

## Open Data Based Digital Platform for Regional Growth and Development in Norway: A Heuristic Evaluation of the User Interface

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**Abstract**—Even though a homogenous growth is more desired and expected, socio-economic disparities can still be observed across different regions of a country. Measuring regional growth is essential for the regions that are falling behind or struggling to achieve desired growth. While there exists different statistics of regional growth data, there is a lack of digital tools that represent the growth data in a visual friendly manner to the different stakeholders involved in the region. We have developed a digital platform to address this issue for a region in Norway. The platform is developed to use open data from different sources that is presented in five major groups related to growth: goals, premises or prerequisites for growth, industries, growth, and expectations. The platform helps to improve decision-making and transparency, as well as provide new knowledge for research and society. Compared to other similar digital platforms from Norway, our platform has the strength of providing more options for visualization that makes the statistics more comprehensive. However, we believe that proper usability of the tool can be improved by getting feedback from real users. Therefore, a heuristic evaluation is conducted in order to find out the usability issues and further improve the tool for its users. In this article, we report the results of evaluation and implications for the future improvement along with the presentation of our tool.

**Keywords**-digital platform; growth barometer; regional growth; open data; analytics; visualization; usability; heuristic evaluation.

### I. INTRODUCTION

This paper is an extended version of our previous work [1], where we presented *Vekstbarometer*, an open data and analytics driven digital platform for regional growth and development used in a municipality in Norway. Open data nowadays represent an indispensable source for governments' strategy when it comes to coping with many innovation challenges of the future. In addition, open innovation philosophies and approaches are continuously being initiated and ratified by public sectors in many different countries [2][3].

In Norway, many governmental agencies have adopted the open data initiative and are making data accessible for general use. Hence, in order for many businesses and even citizens to create innovative value-added products and services, they can now access and utilize these open data resources [4]. Businesses while relying on open data

resources can make more intelligent and effective moves by performing data analytics on top of open data.

When defining the meaning of open data, we use the definition provided by Open Data Institute, which defines open data as “data that is made available by government, business and individuals for anyone to access, use and share” [5]. It is worth noting that the global economic potential value of open data has been estimated to \$3 trillion [6]. However, the potential and advantage of Open Government Data (OGD) for improving services in different economic sectors has not been realized to a large extent [7].

*Vekstbarometer* is an application that documents and illustrates our effort of using open data provided by *Statistics Norway* [8], *Real Estate Norway* [9] and the *Brønnøysund Register Centre* [10], to create an analytics-driven web application that presents regional indicators together with research-based knowledge relevant and applicable to regions' growth. As illustrated with the conceptual model shown in Figure 1, regional growth correlates with growth in Value Creation, Employment, Workplace and Population. A region's growth is often measured by growth in GDP (Gross Domestic Product). Nonetheless, the main goal of the policy is to contribute to higher welfare and transform the region into better place to live and run business. In order for the growth barometer to be able to clarify developments and provide compatible information connected to political and business decisions, a comprehensive definition of growth is therefore necessary. The indicators are based on open data while statistical visualizations can be created also for purposes other than regional growth. In this study, we have focused in the region of Ringerike, located in the southeastern part of Norway, which has recently seen a decline in the number of jobs and insufficient economic growth. To the best of our knowledge, there is no similar system developed so far, which includes research-based knowledge on a regional level in Norway.

In a national level, one can encounter various digital platforms, but they are all different in the sense that they are using different data categories, but also, they have different purposes. Above all, they provide a limited set of key indicators, which visualize, and, are associated with regional growth and development.

A considerable number of regions have business barometers based on survey data, gathered on yearly basis and register data. They can predict the national and regional

business trends. One such example is Konjunkturbarometer Østlandet [11], a digital platform that contains, inter alia, a knowledge-based database covering information on developments in the counties of Hedmark, Oppland, Oslo, and Akershus. The Confederation of Norwegian Enterprise (NHO), which is Norway's largest organization for employers and the leading business lobbyist, represent another case of digital platform. Their platform, Økonomibarometeret [12] encompasses the current market situation, operating profit, investments, and employment on a county and national level.

The main objective behind developing our innovative system, which can be accessed at [vekstbarometer.usn.no](http://vekstbarometer.usn.no) or with the path [vekstbarometer.usn.no/ringerike](http://vekstbarometer.usn.no/ringerike), is to offer public sector organizations and local businesses a management tool with key indicators related to the region's growth. Besides having the feature of improving public sectors' transparency and engagement of civil society, our system can also add value towards enhancing economic growth via processing, interpreting, and illustrating regional open data in a comprehensive and meaningful way.

The remainder of this paper is structured as follows: Section II presents related work while Section III informs the research context: Ringerike region's need of a digital platform for its development. Section IV introduces the *Vekstbarometer* system and the technology used for its development, along with its strength and impact for regional growth. Section V presents the heuristic evaluation of the user interface of the application and lastly, Section VI concludes the paper and provides some insights about potential future work.

## II. RELATED WORK

As a result of the emergence and pervasiveness of ICT, many governmental institutions across the globe have been embracing initiatives to transform themselves into e-governments [13], and consequently are encouraging citizen participation in governments. OGD represents one of the main extensions of such e-government initiatives [14]. OGD is making data freely available to all with the sole intention to ensure public accountability and transparency [15], to boost innovation in various economic sectors and to increase efficiency in administration.

But, notwithstanding this, for the stakeholders to derive the public value out of the open data, it is of paramount importance for the data sets to be re-usable, comprehensive, interpretable, complete, and permit user-friendly interface. Also, government authorities should be proactive to ensure that the data sets are in harmony with the stipulated norms, such as preserving personal and private information of the users, or protecting and prohibiting the publishing of sensitive data associated to national security. In that regard, the government has created the *Norwegian License for Open Government Data* (NLOD) and have recommended all data owners in the public sector to apply the license, which contains, among others, information on preserving

confidential and personal data [16]. When it comes to global status and trends of open data in the context of readiness, implementation and impact, Norway ranks among the top ten best countries in the world [17].

In the state-of-the-art literature, there exist two categories of OGD research. The first category is mainly based on conceptual models and frameworks including theoretical proposals [18, 19], also incorporating studies, which are discussing the main stages of the OGD life cycle [20]. The second category, where our work belongs, incorporates studies that are taking place in different geographical locations by using OGD at the state or local level. Additionally, one important characteristic of this category is the open data exploration and exploitation. Here, the data generated by multiple sources of governmental institutions are processed and visualized for different purposes. This includes conducting various analysis, creating mashups, to improve the interpretability of open data, or even innovate upon the open data.

Recently, multiple applications have been successfully implemented and developed based upon the open data sets across the world, focusing primarily on larger cities, such as Chicago [21][22], New York [23], Dublin [24], St. Petersburg [25], Singapore [26].

However, despite the interest and the rapid proliferation of open data platforms, many challenges remain when it comes to the accessibility and usability of platforms using open data, data quality and completeness, and interpretability of open data. As far as enhancing the interpretability of open data is concerned, the authors in [21][22] run a case study to analyze the open socioeconomic data released by the city of Chicago, where they use different visualizations adjusted for univariate, bivariate and multivariate analysis. This approach implies that delving into open urban data can lead to more effective data interpretation and analysis. Regarding the usability aspects for user interface design of open data platforms, a case study scenario also including a transportation challenge in Dublin City identified important patterns for highly usable open data platforms for open data policy [24]. This study recommends that these platforms should adopt user-friendly technology and social media platforms. From architectural standpoint, in the literature there is an interesting and relevant work presented by [26]. In this work, an open data platform prototype is developed to illustrate the requirements and the architecture of open real time digital platform. The main aim behind developing this platform is to serve as a base for programming the city of Singapore, and generate visual data analytics in a city context.

Nonetheless, none of the mentioned research works was related to comprehensive visualization of growth data fetched from open governmental datasets in a regional context. Therefore, we aim to fill this gap by developing *Vekstbarometer*, an open data driven digital platform which will aid businesses in making more intelligent and strategic moves. The platform will also help businesses to perform

informed decision making and will increase transparency for citizens.

### III. RESEARCH CONTEXT: REGION'S NEED FOR A DIGITAL PLATFORM

The *Vekstbarometer* application was developed for Ringerike region as a response to deal with the regions falling growth. Many key factors related to growth and welfare pointed out lack of desired growth in the region.

Ringerike has around 43,000 inhabitants. Over the last 10 years, as mentioned in [27], the number of total new employment for the region was only 145 while at the same time the number of jobs decreased was 321. Besides, value creation for the region's business sector has also shown a weaker development compared to other neighboring regions that are natural competitors for Ringerike having, similar background, assets and distance from capital city. If this negative tendency is not reversed in near future, Ringerike region will face the consequences of declining private and public welfare. This will make the region a less attractive place to live. However, politicians and businesses in the region are optimistic in terms of the future. New four-lane highway and new high-speed railway from the capital Oslo to Ringerike region's main city Hønefoss is planned to be completed around 2028. This gives enormous opportunities for Ringerike to reverse the negative trend and generate new growth that will ensure future welfare and good living conditions in the region. Nevertheless, in order to accomplish this growth, it requires good decisions from the region's public authorities and industry. A growth barometer that monitors the growth and significant conditions for growth in the region could provide a useful management tool for strategic decisions.

The target user group for the barometer are politicians, municipality administration, business and the community.

Large amounts of statistics and information related to growth and development for municipality regions already exists from different sources. However, there is a need that these statistics and information are provided in a customized way targeted for the use in Ringerike region besides developing new and better statistics for the region, and breaking them down at regional and local level. In our search of finding similar tools or platforms as growth barometer for other regions in Norway, we found quite a few solutions, but none with the approach and objectives that we mentioned here. We believe that a digital platform like growth barometer could give Ringerike region a significant competitive advantage over other regions, which are also seeking regional growth and development.

#### A. The logical model of Barometer

The conceptual model behind the growth barometer is given in Figure 1. The objective of regional development is given through the points in (A), i.e., higher value creation, employment, jobs and higher populations. In the national level, there will always be a number of people and businesses considering to "relocate". A region will compete with other regions as a national competition to get these businesses and individuals to establish themselves in its own territory. Here, conditions for regional growth (B) and local industry's contribution to local growth (C) can serve as lucrative points for capturing a good share of the influx of national movements of persons and businesses. If the conditions (B) and the local business sector's efforts (C) are large, this portion will be large. The result will be a major influx of businesses and individuals. We assume that growth targets mentioned in (A) can be achieved together with regional economic dynamics linked to business development, housing construction, etc.

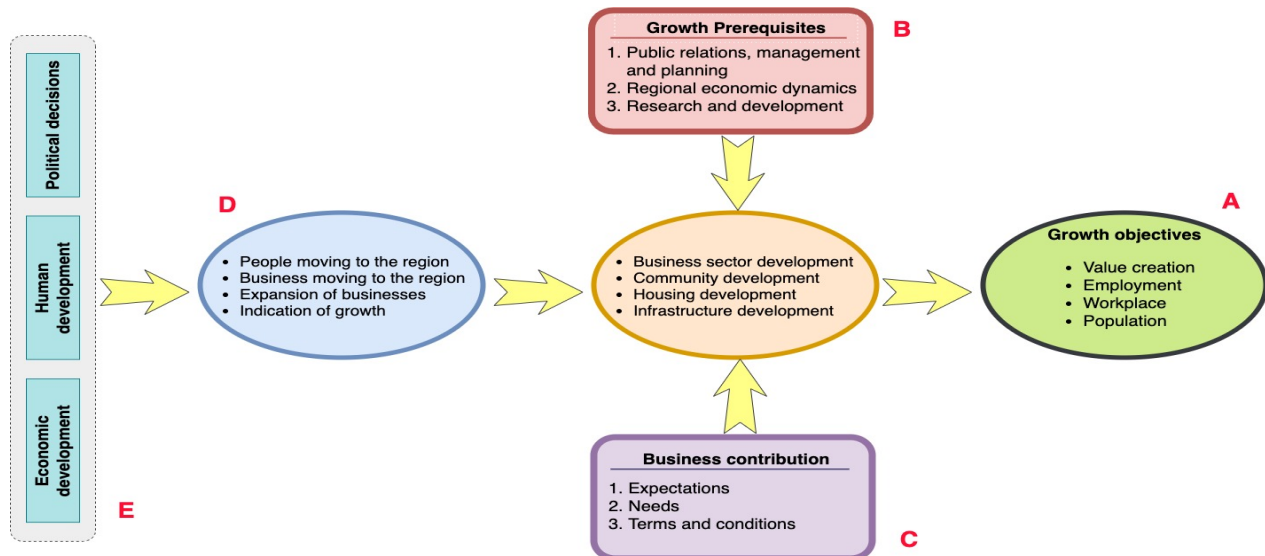


Figure 1. The logical model behind the *Vekstbarometer*

#### IV. VEKSTBAROMETER - THE DIGITAL PLATFORM TECHNOLOGY

*Vekstbarometer*, which in Norwegian stands for “growth barometer” is a digital platform that provides the development trends in the regional context in a visual and user-friendly way. The platform uses data from different sources, these data are presented mainly in five main groups: i) Goals, ii) Premises or Prerequisites for growth, iii) Industries, iv) Growth, and v) Expectations.

Each group consists of several categories and each category contains several variables, which actually holds the statistical data. The groups and the categories form the information architecture of the digital platform, which is shown in the Figure 2.

The group *Goals* contains the following categories: *Population, Value Creation, Employment, Jobs, and Welfare*. Each of these categories contains a number of variables, which for the sake of simplicity, are not shown in the figure. These variables represent the data analyses and are used to generate the visual representations in the form of charts, graphs, and diagrams. For example, the category *Population* contains ten variables, some of which are: total inhabitants, age-wise population, population change trends, net population change etc. Each variable is represented by a number, for example total inhabitants is presented by 1, age-wise population is presented by 25. The numbers are not assigned in any particular order; rather they were assigned when the statistics of the variables were being added in the system.

The variable number can be seen from the URL; when browsing a certain statistic from the navigation menu the URL gets changed with the variable number such as <https://vekstbarometer.usn.no/statistic/25>.

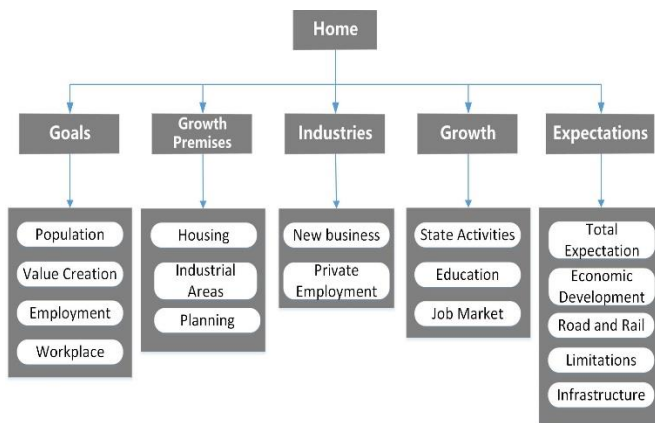


Figure 2. Information architecture of the application

Thus, the statistic variable 25 can be accessed from the navigation menu, as well as from the URL by appending the variable number (25) after the URL given at [28].

In addition to presenting open data, *Vekstbarometer* also presents survey data from the local industries that reflects the

expectations and assumptions of the local entrepreneurs and business owners. The application consists of mainly three parts: backend, presentation and database. The system architecture of *Vekstbarometer* application is given in Figure 3.

Backend is mainly responsible for processing requests from the presentation layer. Based on the requests, it retrieves raw data from the database, sort them and send them to the presentation layer. Backend collects data from external data storage such as open data that are provided by others (such as Statistics Norway) through APIs. It also processes other input data to the system and the survey data. Data from external sources are retrieved in the desired formats and are saved in the database for storage. Different external data are updated in different periodic intervals, such as quarterly, half-yearly and yearly. These data sources are fetched periodically to keep the main database updated.

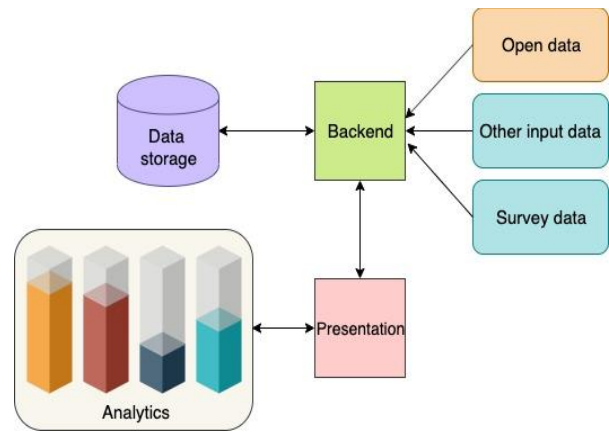


Figure 3. *Vekstbarometer* system architecture

Presentation takes care of conversion of data transmitted from backend, transformation of these data and displaying on-screen to end-user. This is the main part of the application that the user sees and interacts with.

The database holds the persistent and transient data that are critical for running the application. At the beginning, we have used *MySQL* databases for the persistent storage, which was later migrated to *MariaDB*. We have used *Angular 2* for presentation and frontend, and *PHP* for the backend.

While developing the digital platform, at first the relevant growth indicators and variables were carefully selected and matched with the region’s context. Relevant indicators were chosen based on our previous research and then they were matched with regional contexts through several meetings with local stakeholders, key business people and municipality administrators. The relevant regions to which Ringerike’s statistics are compared with were also selected through these meetings.

Later on, based on the variables, suitable data providers were searched and identified for them. In case of selecting a data provider, the accuracy and trustworthiness were prioritized. When multiple providers were found for a single

variable, the originality or the owner of the data was sought. In order to avoid any discrepancy, we followed the principle of collecting data from the original providers and in case of multiple sources of some data; we collected all similar data from a single source to have validity of comparisons among them.

Most of the data used in the platform is collected from *Statistics Norway*, which provides data from country level to municipality level for all municipalities in Norway. It provides an API service to query through its 6000 tables and output is provided in *JSON-stat*, *csv*, and *.xlsx* formats.

For the initial phase of the application, we collected the desired data for one or more municipalities of the barometer by using *Statistics Norway's* API console, and stored them in the application's database. Subsequently, an admin panel was added in the application from where admin can update these tables whenever new data is available in the source providers.

#### A. Data

The growth barometer application *Vekstbarometer* is a data visualization platform. It deals with several kinds of data some of which are sensitive data and some are not sensitive data. Data that are already presented as open data by other sources, such as *Statistics Norway* are non-sensitive. Since these data are already available and open for public, we do not have any restrictions on showing them in raw format or in any modified format. Apart from non-sensitive data, there are data or part of data which contain some sensitive information about people or businesses that should not be made publicly available, e.g., a person's personal number (social security number) or a business's sales and marketing plans, confidential customer or supplier information, etc.

*Vekstbarometer* also stores and shows data collected through surveys. These surveys are done anonymously and therefore personal information and anonymity should be handled as sensitive. Besides, we follow the EU General Data Protection Regulation (GDPR) rules when collecting data from local businesses.

Data that are collected from other sources are mostly obtained by running some data processing operations such as filtering or making queries in order to fit our local needs that are represented by the statistics variables. Referring to the Article 4 EU GDPR definitions, we can say that data processing is a broad term that includes several operations such as collection, recording, organization, structuring, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, restriction, erasure or destruction etc. [29]. Being a data driven platform, *Vekstbarometer* includes lot of these data processing activities as the data provided by the sources come in various formats, various shapes and they require to be adapted to a standard format before being stored in the application's database.

*Vekstbarometer*, though mostly presents selected variable/indicator's data from other sources in suitable visual friendly graphical presentations, it also provides the users some pre-selected operations such as selecting and deselecting range of parameters and regions for a certain statistic variable. Besides, the growth barometer has the capability to show some newly created data that are not available in any other data sources.

#### B. Visualizations

Data in the growth barometer is presented using different kinds of charts and diagrams which include line charts, bar charts, stacked columns, stacked percentage column, column with drill down, pie charts etc. For visualizations, we have used a JavaScript library called *Highcharts*. With *Highcharts*, it is possible to create charts in many shapes, like heat maps, waterfall series and more. In addition, the charts are highly configurable, customizable and interactive.

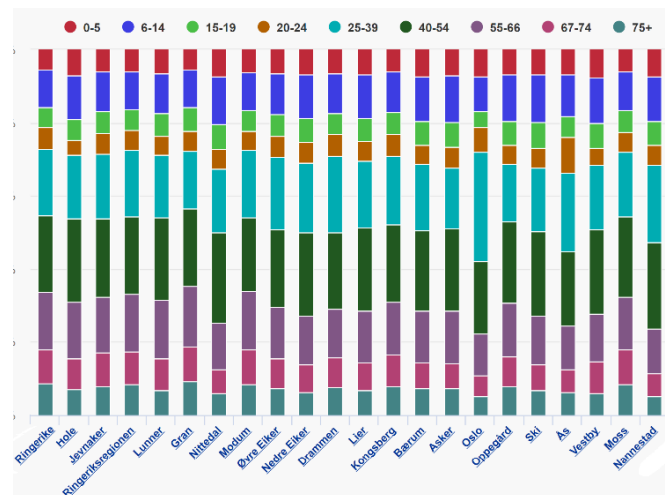


Figure 4. Age wise population chart for all regions, variable 25

When we say configurable and customizable, we mean that values can be added and removed to the charts on the fly. As an example, if we take a look at Figure 4, which presents the graph for variable 25 and shows the age-wise population comparisons in different regions; we can choose the age groups that will be presented in the graph. The graph shows not only the percentage of an age group, in addition, it also the absolute value of that group in a tooltip text when mouse is hovered over on that group. Besides these customization features, the regions in the x-axis is linked to a detailed view of the age wise population chart for only that region (Figure 5), thus making the visualization configurable and interactive at the same time.

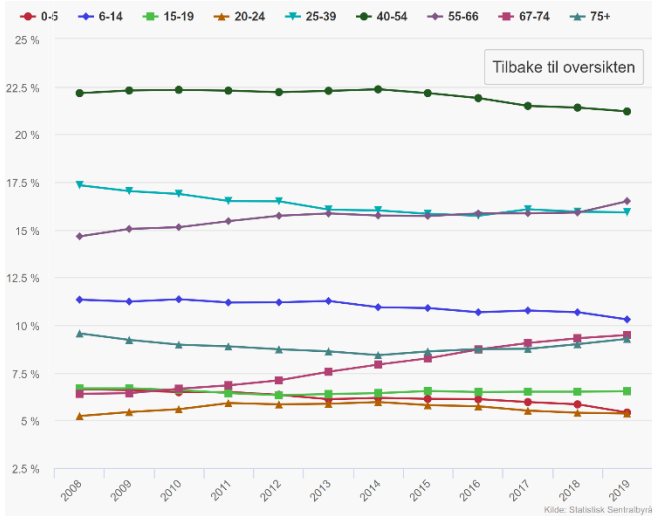


Figure 5. Age wise population chart for a specific region, variable 25

The visualization of a statistic variable is further complemented by some additional information such as: i) *textual description of the variable*, ii) *links to related documents* iii) *links to related variables*. Besides, each variable presentation is provided with *alternative graph/presentation options*. Accompanying textual description gives a brief introduction of the variable for a better understanding of the variable and its usage. Users can read the *links to related documents* for further understanding of the concepts. By using the *links to related variables*, users can navigate to related statistic variables directly from a specific variable’s page. The *Alternative graph option* lists a number of options, and by selecting one of those options, the user can view the same statistical variable in a different form of presentation, for example in linear chart, bar chart, pie chart etc., which could give another view and perspective of the variable.

### C. The Strength and Impact of the platform

As reported in our previous study [1], the growth barometer digital platform shows data in an easy, comprehensible and meaningful way. Although some data that our platform presents are already provided by other data outlets, our platform adds extra value by making a better presentation of the data. Furthermore, in contrast to other platforms, such as [30][31][32][33][34], where the data is presented as raw data or with basic level of presentations, our platform has the advantage of providing a range of options for visualization that makes the statistics more comprehensive. Even in case where the platform is showing existing data from other sources, still we add value on it.

In addition to showing already existing data, the platform shows some new data as well. The new data can be of two types: i) newly formed data, ii) newly created data. Newly formed data is created by combining and filtering data from multiple sources where the data were partly available but not

in the exact form that is presented here in the growth barometer.

On the other hand, newly created data refers to the case where we create, collect or gather new data that were not available or presented in any other platform. As an example of newly formed data, we can mention “future population growth”, which is represented in our platform as statistical variable 56 (see Figure 6). Here, the expected *future population growth* is taken from three different sources: *Statistics Norway* estimation, political estimation and housing building estimation. This new variable shows the gap or surplus of housing capacities with the *Statistics Norway* estimation or political assumptions and gives a good indication whether the assumptions or planning are feasible or not compared to the housing capacities that are planned for the region. In addition to showing the statistics in visual form, the platform also provides the option to download data and images. It has the options to download data in multiple formats such as *csv*, *pdf*, *xls*, and the images in *png*, *jpeg* and *svg* vector image formats. It also provides the option of printing the chart and view the data of the chart in tabular forms. All these options increase the usability of the tool and facilitates multiple use cases for the users of the system. Users of *Vekstbarometer* can use customized graphs and charts from the platform and include them in their presentations or documents.

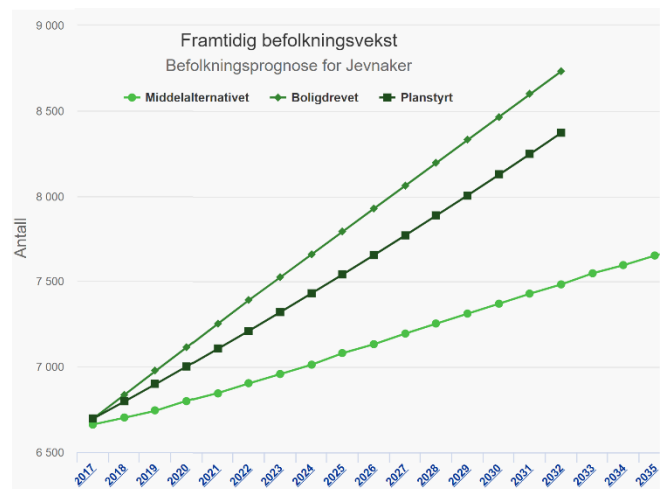


Figure 6. Future population growth, variable 56

The *Vekstbarometer* digital platform is a constituent part of the five years long *Vekstbarometer Project*, which is managed by the *Regional Development Group* at the University of South-Eastern Norway (usn.no). Since the initiation of the project, a status report is planned to be issued every year presenting the current growth status of the region. Ringerike region also has a business policy strategy which sets the premises for how business policy is to be pursued to create growth in the region’s business community. The *Vekstbarometer* platform helps to create the strategy and present the annual results of the regional growth according to the growth objectives given at Figure 1. Moreover, the

municipality authorities can rely on *Vekstbarometer* data in order to define their targets and priorities and make better decisions.

## V. HEURISTIC EVALUATION

In order to perform the heuristic evaluation of the *Vekstbarometer*'s interface, we have followed the methodology proposed by Jacob Nielsen and Robert L. Mack [35], by having each evaluator inspect the interface independently. As it is recommended by Nielsen on this seminal work, for performing a heuristic evaluation, three to five evaluators are sufficient. In our experiment, four users are involved to examine and evaluate the interface and assess its compliance with recognized usability principles described in [35].

### A. Procedure and Data Collection

The evaluators were contacted by phone and were sent information about the survey as well as the questionnaire. Four people were asked and all agreed to participate. The respondents were selected on the basis of their central role in the regional development and their perceived benefit of this application. One of the authors of this paper has also had a dialogue with these people and have understood they have used and were familiar with *Vekstbarometer* web application. The users have been instructed about how the interfaces work and were informed for the purpose of the app, i.e., the evaluators were provided with hints on using the interface. All the evaluators were asked to evaluate *Vekstbarometer* independently. They were very informative and had a lot of relevant feedback as well as the rating of the various criteria in the Nielsen checklist. Duration of the survey including information and some "short discussions" was between 30 and 40 minutes. When it comes to various assessment criteria of the application interface, users were asked to assess the severity of any errors based on the scale given in Table II. In Table I, we present the results from the Nielsen's heuristic evaluation framework for *Vekstbarometer*.

### B. Findings and Discussion

Generally, the results from the user evaluation of *Vekstbarometer* indicate positive attitude and experience from our evaluators. All the four evaluators unanimously agree that out of 23 heuristic sub-principles in the checklist, there is no usability problem at all (scale 0) for 1a, 2a, 4a, 5a, 7c, 7d, and 9a, 9b, 9c, which corresponds to the following sub-principles in Table I:

- Visibility of system status/The app provides feedback about status (1a),
- Match between system and real world/Clear terminology/no jargon (2a),
- Consistency and standards/Links are clear and follow conventions (4a),
- Error prevention/Error message problem (5a),
- Flexibility and efficiency of use/Consistent way to return to Home Menu (7c),

- Flexibility and efficiency of use/Simple navigation menu (7d).

The overall evaluation results presented in Figure 7 show that the majority of experienced usability problems by all evaluators correlate with heuristic principles 3 (user control and freedom), 6 (recognition rather than recall), 8 (aesthetic and minimalist design), and 10 (Help and documentation). As far as the first evaluator feedback is concerned (E1), there is no usability issue (scale 0) identified in 19 sub-principles i.e., 1a, 2a, 2b, 3a, 4a, 4b, 4c, 5a, 6b, 7a, 7b, 7c, 7d, 8a, 8b, 8d, 9a, 9b, and 9c from Table I. He identified no cosmetic problems that need to be fixed (scale 1). Three minor usability problems with low priority to be fixed are identified (scale 2), which correspond to principles 3a, 6a, 6c, and only one major usability problem with high priority to be fixed (scale 3) corresponding to 10a.

TABLE I. HEURISTICS EVALUATION RESULTS FOR VEKSTBAROMETER

Heuristic evaluation checklist		Evaluators			
		E1	E2	E3	E4
<b>1</b>	<b>Visibility of system status</b>				
a	The app provides feedback about system status	0	0	0	0
<b>2</b>	<b>Match between system and real world</b>				
a	Clear terminology, no jargon	0	0	0	0
b	Content is clear and follow conventions	0	0	2	0
<b>3</b>	<b>User control and freedom</b>				
a	Logical structure of the app	0	0	2	2
b	Effective internal search	2	1	3	0
<b>4</b>	<b>Consistency and standards</b>				
a	Links are clear and follow conventions	0	0	0	0
b	Various app functions are well integrated	0	0	2	0
c	Clear and consistent navigation throughout the app	0	0	3	0
<b>5</b>	<b>Error prevention</b>				
a	Error messages problem	0	0	0	0
<b>6</b>	<b>Recognition rather than recall</b>				
a	Objects, actions and options are visible	2	1	3	2
b	Organization of information makes sense	0	1	2	0
<b>7</b>	<b>Flexibility and efficiency of use</b>				
a	Very easy to use and interact	0	0	2	0
b	Provides shortcuts for frequent tasks	0	0	3	0
c	Consistent way to return Home/Menu	0	0	0	0
d	Easy to identify current location	0	0	0	0
<b>8</b>	<b>Aesthetic and minimalist design</b>				
a	Clean and simple design	0	0	2	0
b	Text and colors are consistent	0	0	2	0
c	Images are meaningful and serve a purpose	2	0	0	0
d	Simple navigation menu	0	0	3	0
<b>9</b>	<b>Help users recognize, diagnose and recover from errors</b>				
a	(Error) Messages are explained in a plain language	0	0	0	0
b	Any problem is precisely indicated	0	0	0	0
c	A potential solution is constructively suggested	0	0	0	0
<b>10</b>	<b>Help and documentation</b>				
a	Help or Tips are available and clear	3	0	3	3

TABLE II. RATING SCALE

Scale	Meaning
0	Not a usability problem at all
1	Cosmetic problem only, need not to be fixed
2	Minor usability problem, low priority to be fixed
3	Major usability problem, high priority to be fixed
4	Usability catastrophe, imperative to fix this before product can be released

When it comes to the second evaluator's (E2) results, no usability problems at all (scale 0) were identified in 20 sub-principles, i.e., 1a, 2a, 2b, 3a, 4a, 4b, 4c, 5a, 7a, 7b, 7c, 7d, 8a, 8b, 8c, 8d, 9a, 9b, 9c and 10a.

This evaluator was the only one to discover cosmetic problems (scale 1) relating to principles 3b, 6a, and 6b. No minor usability issues (scale 2) and no major usability problem with high priority that need to be fixed (scale 3) were identified in the rest of 20 heuristic sub-principles.

On the other hand, the third evaluator's (E3) results seem to be more criticizing from the rest of the participants, when it comes to heuristic evaluation of *Vekstbarometer* interface. The feedback from E3 indicate that there are no usability problems at all (scale 0) in 10 out of 23 principles, i.e., 1a, 2a, 4a, 5a, 7c, 7d, 8c, 9a, 9b, and 9c.

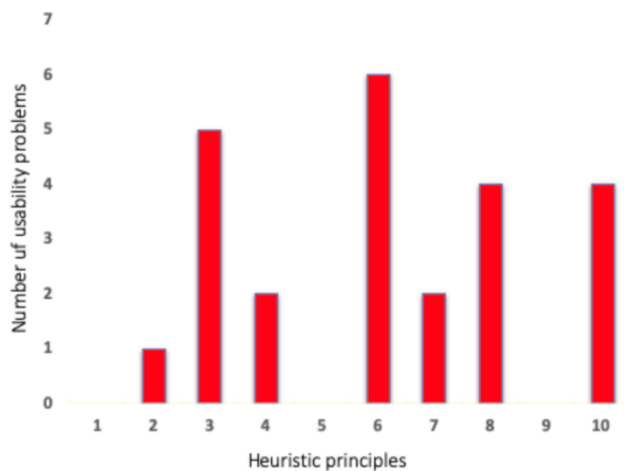


Figure 7. Distribution of usability problems per heuristic principle

Whereas no cosmetic usability problems were identified, still there are 7 minor usability problems (scale 2) discovered in 2b, 3a, 4b, 6b, 7a, 8a, and 8b. Furthermore, this evaluator also identifies 6 major usability problems with high priority of fixing (scale 3), which are corresponding to sub-principles 3b, 4c, 6a, 7b, 8d, and 10a.

Lastly, regarding the fourth evaluator (E4) feedback, only three heuristic sub-principles received usability problem related points. No usability issues at all (scale 0) and no cosmetic problems that need to be fixed (scale 1) were identified in the rest of the 20 heuristic sub-principles. Two minor usability problems with low priority of fixing (scale 2) were identified in sub-principles 3a and 6a, and only one

major usability problem with high priority of fixing (scale 3) was identified for 10a.

As can be seen from Table III, none of the feedback from the four evaluators relates to severity scaling 4 of the Nielsen's heuristic principles, which means that no usability catastrophe is found with this prototype of *Vekstbarometer*. On the other hand, there were altogether 23 usability problems experienced by the 4 participants in heuristics evaluation, of which 3 were cosmetic, 12 were minor, and 8 were major usability problems.

TABLE III. FREQUENCY OF A SEVERITY SCALE USED

Severity scale	E1	E2	E3	E4	Total
0	19	20	10	20	69
1	0	3	0	0	3
2	3	0	7	2	12
3	1	0	6	1	8
4	0	0	0	0	0

### C. Comments from evaluators

In this section, we present some of the comments of the evaluators for the readers. All of the four respondents pointed out that the solution contained highly relevant and useful information relevant to their job. However, all of them mentioned that they had to spend a lot of time getting to know the solution and its functionalities.

"We regularly use *Vekstbarometer* at meetings. Here we get information that helps us to better understand the connection between different goals set by the municipality." Evaluator #3.

"By using *Vekstbarometer* we have gained a greater understanding of the factors that are important for the municipality for transforming it into a better place to live." Evaluator #2.

"The *Vekstbarometer* helps us to see the market potential of our products by studying indicators that describe the business structure of the region." Evaluator #1

"Still many variables of *Vekstbarometer* application are not fully explained and therefore they make it somewhat unclear." Evaluator #4.

The users were also aware that the solution needed improvement related to help and tips related to navigating in the solution. Since users were familiar with the solution, they found the information they wanted, but were aware that for new users, improved help and tip functionality would be required.

"The search function is bad. It is important and needs to be improved. However, in the meantime, I have become familiar with the content and the functionalities of the



application, so I can manage to find the stuffs that I want.” Evaluator #3

“Since the content of the *Vekstbarometer* is good, I had great motivation to find relevant information from the system despite some weak functionalities.” Evaluator #3

“After having a detailed explanation of the functionalities, I see that I have not been able to find all the relevant information. This means that the functionalities needs to be improved.” Evaluator #4

The four respondents were respectively a business manager (evaluator 1), an elected representative/politician (evaluator 2), a municipal employee (evaluator 3), and a private consultant (evaluator 4). In overall, they represented well the target group of the *Vekstbarometer*.

## VI. CONCLUSION AND FUTURE WORK

In this paper, we have presented the *Vekstbarometer* digital platform and the heuristic evaluation of its user interface. Inspired by the developments in the field of open data initiatives, we developed the platform to combine multiple open data sources to generate various visualizations. This gives insights into the regional growth and development, and demonstrates the usefulness of open data in regional context. Furthermore, it also helps to improve decision-making and transparency, as well as provide new knowledge for research and society. The platform was well accepted by the regional stakeholders. For the purpose of successfully running our experiment, we involved four active users of *Vekstbarometer* to conduct a heuristic evaluation of the tool. The evaluation indicated that the tool has mostly high usability features with a minimal set of major usability problems. Even though the usability problem issues are minimal and mostly coming from one user, still this is a good indication for our future improvement. The application is relatively complex and deals with a lot of statistical parameters and indicators of which many are very similar or has only slight differences among them. Therefore, it is very important to have a well-organized content structure and easy to follow navigation. The evaluation also revealed some of our drawbacks, such as lack of effective internal search, which will help us to focus on our future work.

We also take the positive findings of the heuristic’s evaluation as an indication that the *Vekstbarometer* application has been able to provide desired information and interactions to its users and has a good potential for the regional stakeholders.

As a future work, we intend to expand the functionality of the platform by expanding the dataset and focus on converting the digital platform into a fully-fledged and mobile-friendly application. Besides, as a takeaway from the evaluation, we would like to further improve the content structure of the application and implement the internal search options.

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