analysis.

When analysing students results, with the methods mentioned above, in the municipality there were no signs of significant long-term effects on academic outcomes when students from vulnerable areas switched to schools in non-vulnerable areas. Although a short-term disruptive effect was observed.

- **Action:** The study has indicated the possible uses and benefits of GIS data for informing and supporting decision-making and action at different levels of the educational system, such as policy, governance, management and practice. However, the study has also warned about the potential pitfalls and drawbacks of using GIS data for action, such as oversimplification, stigmatization and discrimination. The study has shown the need for a systematic approach and a supportive culture, i.e., the ability to plan, implement and evaluate actions based on data analysis, as well as to foster collaboration and dialogue

among different stakeholders. Additionally, the study has underlined the need for ethical awareness and responsibility, i.e., the ability to respect and protect the rights and interests of the data subjects and users.

- Finding patterns through visualization: Using data visualization in educational initiatives can be used as a tool to identify and address academic disparities. By graphically representing data, educators and policymakers can easily pinpoint vulnerable areas and students that are underperforming, thereby facilitating timely and targeted interventions. This approach enables the identification of patterns and trends that might not be evident in raw data, such as correlations between socio-economic factors and academic performance. Furthermore, visualized data allows a more transparent and accessible means of communication, making it easier for stakeholders, such as school leaders, to understand and engage with the information. With this kind of visualization, school leaders and schools have access to a new perspective in their analysis work, in order to be able to implement early interventions and work with preventive and supportive measures in a different way than before.

Recommendations

The findings from this study illuminate the potential and challenges of using data, particularly GIS data, to inform and support educational decision-making processes in the municipality. This document outlines the recommended steps to further develop and improve the use of data in educational contexts. The recommended steps are sorted into two perspectives, macro and micro.

By implementing these steps below, the municipality can continue to develop and improve the use of data for educational purposes, ensuring data-driven decision-making is ethical, effective, and impactful. This approach will help create a more equitable and high-performing educational system, benefiting all students and communities within the municipality.

A crucial requirement for implementing these further steps for municipalities is the provision of quality-assured official data by the state. Quality data serves as the backbone for informed decision-making and policy development at the local national level. It is essential that this data is standardized and remains stable over time for ensuring consistency and reliability. This allows for accurate trend analysis and strategic planning.

By leveraging network analysis and coordinated efforts across various sectors in the municipality (education, social services, culture and leisure, employment, and the police) a more comprehensive and effective strategy can be developed and implemented. This ensures that interventions are not only well-informed and targeted but also dynamic and adaptive, promoting better outcomes at strategic, tactical, and operational levels. This integrated approach underscores the critical need for a multi-disciplinary collaboration and data-driven decision-making in tackling complex social and educational challenges.

Meso perspective - municipal level

Data Governance Framework (pillar 3)

Objective: Establish a robust data governance framework to ensure data quality, security, and appropriate usage.

- Define clear roles, responsibilities, and rules for accessing, handling, and sharing data within the municipality.
- Standardize procedures for data collection, storage, and analysis to maintain high data quality and reliability.
- Implement security measures to protect sensitive data and prevent unauthorized access or breaches.

Actionable Data Utilization (pillar 3)

Objective: Ensure that data, including GIS data, is used effectively to support decision-making and action at various levels of the educational system (policy, governance, management, and practice).

- Establish a systematic approach to data utilization, ensuring that data analysis informs planning, implementation, and evaluation of actions.
- Foster a supportive culture that encourages collaboration and dialogue among stakeholders, promoting shared understanding and collective action.
- Address potential pitfalls such as oversimplification, stigmatization, and discrimination by promoting nuanced and context-sensitive data interpretations.

Ethical Awareness and Responsibility (pillar 1)

Objective: Promote the ethical use of data to protect the rights and interests of data subjects and users.

- Develop and enforce ethical guidelines for data collection, analysis, and usage, ensuring compliance with regulations like GDPR.
- Provide training on ethical data practices to staff and managers involved in data handling and analysis.
- Ensure transparency and accountability in data usage, making information accessible and understandable to all stakeholders.

Targeted Early Education Programs (pillar 3)

Objective: Enhance early skill formation by investing in early education programs, particularly in vulnerable areas.

- Identify and allocate resources to early education initiatives that provide a strong foundation for students before they advance to higher education levels.
- Implement evidence-based interventions that have demonstrated positive impacts on early childhood education outcomes.
- Monitor and evaluate the effectiveness of early education programs to ensure continuous improvement.

Data Community of Practice (pillar 3)

Objective: Create a community of practice to facilitate the exchange of experiences, insights, and feedback among data users and producers.

- Organize regular meetings and workshops to share best practices, challenges, and solutions in data utilization.

- Promote cross-sectoral collaboration and coordination to address complex issues such as segregation and pupil achievement.
- Encourage innovative uses of data through collaborative projects

Meso and micro perspectives

Data Literacy Program (pillar 2)

Objective: Improve data literacy among staff and managers to enhance their analytical and client competences.

- Develop and provide training modules on data analysis, interpretation, and application tailored to different roles within the educational system.
- Raise awareness of the ethical and legal aspects of data usage, emphasizing the importance of data privacy and security.
- Support continuous learning and professional development in data literacy through online courses, seminars, and mentorship programs.

Data Impact Assessment (pillar 2)

Objective: Conduct regular assessments to evaluate the effects and outcomes of using data for action.

- Identify opportunities and challenges in data analysis and usage practices, providing recommendations for improvement.
- Use assessment findings to refine and enhance data utilization strategies, ensuring they remain relevant and effective.
- Measure the impact of data-driven interventions on educational outcomes and decision-making processes. For example, Jackson, C. K., Johnson, R. C., & Persico, C. (2016) examine the effects of school spending on educational and economic outcomes, offering valuable insights for data-driven decision-making. Heckman, J. J., & Mosso, S. (2014) also provide important perspectives on the economics of human development and social mobility, further informing our understanding of educational outcomes.

Equity and inclusion considerations

- Identify the key ages and thresholds that determine when a student can dropout.
- Study the qualitative variables that indicate a risk of dropout during those stages.
- Create a socio-economic index combining available data sources and academic knowledge on vulnerability factors to identify areas with drop out risk.

- Link findings to compensatory measures that enhance protective factors to foster greater equity.

Final words

We would like to extend our heartfelt thanks to the municipality of Sollentuna for their invaluable contributions of time and knowledge. Their support has greatly enhanced our understanding and efforts in improving data literacy and its impacts.

Given the significant differences in circumstances and outcomes across areas and schools, it is essential to analyze data more specifically than at the overall municipal or school level. Data visualization can help highlight areas most in need of attention and resources, thereby promoting educational equity.

Ultimately, these initiatives aim to foster a culture of continuous learning and professional development in data literacy, ensuring that our educational strategies remain relevant and effective.

In conclusion, visualizing data can be a useful method for informed decision-making as it allows stakeholders to identify patterns and trends that may not be immediately apparent. Nonetheless, it is important to recognize the risks associated with data visualization, such as potential misinterpretation or oversimplification of complex issues. Ensuring the accuracy and context of visualized data is essential for making equity ensured as well as proper data-informed decisions intended to improve student learning outcomes.

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