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Visualizations for increased curiosity: How use of the socio-economic index Business Index North can change internal representations of the High North

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Abstract

There is no widely accepted theory on how users generate new knowledge and insights based on information visualization, and the purpose of this thesis is to better understand the relationship between information, visualizations, curiosity and internal (mental) representations in users and we take a closer look at how all these concepts interact in a context.

This is a qualitative exploratory study, the context is the High North region and the information and the visualizations used to gather data is the Business Index North (BIN) reports. The data was gathered by conducting a three part survey among 91 students at the University of Siena. Our analytical approach builds upon cognitive fit theory, studies on mental models, research on curiosity and accounting theory.

The findings show that the BIN reports are able to generate curiosity and interest, change internal representations and as a consequence influence intentions among the survey-participants. The BIN reports promote contrasting views of the High North region, dividing the test-participants into two major groups which is named the “Potential-group” and the “Sceptics-group”. The “Potential-group” became to view the High North as an area with a huge potential for economic growth, and the “Sceptics-group” became worried about climate change, and did not see the same economic potential in the region. The “Potential-group” became more eager to interact with the High North region in terms of travel, work and investments, than the “Sceptics-group”. Cognitive bias may be one reason why users react differently to the same information.

This thesis shows the importance of understanding how visualizations can be tailored to enhance curiosity, which can lead to change in internal representations and intentions in users. Our findings suggest that moving from an author-driven approach to a reader-driven approach could possibly reduce cognitive bias in users.

Keywords – *High North development, socio-economic information, infoviz, mental models, internal representations, curiosity, cognitive bias, author-driven, reader-driven*

Preface

Developing the High North region is one of the main priorities to the Norwegian government today and the Business Index North project is an attempt to create awareness to the challenges and the opportunities of the region. The findings in this thesis could be of value to other projects that have a goal of developing the High North region, the findings could also be of interest and value to other disciplines that are interested in the interaction between information visualization, curiosity and users.

Thanks to my supervisor Anatoli Bourmistrov for guiding me through the long process of completing this thesis. Thanks to Andrei Mineev who gave me many valuable suggestions. Thanks to Roberto Rivas Hermann who helped me analyze the data material. Thanks to the High North Center for supporting me financially for my trip to Siena in Italy where I gathered most of the data material. And thanks to my family and friends.

Sammendrag (Norwegian)

Det finnes ingen allment akseptert teori om hvordan brukere genererer ny kunnskap og innsikt basert på informasjonsvisualisering, og formålet med denne oppgaven er å bedre forstå forholdet mellom informasjon, visualiseringer, nysgjerrighet og interne (mentale) representasjoner hos brukere og vi tar en nærmere kikk på hvordan alle disse konseptene samhandler i en kontekst. Dette er en kvalitativ utforskende studie, konteksten er nordområdene, og informasjonen og visualiseringene som brukes til å samle inn data er Business Index North (BIN) - rapportene. Dataene ble samlet inn ved å gjennomføre en tredelt undersøkelse blant 91 studenter på Universitetet i Siena. Vår analytiske tilnærming bygger på kognitiv passningsteori, studier på mentale modeller, forskning på nysgjerrighet og regnskapsteori. Funnene viser at BIN-rapportene er i stand til å skape nysgjerrighet og interesse, endre interne mentale representasjoner og som en konsekvens påvirke intensjoner blant deltakerne i undersøkelsen. BIN-rapportene fremmer kontrasterende syn på nordområdene og deler test-deltakerne i to store grupper som vi kaller "Potensial-gruppen" og "Skeptiker-gruppen". "Potensial-gruppen" oppfattet nordområdene som et område med et enormt potensial for økonomisk vekst, og "Skeptiker-gruppen" ble bekymret for klimaendringer og så ikke det samme økonomiske potensialet i regionen. "Potensial-gruppen" ble mer interessert i å samhandle med nordområdene når det kommer til reise, søke arbeid og investeringer enn "Skeptiker-gruppen". Kognitiv bias kan være én årsak til at brukerne reagerte ulikt på den samme informasjonen.

Denne oppgaven viser viktigheten av å forstå hvordan visualiseringer kan skreddersys for å øke nysgjerrighet, noe som kan føre til endring i interne mentale representasjoner og intensjoner hos brukere.

Våre funn kan tyde på at å gå fra en forfatter-drevet tilnærming til en leser-drevet tilnærming kan muligens redusere kognitiv bias hos brukere.

Stikkord - *nordområde-utvikling, samfunnsøkonomisk informasjon, informasjonsvisualisering, mentale modeller, interne representasjoner, nysgjerrighet, kognitiv bias, forfatter-drevet, leser-drevet*

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1 Introduction

1.1 Background of the study and motivations for research

In this thesis we take a closer look at how information visualization (InfoViz) can generate curiosity, knowledge and insights in users. This is done by studying how the Business Index North (BIN) reports influence the internal mental representations of the High North in people living outside of the region. Curiosity has the ability to enhance business and organizational performance¹ and we make an inquiry into whether curiosity can lead to increased activity in the High North region in terms of travel, work and investments. This can be of interest to the accounting and management control literature where the psychological aspects of accounting is of great interest (Hall 2016), however the BIN report is not an accounting report, as there is no principal/agent-relationship present, so the main focus in this thesis will be on InfoViz and users. The purpose of this thesis is to better understand the relationship between socio-economic information, visualizations and internal mental representations. This is done by looking at the KPIs and visualizations in BIN and applying cognitive fit theory and Information visualization (InfoViz) theory to explore the effects of the information in the report on users. In this thesis I have two motivations for conducting research on socio-economic information and its effects on users: the first is theoretical and the second is practical.

Motivation One (Theoretical): Information Visualization (InfoViz) and its effects on users internal mental representations. Information Visualization plays an important role in how governments and media communicate socio-economic information to the public (users). There is no widely accepted theory on how users generate new knowledge and insights based on InfoViz (Schreder et al. 2016). There is a need for more knowledge on how InfoViz contributes to building up internal representations of communicated information in mental models. One way to study this is to explore how InfoViz generate curiosity — Knowledge as a source of change (Alexandrov et al 2016). If information Visualization generate curiosity it could lead to change, not only change in mental models, but also in change in institutions. If people / users get curious,

¹ <https://hbr.org/2018/09/curiosity>

they are more likely to travel, seek work and invest, this behavior could lead to major changes in institutions and in socio-economic development.

Motivation Two (Practical): Regional development of the High North and BIN as a report.

The context of this research is the High North region, a region with a potential for economic development, especially in the industries of oil, gas, minerals and tourism and the purpose of the BIN report is to create awareness of the challenges and opportunities in the region. Previous research on BIN show that there is a need for a better understanding of what effects the reports have on its users (Danilov & Mineev 2019). Therefore in this thesis research is conducted on how BIN as a rapport can promote High North development, specifically how and if BIN can attract people to travel, seek work and invest in the High North.

To sum up: In his thesis research is conducted on how Information visualization can create new knowledge / insights in users and how this could lead to increased curiosity and a change in intentions towards High North development and how BIN as an external representation of the High North interact with the users internal representations.

1.2 Context: The High North and the Business Index North project

The High North is a part of the world with a unique set of challenges and opportunities. The region is facing rising demographic problems; the area is sparsely populated, struggles with low population growth and has a slightly uneven gender-balance (more men than women).

There are however many opportunities in the region for massive growth; the High North is rich in natural resources such as oil, gas and minerals and the area is becoming a popular tourist destination, especially attracting many tourists from Asia. The High North is also an important strategic area for geopolitics; where mighty states like the US, Russia and China wants to increase their influence. These challenges and opportunities needs to be addressed and the Norwegian government has in the last decade prioritized High North development. According to the Norwegian governments Arctic strategy the region needs to attract more people, especially women and people with higher education and the region needs to grow and develop business and

industry in a sustainable way². The Business Index North (BIN) is a project which goal is to communicate these challenges and opportunities to a wider audience.

BIN is to be a tool to promote interest to do business in the High North, but it failed to mobilize attention and interest from businesses (Danilov & Mineev 2019). Still BIN could have a potential for attracting attention to the regions challenges and opportunities due to its visualizations of High North development. The BIN project is an attempt to materialize the High North by creating a perspective on management information. The Index gives an overview over the socio-economic development and business opportunities in the BIN-region. The BIN-region is located inside the High North area and overpass borders. The High North is a name for the arctic circumpolar area between the North Pole and the Polar Circle, including the Barents region and the Barents sea. How can the potential from these visualizations be materialized? How can BIN contribute so that people become more interested and engaged in High North issues? These questions are discussed in chapter 5. There are other indexes for Northern Norway: Index Nordland³ which only focus on Nordland and Konjunkturbarometeret for Nord-Norge⁴ which focus on Nordland, Troms and Finnmark. What makes BIN interesting is that it tries to facilitate cooperation, investments and communication across borders in the region. BIN encompass several countries in the Arctic and makes aggregations and comparisons possible across borders. The projects definition of the BIN area correspond with the EU definition of a macro region: “*an area including territory from a number of different countries or regions associated with one or more common features or challenges.*”⁵. Below is a map of the current BIN-region.

² <https://www.regjeringen.no/contentassets/fad46f0404e14b2a9b551ca7359c1000/arctic-strategy.pdf>

³ <http://indeksnordland.no/>

⁴ <http://kbnn.no/>

⁵ https://ec.europa.eu/regional_policy/sources/cooperate/baltic/pdf/macrorregional_strategies_2009.pdf



Figure 1: Map of the BIN area (Anon 2017)

Expected contribution: Mostly to Information Visualization literature, but could also be relevant to the management accounting and control literature (Hall 2016; Aleksandrov et al. 2018; Bourmistrov 2017).

1.3 Problem statement

«How does Business Index North, as an Information visualization tool, interact with users mental models in terms of changing internal representations, promoting curiosity and intentions towards High North development»

1.4 Research Gap

There has been conducted a lot of research in the management accounting literature on the relationship between information, the user and the context. In recent times, a particular focus has been on the psychological and cognitive aspects of the use of information, especially how the visualization and the disposition of information can change the mental model of the user (Hall 2016). However, there is no widely accepted theory on how information visualization generate insight and knowledge in users (Schreder et al. 2016). (Aleksandrov et al. 2018) discovered that curiosity was essential in initiating the participatory budgeting process, but not in sustaining and developing it further, the authors suggest further research into the role of curiosity in accounting and institutional work. (Harrison 2011) Suggests that future research on curiosity should study the full range of behaviors curiosity might cause to get a more clear picture of the costs and benefits of curiosity in organizations, and he also suggest more research on exploring curiosity at collective levels of analysis. Therefore, in this thesis we want to explore the relationships between visualization, information, curiosity and the user and how this could promote High North development.

No research has been done on the effect of the socio-economic indexes in the High North. The other two indexes covering parts of the region (Index Nordland and Konjunkturbarometeret for Nord-Norge); Do all of these indexes create more interest for the region and do they contribute to attracting investments? Therefore we make an inquiry into these questions in this thesis.

The most important elements of this study is: visualizations, internal representations, curiosity, and quality of information. This study has several limitations: type of information, geographical and conceptual. This is a case study on Business Index North, done in Siena, Italy, on how BIN as an external representation of the High North can change internal representations in users, enhance curiosity and thus increase/decrease the desire to seek work, travel and investment in the High North.

2 Theoretical framework

In this chapter the theoretical framework of the thesis is presented. The problem statement consists of three concepts. One; the information visualization source (BIN), two; the internal (mental) representations of the test-participants, and three; curiosity. Since this thesis tries to investigate how and if the BIN-report can change internal representations and increase curiosity for High North development; I use cognitive theory to research the cognitive aspect of the problem statement (how visualizations and internal representations is linked with curiosity), and I use accounting theory to measure the quality of the information the participants interact with. And finally we look closer at how and if curiosity could make the participants want to interact closer with the High North region in terms of travel, work and investments.

A mental model is a scaled down cognitive image of external reality that humans have in their minds about how they assume the world function, these models are used to predict events, reason and form meaning (Jones et al. 2011). Cognitive fit is the level of discrepancy between a decision-maker's mental model and the information he or she interacts with. Sometimes the mental models of decision-makers are too simple and they do not seize the complex interdependencies of a given problem, and occasionally the cognitive styles are too intricate where they contain connections that does not exist in reality (Martignoni et al. 2016). Since our comprehension of reality is heavily influenced by experience, environment, education and so forth; different mental models develop in the minds of different people in different fields in different environments.

2.1 Cognitive fit theory

Cognitive fit theory is about how the use of information and mental models are linked. The theory suggests that when there is a match (cognitive fit) between the user and the information presented about a task; performance will be enhanced (Vessey 1991). Cognitive fit is the grade of fit between the cognitive characteristics of a decision-maker and their strategic environment and the information they base their decisions on. Cognitive fit is characterized as either an over- or an under-specification. Do the decision-makers have an oversimplified mental model of their

strategic environment, or do they have a too complex model which contains relationships that does not exist in reality.

The decision-maker is influenced by their particular mental model, and this mental model reflects the desired outcome of a given action and the interdependence between the variables the user control and the variables which he or she does not control (Martignoni et al. 2016). In this thesis cognitive fit theory and mental models is combined since it is humans who read and make meaning of the BIN-report, and if we ignore the psychological and cognitive aspects of how humans interact with information we ignore an essential part of the decision-making process (Hall 2016).

The visualization of information, i.e if it is presented as graphs or tables affects the cognitive fit and the mental model of the information-user, depending on task characteristics and the characteristics of the user, this presentation of information can affect the performance of decision-makers (Vessey 1991). Neil Fleming's VARK model suggests that different people learn most effectively in different ways; Visual, Auditory, Read/write and Kinesthetic learning (Leite et al. 2009). The BIN-report is a combination of text, graphs and tables and different users will understand and interpret it differently.

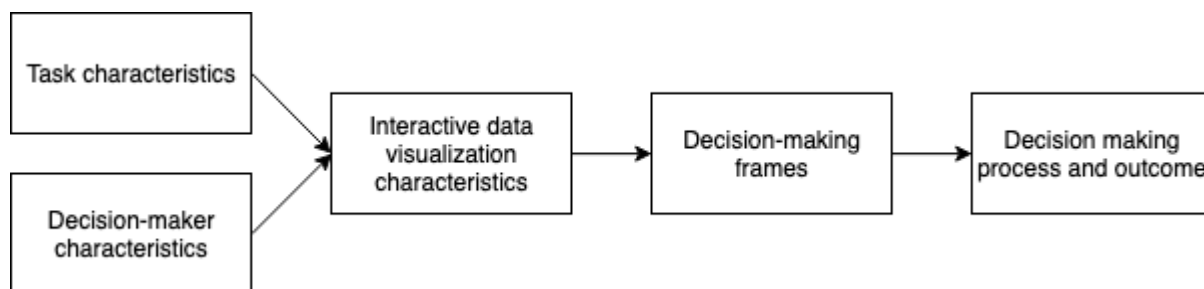


Figure 2: Dilla's Characteristics of Interactive Data Visualization and Implications for Decision Making (Dilla et al. 2010)

The relationship between the task at hand (directed vs exploratory, complexity, context, etc.), the characteristics of the decision-maker (expertise, experience, personality and cognitive style) and the visualization characteristics (information selection and visual representation) influence the decision making frames and thus the decision making process and outcome; in other words: the mental models of the decision-makers that interact with the information provided by accounting

information systems (AIS) and the mental models either have a cognitive fit or misfit with the AIS, depending on information complexity and the decision-maker's characteristics like domain-distinct prowess and cognitive aptness (Dilla et al. 2010).

«The expansion of mental models research from an individual to a collective focus stems from a growing recognition that there is a social component to cognition at the individual level, and that decision making occurs at a range of scales from an individual to group to societal level.» - (Jones et al. 2011 p. 6)

Due to the recent focus on the psychological and cognitive aspects of how information is used and how it affects the mental models of the user a more nuanced view of how decisions are made have transpired. Below I present a reinterpretation of Dilla's model of characteristics of interactive data visualization. Cognitive fit theory miss an important component: curiosity. Task characteristics and, decision-maker characteristics is not that clearly defined in studies of curiosity.

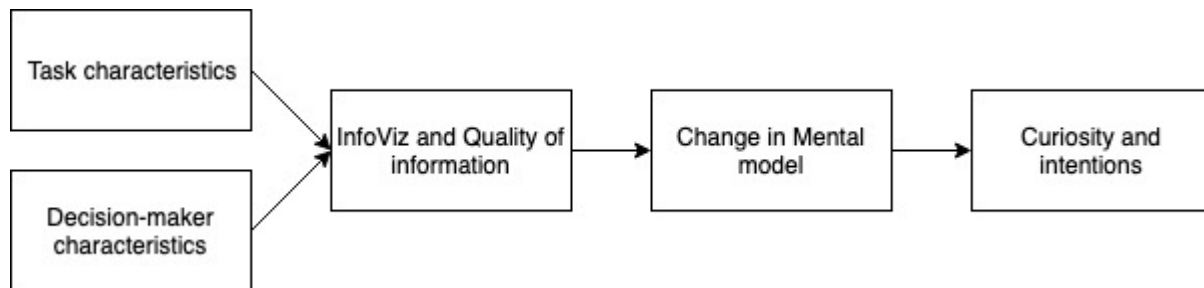


Figure 3: Reinterpretation of Dillas model.

I modify the model by adding the concepts of Information Visualization, information quality, mental models and curiosity and intentions. All these concepts are interconnected, if curiosity is to be increased and a change in intentions is to occur it depends on the task, the user and what is communicated.

2.2 Information Visualization and qualitative characteristics of information

Information Visualization can be author-driven and reader-driven and both have pros and cons. A challenge when presenting information is to get a good balance between the two (Schreder et al. 2016). The pure author-driven approach to presenting InfoViz leads the user through the information in a predetermined course, in this way there is no way for the user to customize the presentation of the information, sort the data in another way, or play with it. This can have some implications in how the reader process the information, and it can affect how convincing the information is. In a reader-driven approach to presenting data, the reader or the user can play a lot more with the information, adding colour, sorting the data in different ways. GapMinder⁶ is a good example for a reader-driven InfoViz tool. In GapMinder the user is quite free to play with the data in the way the user wants. For example, the user can choose any country on earth, and then compare its economy, education, CO2 emissions, child mortality etc., to another country of choosing. The possible disadvantage to a full reader-driven approach is that it can be harder for a sender to impose a predefined message into the readers or users of a data material. BIN in its current form is entirely author-driven.

Economic Information

This study is about economic information, not accounting information or theory, but the socio-economic information in the Business Index North reports have some similarities to accounting information and performance indicators (KPIs), however the BIN report is not a financial report; BIN have different purposes, different areas of use and different impact on decisions. I use some principles from accounting theory to measure the quality of the information in BIN using the four qualitative characteristics of useful financial information; understandability, relevance, reliability, and comparability (Alexander et al. 2007). These qualitative characteristics can be used to measure any information, not only accounting information.

⁶ <https://www.gapminder.org/tools/>

Information is what decision-makers use to operate in their strategic environments, and different decision-makers with different mental models have a different degrees of cognitive fit to their environments, and to the information presented. The goal of accounting theory is to develop a set of logical principles that shape the framework of reference for the assessment and evolution of accounting practices (Alexander et al. 2007). Accounting information can be used as a financial language to facilitate cooperation. One of the purposes of BIN is to facilitate cooperation in the High North, BIN contains financial and socio-economic information, and these measures are useful to the BIN report.

“In particular, and in contrast to traditional criticisms of accounting, the strengths of accounting information relate to its aggregation properties and its role as a common, financial language to facilitate communication among managers.” (Hall 2010 p. 4)

Below is a depiction of the qualitative characteristics of useful financial information. All these attributes are used by different decision-makers with different characteristics (Alexander et al. 2007).

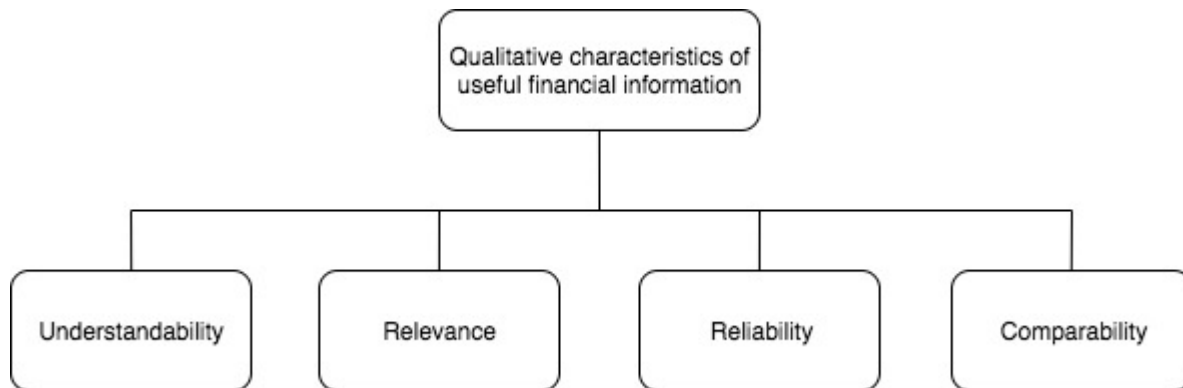


Figure 4: Model of the qualitative characteristics of financial information need to possess in order to be useful for decision-makers and other users (Alexander et al. 2007).

Decision makers and their characteristics

The users of economic information can have quite different characteristics with different understandings of accounting principles and economic information. Examples of different users of financial reports are: controllers, accountants, investors, employees, lenders, the state, and the general public. These different users desire and accentuate different aspects of accounting

information (Alexander et al. 2007). The intended users of the BIN reports are just as diverse, central government bodies, regional authorities, businesses, media, students and pressure groups.

Qualitative characteristics of financial statements

Socio-economic and financial information must be understandable by the users, and it is assumed that most users have some economic knowledge and a certain comprehension about accounting principles. Nevertheless, one should try to avoid excluding users and complex issues should be disclosed in detail. Economic information must be relevant since decision-makers make decisions and predictions rooted in the accounting reports.

Relevance can become a difficulty when the value of something may vary a lot over time. The dispute amid market value and historical cost is a matter that is still not solved. When economic information is free from material error and bias it is regarded as reliable (Alexander et al. 2007). When there is uncertainty, the best estimate shall be used, based on the information available when the financial statements are made. In the case of uncertainty, it is advisable to value assets at an expected value based on the best estimate. This means that uncertain assets must be valued based on all information available when the report is made.

Financial reports should be prepared according to uniform principles, which must be applied consistently over time. *«Users need to be able to identify differences between the accounting policies for like transactions and other events used by the same enterprise from period to period and by different enterprises»* - (Alexander et al. 2007 p. 127) This means that the same principles must be applied to similar transactions and events.

Qualitative characteristics of (accounting) information and the Business Index North

The Business Index North is produced for a wide set of stakeholders: Companies, academics, states, counties, municipalities, and the media. The different users have different levels of education and different understanding of economic principles. For example, it is not clear what depreciation means for anyone without education in economics. Is it possible to understand the content of BIN in a good way without an education in economics?

Do the information in BIN influence people with different educations in different ways? The information in BIN describes stable trends such as population growth, job growth and patenting, thus the information in the index has longer durability and relevance than, for example, accounting information. An index number appoint one number as the base and then convey the second number as a percentage of the first.⁷ This makes it possible to compare the socioeconomic information in the BIN-region with the rest of Norway, Sweden and Finland.

2.3 Mental models and internal representations

How are internal representations different from mental models? In this thesis I do not study the whole mental model of a user, I study only a small part of their mental model, the part that is responsible for how they think about the High North, this part of their mental models is their internal (mental) representation of the High North.

The human brain is basically a model building device (Ford & Johnson-Laird 1985). In this thesis an explanatory model of human thought processes is used; defined by Kenneth Craik as mental models. A mental model is a scaled down cognitive image of external reality that humans have in their minds about how they assume the world function, these models are used to predict events, reason and form meaning.

«when a person explains a domain with which they are unfamiliar, they tend to draw on a familiar domain, which they perceive as similar. This involves tapping into an existing mental model and importing its relational structure to another domain.» (Jones et al. 2011 p. 4)

All humans perceive and experience reality through subjective cognitions, thus we create methods, models, indexes and languages as instruments to communicate in order to make it possible to constitute a consensus on something that resembles a form of objective reality. These instruments of communication have different degrees of information complexity and different people with different mental models have different degrees of cognitive fit or misfit with the information they interact with (Martignoni et al. 2016). This means that a student, a politician, an

⁷ <http://www.kpb.no/sites/k/kpb.no/files/businessindexnorth2017web.pdf>

economist and a bureaucrat with different educations and backgrounds probably will have different mental models and use different analogies to make sense of the content of reports and indexes.

2.4 Interaction between InfoViz and Mental Models

Information Visualization can be defined as: “*the use of computer-supported, interactive, visual representations of abstract data to amplify cognition*” (Card 1999 p. 7) Another definition is: «*The representation and presentation of data that exploits our visual perception abilities in order to amplify cognition*» (Kirk 2012 p. 12) Both definitions cover the use of information and its effects on cognition. BIN in its current form is not interactive, so in this thesis Kirk’s definition the most relevant.

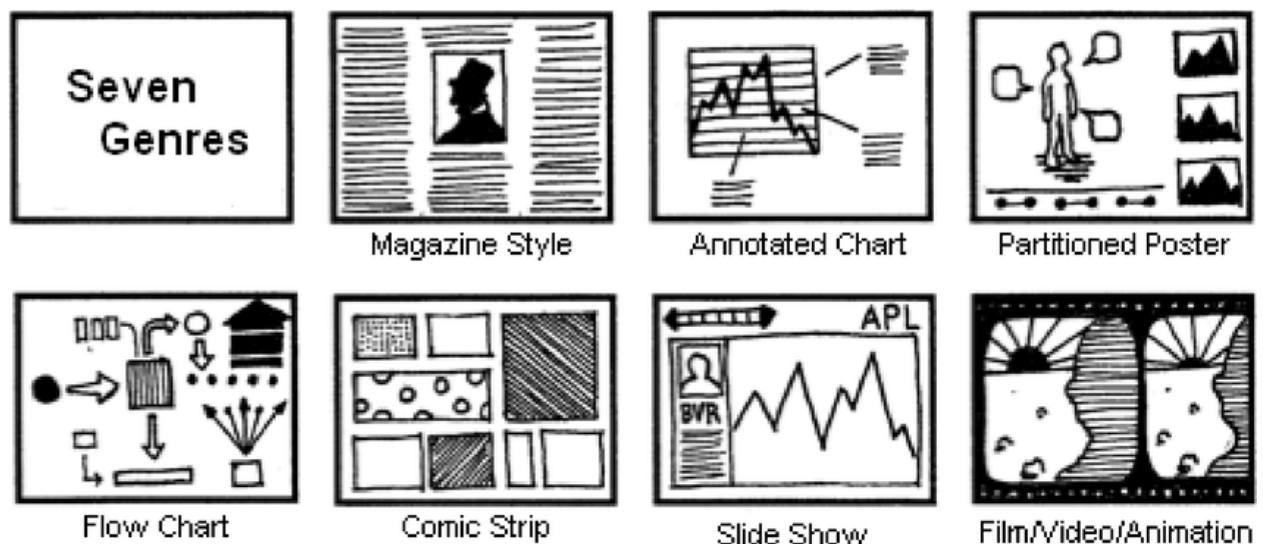


Figure 5: Seven different genres of information visualization.⁸

Above is the seven genres of information visualization according to (Segel & Heer 2010). Most of the InfoViz in the BIN reports is in magazine style, annotated chart and partitioned poster.

⁸ <http://vis.stanford.edu/files/2010-Narrative-InfoVis.pdf>

The formats of mental models

There are different views regarding the format of mental models; (Johnson-Laird 2013) argues that mental models are abstract and are mere spatial representations, while (Borst et al. 2012) view mental models as mental images, which are like pictures with color, texture and form. (Liu & Stasko 2010) combines these two formats into what they call a “cognitive collage” where a mental models consists of images, spatial, colours, text etc. are combined. Another type of mental model which is similar to the “cognitive collage is called a “situation model”, where the mental model is a representation of a situation, a kind of story or narrative. These mental representations can include multidimensional and abstract information (Schreder et al. 2016). The notion different people have of the “High North” is probably such a “cognitive collage” involving images, feelings, thoughts and stereotypes.

Mental models and interaction with information

When we study how the internal (mental models) interact with the external world (information of any kind), we need to study how these work in interaction, and in this thesis we look holistically at the process by employing three functionalities: external anchoring, information foraging and cognitive offloading (Liu & Stasko 2010)

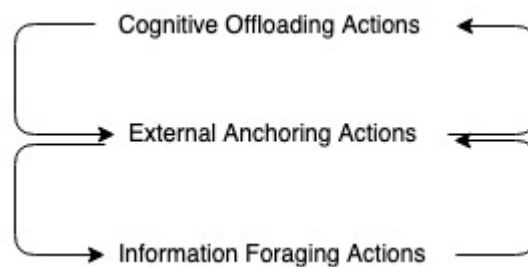


Figure 6: A Holistic approach to interaction as understood by (Liu & Stasko 2010)

External anchoring

External anchoring consists of two aspects; projection and location. A reasoning process require a stable representations (Liu & Stasko 2010). In the BIN reports the socio-economic development is presented through graphs, tables, images and texts, and the current situation looks static in the current report, since it is in printed form, however the representation does not have to look entirely static in order to make it possible to start a reasoning process, GapMinder is

a good example of an interactive tool that creates non-static images of socio-economic development, and is great at initiating reasoning processes, as everyone that has seen a lecture by Hans Rosling can possibly agree with.

Projection has some similarities with the psychological concept of projection, where a person “projects” personal thoughts and behavior on to other people, as if it was the other people that were in possession of those thoughts and behavior, when in reality it is the person that is projecting that is suffering with these thoughts and behaviors. This is similar to the concept of projection that Kirsh observed; when someone looks at something, and augments and projects something extra to the thing present that is being observed (ibid). Another concept that is important here is “locating”.

“The action of locating is initiated if the user generates a conceptual structure and needs an external representation to anchor it” (Liu & Stasko 2010 p. 6)

If a person is solving a math problem, the anchoring is done by drawing the problem and solving it (ibid), in this thesis the anchoring is done by encouraging the test-subjects to describe their mental model of the High North in words.

Information foraging

Information foraging consists of two aspects; restructuring and exploring.

When people restructure information in new ways, new patterns can be revealed. For example by adding a new sorting order or new colors etc. to the information. For users to do this the information has to be in an interactive format.

When users explore new information, and in order to make sense of it there is often not enough information to make a hypothesis, and sometimes there is not enough environmental signs that can guide foraging, in this situation, users may adopt semi-random behavior by exploring the environment in order to find useful information (Liu & Stasko 2010).

Cognitive offloading

When users analyze new information/data new patterns emerge, and the users either create new concepts, or they put new information in already existing mental “boxes”.

“During the process of visual data analysis, interesting entities, discoveries and insights can be given stable external forms in marshaling environments such as shoeboxes” (Liu & Stasko 2010 p. 6)

A shoebox is a conceptual box where people throw images, words and feelings which people believe to be right about an issue. One such shoebox is the “High North”.

Creating new mental models

People that have worked long in a field with specific tasks often have firmly established mental models in their minds. There are both positive and negative aspects of well-established mental models. The negative aspect is that users have a predetermined view of how they assume things work and it may be problematic for the user to receive new information, since new information often contradicts what you thought from before, and then a confirmation bias (cognitive bias) occurs where you only accept new information that fits into the established model. The positive aspect of well-established mental models is that the user can make quick choices because the user has previously learned what works. Managers use accounting reports as a dashboard to control and test the relationship between activities and outputs, this also helps confirm the manager's mental model on how activities, processes and performance are related (Hall 2011).

When a user is to build new mental models, the user must set aside the established mental models to receive new and often contradictory information; it depends on the user characteristics if a person is able to build new working mental models. Hall discovered that organizational tenure and the size of an organization affects the mental model building capabilities of managers, where a manager with shorter tenure were able to more effectively build new mental models using a comprehensive performance measurement system (PMS) than managers with long tenure and:

“Comprehensive PMS has a more positive effect on mental model building among managers from smaller sized SBUs compared to managers from larger sized SBUs.” (Hall 2011 p. 15).

In a study conducted by (Bourmistrov 2017) on public servants in Russia, he revealed that they were reluctant to use a revised version of a financial statement, because it contradicted their established mental models. Well established mental models seems difficult to change (based on only economic information). Mental models are not just a subjective and individual phenomenon, employees in an organization also have a collective mental model for how they assume the organization works. Communication among those who share similar mental models is easier because they talk the same language and have an akin understanding of concepts (Denzau & North n.d.). (Chong & Druckman 2007) found through their research on public opinion that the most difficult opinions / mental models people have is those based in identity beliefs.

2.5 Information Visualization and Curiosity

Curiosity is often defined as a desire for knowledge and experience that motivates exploration (Harrison 2011). In the Harvard Business Review article “The Business Case for Curiosity”⁹ several points are made about the value of being curious and how businesses can benefit from curious employees. The author of the article Francesca Gino found in her research that when curiosity is triggered in employees it can lead to fewer decision-making errors, more innovation, reduced group conflict and more open communication and better team performance. This is because curious people are less prone to cognitive bias (they seek out explanations that goes beyond their held beliefs), curious people seek out information from different sources and from different people; this can lead to new thinking and new innovations. Curiosity encourages employees to see things from other perspectives and this can reduce conflict. Curiosity can lead employees to share more information with each other and listen better to each other. In other words: curiosity can lead to superior performance.

⁹ <https://hbr.org/2018/09/curiosity>

Curiosity, cognitive fit and information gap-theory

Information gap-theory explain the same phenomenon as cognitive fit theory from different points of view. According to information gap theory, curiosity will arise spontaneously when an individual is made aware that he or she is missing some information in a domain (Ianole 2011) and curiosity will act as a motive to acquire more information or avoid information about a topic. Whether they acquire or avoid seeking out more information depends if the information will lead to pleasure or pain (Loewenstein 1994). This is similar to cognitive fit theory that propose when there is a cognitive fit between the decision maker and the information he or she interacts with; performance will be enhanced. Also, according to information gap-theory whether a new piece of information changes current beliefs about a topic is measured by how surprising it is; the more surprising, the higher chance it has to change mental models (Golman & Loewenstein n.d.). The connection between visualization and curiosity can be dealt with as a cognitive fit problem but it can also be an information gap problem. These are similar concepts approaching the same phenomena from different angles.

Curiosity is a personality trait which is a part of the main trait “openness to experience”. Openness to experience is one of the five traits in the Five Factor Model (McCrae & Costa n.d.), alongside Extroversion, Neuroticism, Conscientiousness and Agreeableness. One of the five subtraits of openness to experience is intellectual curiosity, which is defined as the desire an individual has to invest time to explore and learn about ideas, concepts, things and places¹⁰, openness to experience is linked to personal success.¹¹ Curiosity has five dimensions: Joyous Exploration, Deprivation Sensitivity, Stress Tolerance, Social Curiosity, and Thrill Seeking (Kashdan et al. 2018). In this thesis the dimensions “Joyous Exploration” and “Deprivation Sensitivity” is the most relevant. When a person experiences “Joyous Exploration” he feels a strong fascination with the world, and wants to learn more. “Deprivation Sensitivity” is when a person feels a frustration when not knowing enough about something, and it feels satisfying filling that gap with information. This study is about how exposure to socio-economic information can change internal mental representations and as a consequence generate curiosity in people. Depending on the person, when they see the word “High North”, some people will

¹⁰ <https://www.everydayhealth.com/neurology/intellectual-curiosity/>

¹¹ <https://hbr.org/2018/09/curiosity>

automatically take more interest in the region just because of their personality. One can assume students at universities score high at intellectual curiosity since they have voluntarily enrolled at the university to explore new ideas.

2.6 The model

Below is a depiction of all of the theoretical concepts presented in this chapter employed in a model.

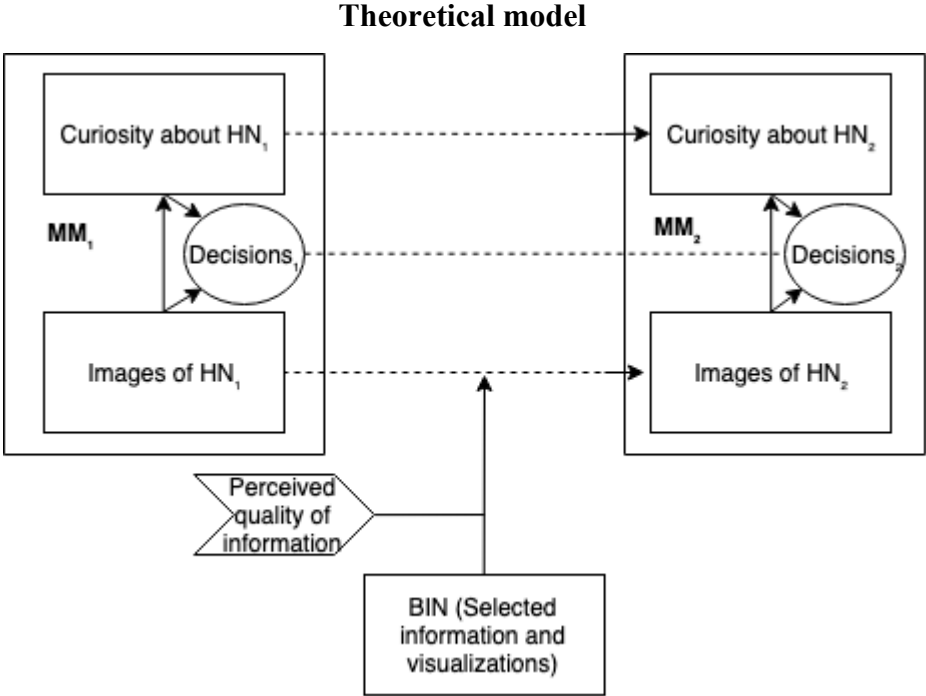


Figure 7: A depiction of the theoretical model used in this thesis. MM = Mental Model. IR = Internal Representation

How the general theoretical framework is embedded in my research context

I try to capture how the test-participants think about the High North by measuring their internal representation of the High North which is a part of their mental model. The KPIs used as socio-economic information used in this analysis is the BIN rapports. I run a three part survey since I am interested in how the KPIs are understood, how the quality of the information is perceived, and I want to get a better understanding of how KPIs can promote curiosity and change mental models of the High North.

How information influence the understanding people have of a given topic or issue and how this can affect their decisions is the primary focus in cognitive fit theory. Cognitive fit is the degree of fit or misfit between decision-makers mental model and his or her strategic environment (Martignoni et al. 2016). Mental models are scaled down models of the world which people have in their minds which they use to navigate and solve problems in the world (Jones et al. 2011). And then the concept of curiosity is added: how curiosity is linked to decision-making is a relatively new topic of research and this concept is added in the research model, which is explained in the next chapter. Accounting theory was a natural choice since the information in the BIN-report can be compared to KPIs and accounting information, and I use the qualitative characteristics of useful financial information to measure the quality of the information in BIN. Accounting reports are used by managers to confirm or build new mental models on how activities, processes and performance are linked (Hall 2011). To what degree Business Index North can change internal mental representations of the High North is revealed in chapter 4, Findings and discussed in chapter 5.

3 Methodology

This chapter outlines the scientific method that is applied to investigate the problem statement described in the antecedent chapters. The phenomenon of «changing internal representations / mental models through the use of information» will be researched by performing exploratory research by conducting a three part survey. The methodological context is the external representation of the High North in the BIN reports, and how this affects the internal representations of people living in a non-Arctic country.

3.1 Ontology and Epistemology

First ontology: how the BIN reports present the High North is one of many possible ways of telling the story of the High North. The High North could be framed in another way with emphasis on different things. This study does not try to figure out what is the “correct” framing of the High North. This study just takes one such framing, and present it to users, and measure how this framing influence them. This approach is ontological relativism since we acknowledge that there is not only one true view of the High North, but many.

How the High North is perceived by different people is highly subjective and the narratives presented in the survey might have some truth to all of them, the narratives constructed by the participants might be equally true. This thesis does not try to answer what is the correct perception/view of what is happening in the High North, it just tries to measure how the High North is actually perceived, and how socio-economic information and visualizations can influence these perceptions. Epistemologically I have tried to make a theoretical abstraction of the qualitative data and then illustrate and analyze how the external representation of the High North presented in the BIN report changed the participants internal representation of the High North.

3.2 The Survey / Qualitative exploratory research

A qualitative exploratory research method is used when a phenomenon or a problem has not been studied clearly, and when one needs to establish priorities and operational definitions before going further (Shields & Rangarajan 2013). The results from this qualitative study could possibly be used in a quantitative study of the problem and the phenomena studied in this thesis in a follow up research.

We apply qualitative exploratory analysis to understand how the test-participants understood and reacted to the information in the BIN reports. To do a classical experiment with a control group would be hard to do in this case, since the independent variable is the BIN reports, the control group would only be able to answer part one of the survey, since part two and three involves the report. This is why we did a three-part survey, to test what the subjects knew before reading the report, and how the BIN reports influenced their thinking of the High North region.

Pre-tests. 20 pre-tests were done of the survey on students from different nationalities and from different fields of study in order to ensure that the survey was understandable and equally important; to make sure the survey actually measure what I intend to measure. My assumption was that people living far away in a non-Arctic state would know less about what is happening in the High North, thus I chose to test people living in a southern European country. My supervisor had connections with the University of Siena, this made it possible for me to travel there and do the three part survey on students residing there. By conducting research on people that presumably do not have a strong prior understanding / mental model of the High North, maybe it

is easier to influence their thinking when exposing them to information that is new and presumably unexpected.

In Part 1 the subjects are presented different narratives of the High North, and are asked which one most resembles their understanding of the High North, they also give their opinions of how strongly they want to travel, seek work or invest in the High North. In part 2 they are presented a condensed version of the BIN-reports which they study in about 30 minutes. Then in part 3, they answer a quick fact check, to see how much they remember from the report, then they are asked if the report changed their impression of the High North, then they are asked to give their opinions on the qualitative characteristics of the economic information in the report, and then finally I ask them again how likely they are to travel, seek work and invest in the High North.

The narratives presented in the three part survey:

- A. The High North is a depopulated area where multinational companies are extracting natural resources, leaving almost nothing for the indigenous people living there.
- B. The High North is a place with pristine untouched nature and is threatened by climate change
- C. The High North is an area with a huge potential for economic growth
- D. I don't have a perceived image of what is happening in the High North
- E. If none of the above, write own narrative (few sentences):

The survey is attached in the appendix. The questions were crafted out using accounting theory, research on curiosity, studies on mental models and cognitive fit theory. Many of the questions were presented as statements, were the respondents were asked to give their reaction or opinion to that statement. To rank the respondents reactions ratings and semantic differentials were used, were a high number indicate that they agree strongly, or a low number indicates they disagree strongly.

The respondents were also given the opportunity to write their own comments to why they responded as they did.

3.2.1 Operationalization of the concepts in the model

In part one of the survey MM_1 is mapped out; how curious are the participants on the High North, what cognitive images and internal representations do they already possess, and how interested are they in making decisions/intentions regarding travel, work and investments (using cognitive fit theory) in the High North before reading the report. Next BIN is presented, then the change is measured by mapping out MM_2 ; where the participants are asked if they have a different internal representation of the High North after reading the report, then they are presented statements regarding the quality of the information in the report (using accounting theory) and then they are finally asked the same questions again regarding travel, work and investments to see if they are more interested in interacting with the High North. Next we need to measure curiosity, cognitive images of the High North and intentions. To measure how curious they were of the High North before reading the report; it was important to know how often they used different mediums (the internet, newspapers, TV, radio etc.) to learn about the High North, because these information sources are relevant to their current mental model of the region. Curiosity consists of five dimensions (Kashdan et al. 2018), and the two most relevant dimensions for this thesis is “Joyous Exploration” and “Deprivation Sensitivity”. When a person experiences “Joyous Exploration”, he feels a strong fascination with a subject, and he takes pleasure in learning new things about it. When a person experiences “Deprivation Sensitivity”, he recognizes a gap in his knowledge of something, and filling that gap with information feels good. Presenting them with a presumably unknown topic such as “High North issues” will hopefully trigger these dimensions.

We wanted to know how interested they were in traveling, seeking work and what they thought about investing money in the region. After they had read the report they were presented the statements: «The information was fascinating» and «The information was surprising» and made them indicate their reaction to them on a likert scale: from Strongly agree to Strongly disagree to measure how curious the information made them. If the information does not create interest and is not fascinating and or surprising, then maybe the information is unable to create curiosity? I use “interest”, “fascination” and “surprise” as three measures for the same concept; curiosity. Alongside their interest in travel, work and investments.

To map the mental models the participants had of the High North before reading the report I presented three different narratives and the option of writing their own narrative. I wrote three relatively strong narratives of the High North. I worked out the narratives in cooperation with my supervisor, and I also tested different narratives in the pre-tests of the study, to check if they made sense to the participants. I made the option of writing their own narratives because mental models can be complex. I also made the option of writing comments to if and why they changed their mental model of the High North to get more detailed information on how the information affected their thinking.

3.3 Quality of the study

To ensure the quality of a scientific study the following aspects are vital.

3.3.1 Selection and recruitment

The problem statement is quite wide when it comes to who is relevant for this study, however, based on the pre-tests of the survey, I figured out that how people living in a non-Arctic country think about the High North would be most the interesting.

3.3.2 Validity

It is essential that there is a relationship between the phenomenon investigated and the data collected (Easterby-Smith et al. 2012). The phenomenon studied in this thesis is «changing mental models through the use of information». Unfortunately, I could not open the scalps of the test-participants and study their internal representations directly, so I had to study the phenomena indirectly. One way to test if people changed their way of thinking about a topic is to ask them what they think about the selected topic before exposing them to the selected information, and then ask them how they think about the topic after they read the information and see if there is a change. This is why I chose to do the data gathering by conducting a three part survey. The participants are given the opportunity to rank the quality of the information, and write their own comments to the information in the report.

I was careful about the use of sources throughout writing this thesis. By doing a thorough literature review. I studied earlier research on curiosity and mental models, and I used their

methods for inspiration for my survey. I believe that what is measured in the survey is what I intended to measure, and that there is a causal relationship between the phenomena studied: For example when measuring how curious the participants were of the High North I asked how interested they were in the region, how curious they were on the region and whether they would like to work, travel or invest there, and finally I asked them to give their own written opinions. I believe all of these inputs give me a quite strong indication on their interest and how curious they really are of the region. The survey was a self-report study, were the participants were asked to give their honest opinions about the report and the region. However, there will always be a vulnerability when using self-report studies, since people can lie on them. I used EndNote to help me keep e detailed overview over the theoretical framework, method and empiricism.

3.3.3 Reliability

Reliability is whether research conducted can be replicated. Reliability is also about the data collected: What data is used, how the data is collected and how the data are processed. (Easterby-Smith et al. 2012). It is therefore very important to have a structured and clear method chapter, which can let others follow the steps through the process, and then try to recreate the result in similar contexts; In order to increase the reliability of this study I will make a log of what decisions I made during the research process, so other researchers can follow my rationale. My supervisor read through the survey and gave me important guiding, also I did several pre-tests; this increased the intersubjectivity and corresponding reliability. According to the science journal Nature¹² 70% of research that have tried to replicate another researchers experiment, failed doing so. This is by some called “The Replication Crisis”¹³, primarily affecting social and life sciences. Since we study human beings in the social and life sciences, the results will always vary a lot, however I believe a lot of the research done in the social and life sciences still can show general tendencies in one way or another. This fact is obviously relevant to this study, but hopefully if one were to replicate this study in other parts of Italy, or in other non-Arctic states there would be some similarities in the end results.

¹² <https://www.nature.com/news/1.19970>

¹³ https://en.wikipedia.org/wiki/Replication_crisis

3.3.4 Generalizability

If the findings in a study is relevant in other contexts, the study have a high degree of generalizability (Easterby-Smith et al. 2012). This study explores the relationship between information, curiosity and internal representations. The research is conducted in a specific context, with specific KPIs and visualizations and on a specific group of people. The High North, Business Index North and on students in Siena, Italy. However how the participants react to new information and how this affects their curiosity, internal representations and how this affects their intentions will hopefully be generalizable to other socio-economic indexes.

3.4 The participants A total of 91 people took part in the three part survey, 71 of them were Italian, the rest were Albanian, British, Filipina, French, German, Greek, Iranian, Nigerian, Russian and Spanish. All of them lived in Italy when the survey was conducted. All of the participants were between 18 and 34 years old. Almost all of them studied economics, with a few exceptions. Almost none of the participants had worked, studied or traveled to the High North. (Between 94% to 96% had never traveled, worked or studied anything related to the High North)

Have you ever worked with or studied something related to the High North?

91 responses

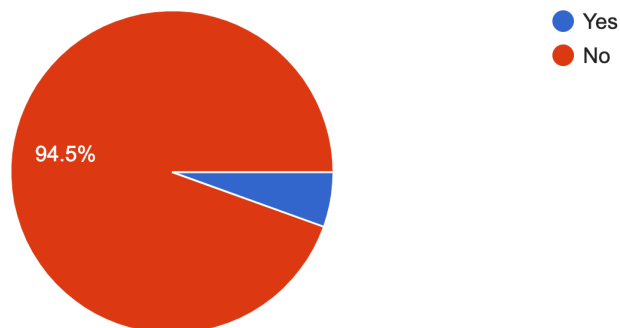


Figure 8: Pie chart of how many participants that have worked with or studied something related to the High North

Have you ever visited the High North?

91 responses

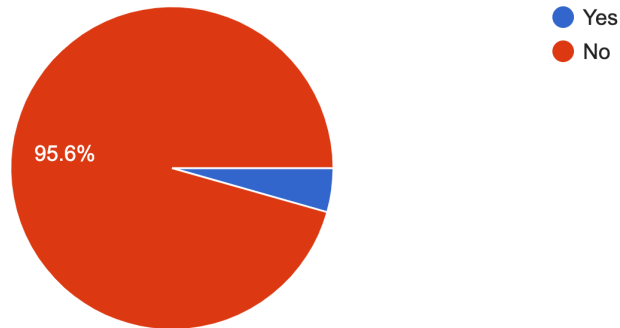


Figure 9: Pie chart of how many of the participants that have visited the High North

94,5% of them had never worked with, or studied something related to the High North, and 95,6% had never visited the High North. This is an indicator that the respondents do not have local knowledge about the region, and the only knowledge they have is from other sources than mass media and the internet.

4 Data & Empirical chapter

In this chapter the findings are presented. First some context and background on High North development are provided, along with previous research on BIN and in 4.2 all the empiricism from the surveys are presented in graphs, text and figures.

4.1 Context: High North development and Business Index North

The High North has historically been an important area for trade, especially between Norway and Russia with the Pomor trade which went on between 1740 until the Russian revolution in 1917. During the Cold War the High North was an important strategic area for both NATO and Russia. For over 40 years Norway and Russia negotiated where the national borders between Norway and Russia should be in the Barents Sea, in 2010 they finally agreed. In the last decade The High North has attracted a lot of attention from nation states from all over the world, international organizations and businesses.

The Norwegian minister of foreign affairs Børge Brende said in 2017 that the High North is Norway's most important strategic area of interest.¹⁴ The High North a place where Norwegian domestic policy meets Norwegian foreign policy. The High North is a melting pot for geopolitics; a region where the Arctic states; Norway, Sweden, Iceland, Finland, Denmark, Russia, the United States and Canada interact, and recently non-Arctic states like China and South Korea have taken an active position and developed their own High North policies; this makes the High North an interesting area with possible conflicts but also great opportunities for international cooperation. After Russia annexed Crimea in 2014, Norway was forced to take a colder approach to Russia, and some trade and cooperation went into a halt.

The High North is a region filled with valuable resources such as oil, gas, minerals such as cobalt, but also sources of renewable energy such as wind, waves and even potential for solar power¹⁵. This is also a region that is struggling. The High North has a relatively low population growth, a slight uneven gender-balance, and the region is in need of people with higher education. How can the region attract more people with competence, and how can the region attract more investments, and how can business and industry grow in the region in a sustainable way? And what can be done to facilitate cross border cooperation? BIN is an attempt to solve these questions.

Business Index North

BIN is a socio-economic index that maps regional development in the High North. There are other indexes covering parts of the High North; Index Nordland, Konjunkturbarometeret for Nord-Norge and some other Scandinavian indexes, but BIN is different. It makes aggregations and comparison easy across borders and BIN has a strong focus on visualizing the socio-economic development in the High North. BIN is created for a wide set of stakeholders, including; governments, regional authorities, businesses, media and academia. The stated goal of the index is:

¹⁴

https://www.regjeringen.no/contentassets/fad46f0404e14b2a9b551ca7359c1000/nordomraadesatsing_fin_al_tekst_ny.mp4

¹⁵ <https://www.highnorthnews.com/en/solar-energy-arctic-underestimated>

“The idea behind BIN project is to contribute to sustainable development and value creation through increased global awareness of business opportunities in the Arctic. The overall goal is to set up a recurring, knowledge based, systematic information tool for stakeholders.” (Anon 2017 p. 8)

The aim of the project is that the reports can generate interest and attention from businesses to High North development, and thus attract more investments to the region. There are major institutional changes going on, and the High North are one of the main focus areas in Norway today. The counties in Norway, Sweden and Finland that is a part of the High North is lagging behind the rest of their respective countries in regards to population growth, job growth, human capital and so forth, and the High North is an area with lots of untapped potential in regard to resource utilization and trade. This area consists of different countries with different actors with different agendas, and communication is vital to ensure cooperation, and BIN can help conceptualize the High North as an area for collaboration among businesses and institutional decision makers. The Index portrays a quite gloomy picture of the socio-economic situation and development in the BIN-region: Low population growth, an aging population, the human capital lags behind the average of Nordic countries, slow job creation speed. 2,5 times lower patenting activity than the average in the Nordic countries. However there are a few bright spots: BIN area is a provider of renewable energy and there are many examples of cross border cooperation.

Previous research on BIN

In an earlier paper published in the journal *Barents Studies: Peoples, Economies and Politics*, the author of this thesis studied the perceived value of Business Index North, and found that businesses and regional authorities in the BIN region found the information was *“nice to know”*, not *“need to have”* (Danilov & Mineev 2019). From this two conclusions can be drawn; BIN in its current form is not that useful for businesses, and that the reports instead possibly can be used as a tool to make challenges and opportunities in the Arctic more known to a wider audience. Below is an overview of the perceived value of BIN from different stakeholders.

USER GROUP	PERCEIVED VALUE OF BIN	DEGREE OF APPLICABILITY
Central government bodies in Norway and Russia	Information about key issues of the High North development to be addressed at a central political level	Rather high BIN presentations raised a lot of interest among these users. The project was invited several times to make presentations to ministries in Oslo and Moscow.
Regional authorities in Norway	Information about various sectors like demographics and businesses to prepare background for political decisions	Medium Comparison between regions is important to build arguments for central politicians; otherwise it adds rather little to their knowledge of the region.
Businesses people and development actors in Northern Norway	Overview of major issues of the High North	Low This group needs more detailed and more relevant information for specific industries. This is derived from customers and more specific studies. Often they possess contextual knowledge of their own region in the High North and therefore the information in BIN is not a big surprise for them.
Media in the High North	Background material	Medium Media outlets are interested in the information presented in BIN, they tend to develop emphasis frames (mostly dramatized versions of signalling gaps) and they reframe key messages in the report.
Students and experts interested in issues of the High North (Norwegian, Russian, Finnish, international)	Information about key trends in the High North	Medium to high During the BIN presentations this group asks a lot of questions and show interest in the figures. It is clear that those who want to get introductory knowledge of the High North find it in BIN presentations. Numerical information on key topics is helpful in developing a structured view of the North. Not least, these people find it easy to connect to the discussions about BIN figures/graphs by drawing on their own perspectives and life experiences. This user group is mostly motivated to go into the details of the report.
Pressure groups: environmentalist organizations in Norway and North-West Russia	Solid statistical overview	Low BIN in its current form is unlikely to be relevant for this user group as it has neither direct information on environmental hazards nor first-hand information on development decisions to be made by high level political and business actors.

Figure 10: Degree of applicability of BIN (Danilov & Mineev 2019)

As we can read from the table only one group considered the BIN reports to have a rather high degree of applicability; central government bodies in Norway and Russia, where the BIN project generated a lot of attention and interest. Regional authorities in Norway, Media in the High North and students found medium applicability for the information in the report. Probably the most surprising find is that businesses found the report to be almost uninteresting and they could not find any use for the information in the reports.

4.2 Findings from the survey

In this part the findings from the survey are presented. First the most impactful visualizations from the BIN reports are shown, so the reader of this thesis get a better understanding of what information the survey-participants were presented.

4.2.1 The visualizations in BIN

To do the survey on over 90 participants in a short week; I had to condense the two BIN reports into one summary which was readable in 30 minutes. I started with the executive summaries which are presented by the BIN project at conferences. Each chapter in the index covered issues regarding the following in the High North; People, Life and Work, Business Activities, Innovations and Value Creation, Maritime Transportation and Connectivity.

I took the main points from these, there are about 5-8 main findings from each chapter of the report. I wanted to use visualizations which show all of the activity happening in the High North in a self-explaining way; I chose figures and graphs that I thought summarized the points in each chapter the best. To show the maritime transportation activity in the High North I chose a graph showing the increasing cargo shipped on NSR from 1933 to 2018, and also a map of all the lanes where the vessel travels at the NSR to go along with the graph. To show the Value Creation and Business Activities happening in the region I chose a bar chart comparing the amount of value produced in each part of the BIN region with each other, and to accompany that I chose a graph showing what type of industry that comprise the BIN economy. To show the main points in the chapter People, Life and Work I chose a variety of graphs and figures showing which type of industry are growing and reducing in size, and different figures revealing employment development. And finally to show the main points of the Connectivity-chapter I presented a map showing international subsea fibre initiatives in the Arctic. My point in choosing exactly these

were to use the most revealing visualizations, so the reader got a quick understanding of the situation. Following are the visualizations that made the most impact in the report which the participants ranked in the survey. I made an interview with a representative for the BIN project, and asked him about what the intended message behind the visualizations was supposed to be, under each visualization a short summary of his comments are included. All of the visualizations in the BIN report is author-driven, where the sender (the BIN project) have an intended message they want to reach people with, and the users (people) cannot interact or do anything themselves with the information or with the visualizations.

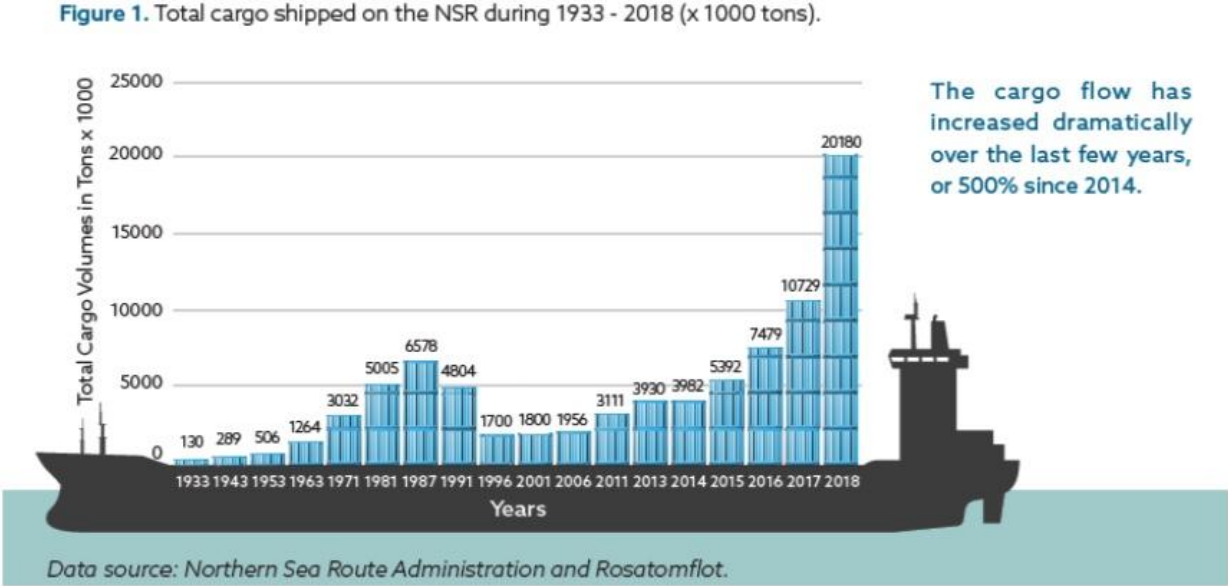


Figure 11: Excerpt from the BIN report (Shipping volumes)

The BIN projects wants two things with visualizations of the Northern Sea Route: create awareness of the sea-activity that is happening in this area and to show the economic potential in the region. For instance by showing the pillars with the tonnage the idea is to provoke the reader to see that there was a drop in cargo and recently it has increased almost exponentially in the year 2018. This is an obvious indicator of the economic growth in the region.



Figure 12: Excerpt from BIN report (Shipping lanes)

The intended message of this visualization is to show that the BIN region is located centrally as a natural hub between the east and the west, this is shown with red lines which reveal that the heaviest activity on the whole Northern Sea Route is in the Barents Sea.

Map of power production in the BIN area at the county level, 2014

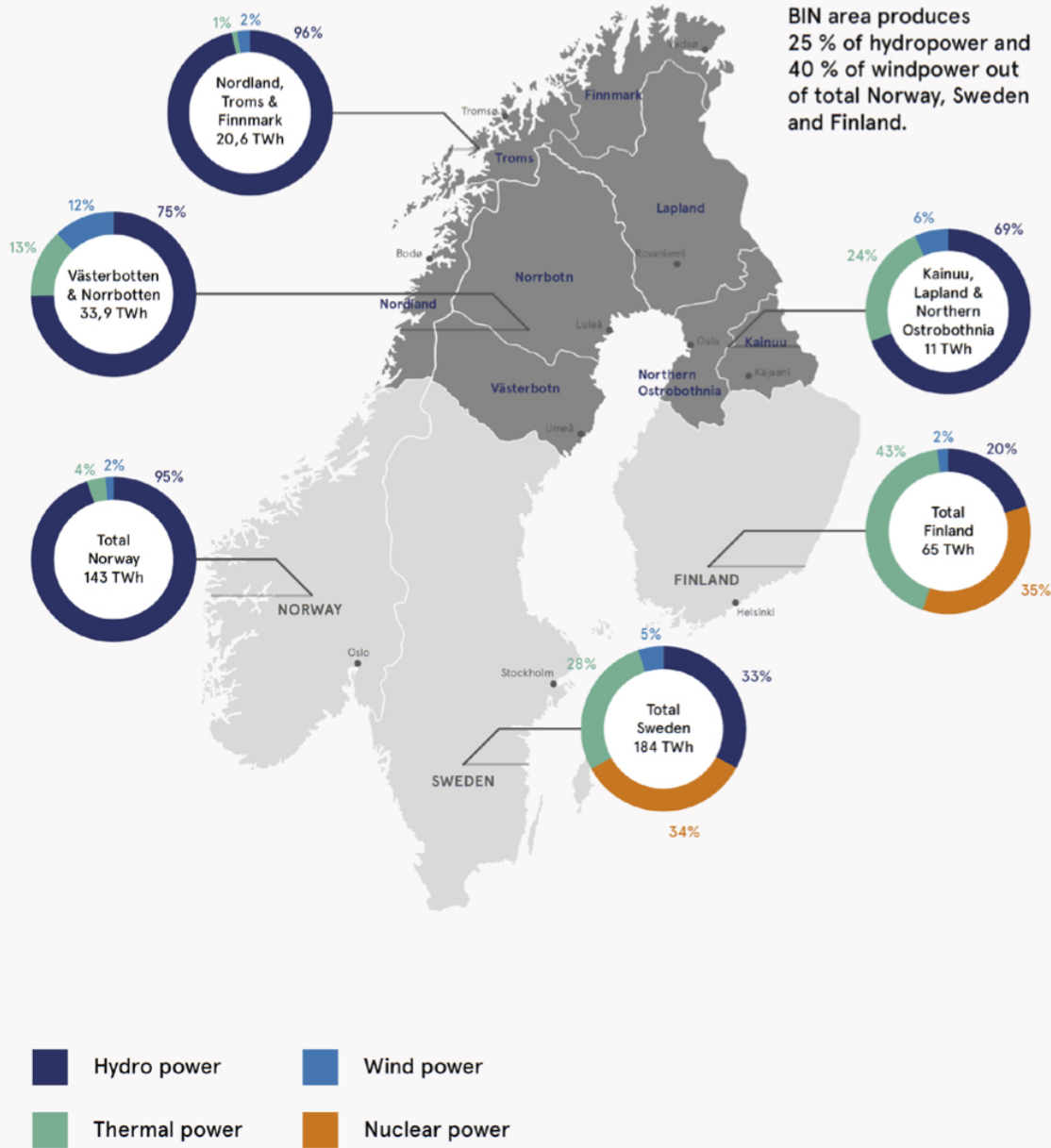


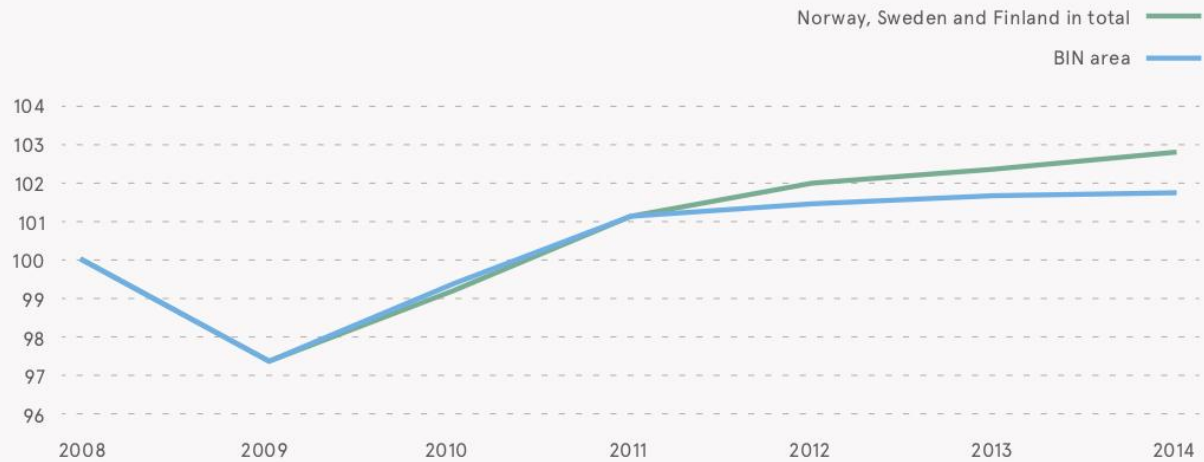
Figure 13: Excerpt from the BIN report (Power map)

With the map above the BIN project want to show how central the BIN-region is in creating renewable energy, and they want to communicate that there is a lot of potential in the region in creating environmental friendly businesses. By looking at this picture the reader should recognize that Nordland, Troms and Finnmark in Norway, Västerbotten and Norrbotten in Sweden and Kainuu, Lapland and Northern Ostrobothnia produce a majority of their energy with hydro power, compared with the southern parts of Sweden and Finland which produce 1/3 of their energy with nuclear power. This map is among the top graphs that changes internal mental representations, this could be due to the fact that nuclear power can produce worry in many people¹⁶.

¹⁶ <https://www.forbes.com/sites/michaelshellenberger/2018/06/11/if-nuclear-power-is-so-safe-why-are-we-so-afraid-of-it/#7f77f1e26385>

Employment development

All industries except agriculture, forestry and fishing
2008-2014, index 2008 = 100



Employment growth at the BIN county level

All industries except agriculture, forestry and fishing
2008-2014, %

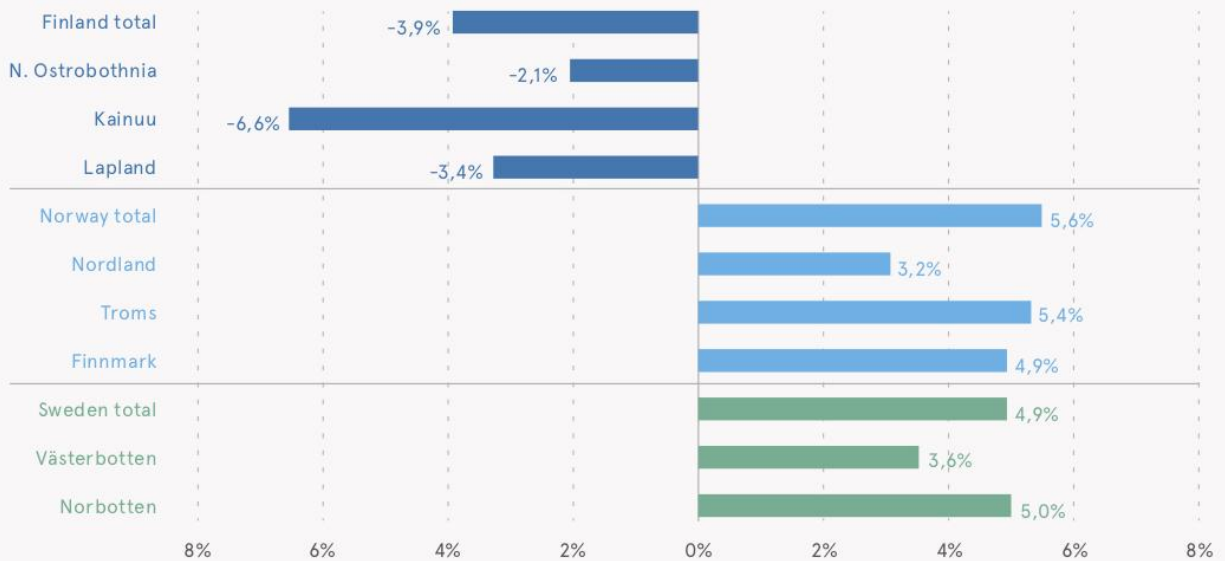


Figure 14: Excerpt from the BIN report (Employment development)

Employment development is a key question when it comes to regional socio-economic development and the BIN projects want to show that the BIN area as a whole is lagging a little behind the rest of the corresponding regions in the countries that the BIN area is a part of, but at the same time show that employment is growing in most parts of the BIN area.

Biggest job creation and losses in the BIN area 2011-2014

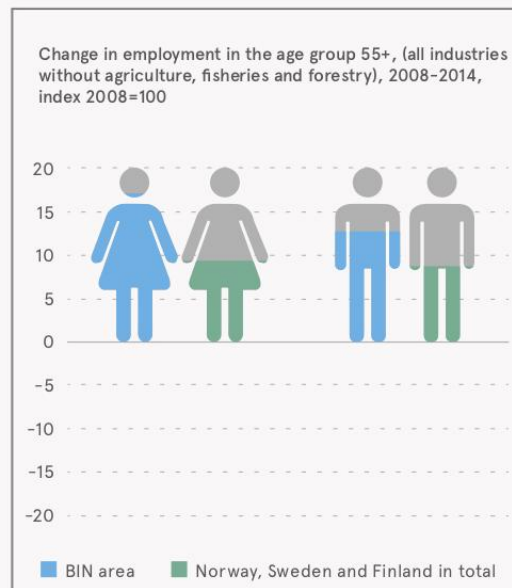
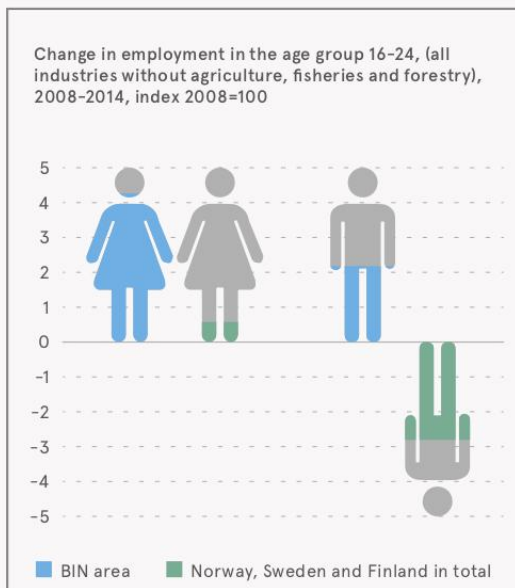
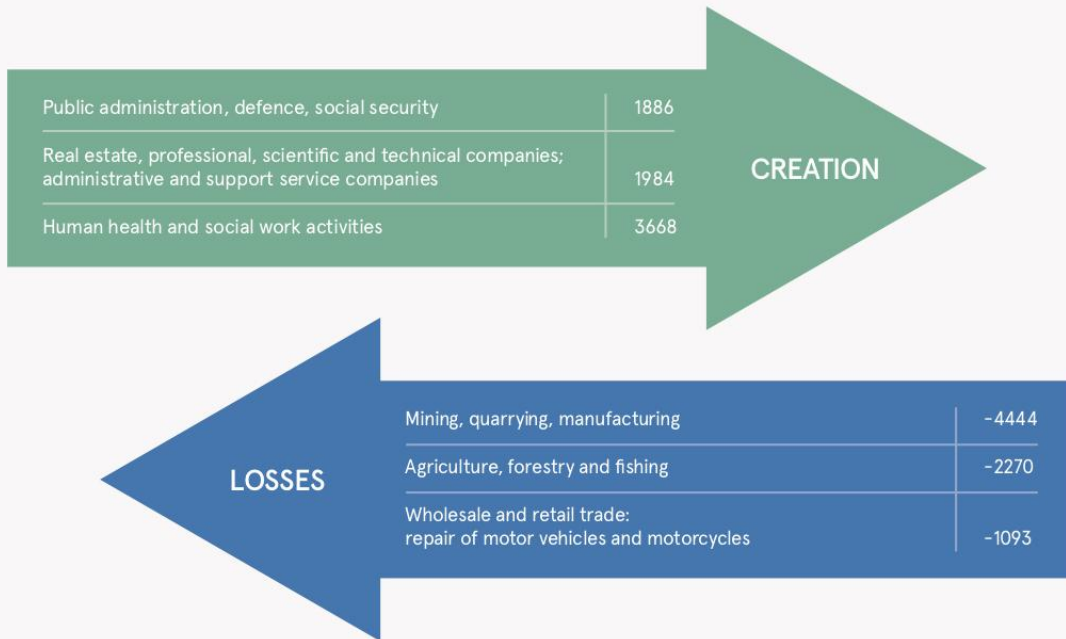


Figure 15: Excerpt from the BIN report (Job creation and losses)

With the visualization above the BIN project creates an equivalency frame where they use dramaturgy to show job losses and job creation, it is supposed to provoke thinking about these issues in the BIN audience.

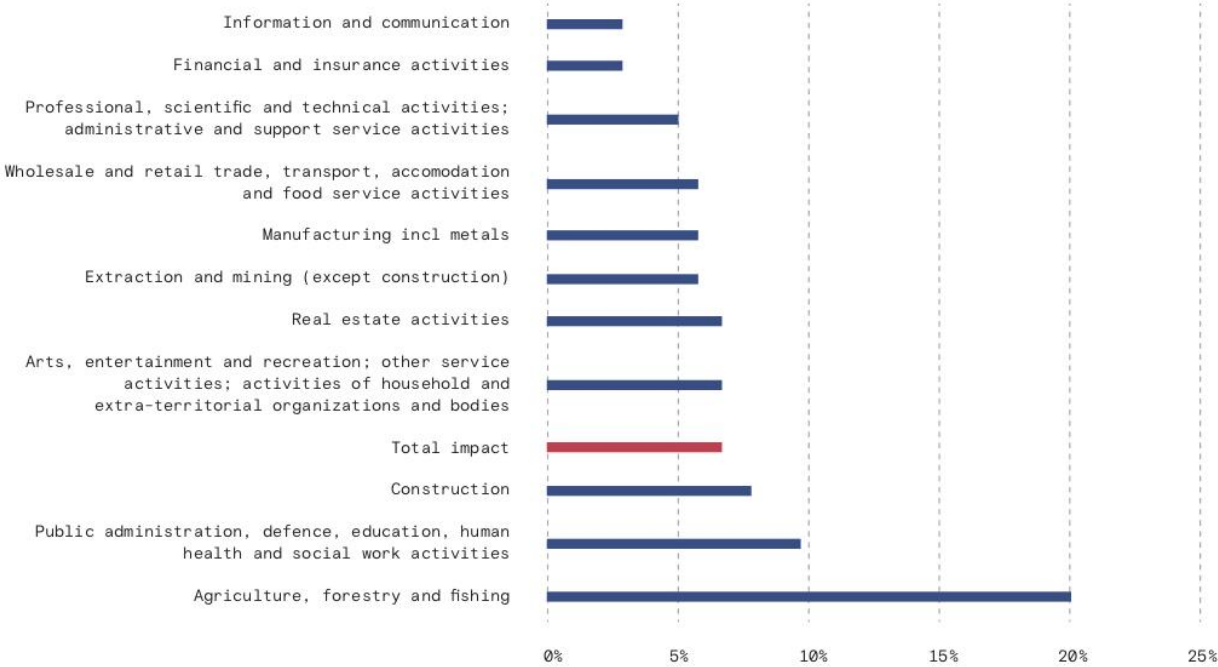


Figure 16: Excerpt from the BIN report (How much value each industry in the region produce)

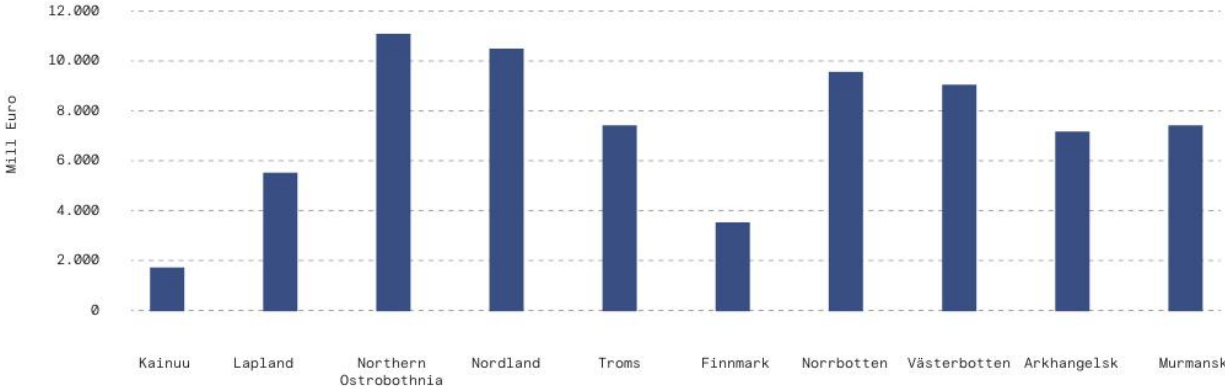


Figure 17: Excerpt from the BIN report (The size of each region in terms of gross value produced)

The visualizations above is classic benchmarking, where they compare industries and regions with each other, the intended function of the graphs is to evoke thinking around these issues in readers and debates at conferences.

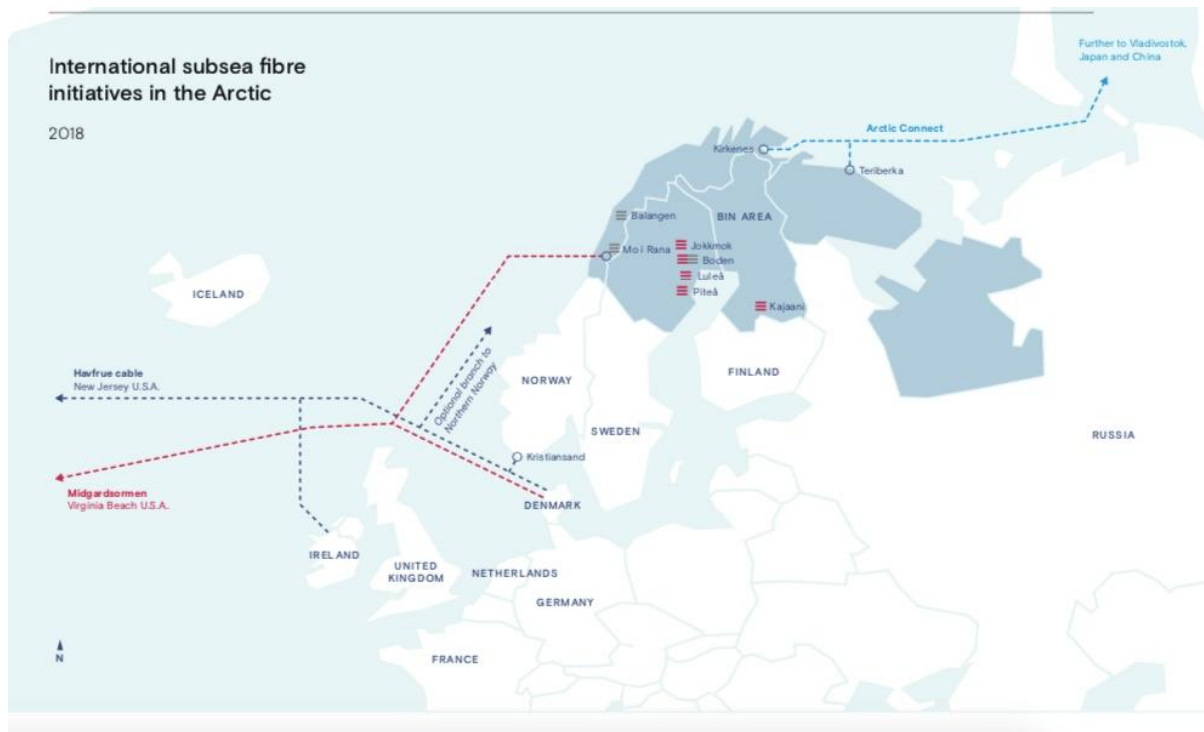


Figure 18: International subsea fibre initiatives in the Arctic

With the visualization above the BIN project wants to direct attention to digitalization in the High North, they want to communicate both that sub sea fibres currently does not exist and that there is potential for developing connectivity in the region.

4.2.2 Data from the pre-tests

The first pre-tests were done on ten Norwegian students, the second on five Ukrainian students and the last 5 on students from Germany and France. The ten students from Norway already knew quite a lot of what is happening in the High North, so the report only confirmed their already held beliefs. Nine of them already thought that the High North was an area with a huge potential for economic growth. Then I tested five students from Ukraine, four of them also held the belief that the High North is an area with a huge potential for economic growth, and one of them thought that the High North is a place with pristine untouched nature and is threatened by climate change. Then finally I tested the five students from France and Germany, and all of those perceived before reading the report that the High North is threatened by climate change, and after

they read the report four out of five changed their mental model of the High North to “The High North is an area with a huge potential for economic growth”.

Before reading the report (All pre-test-participants)

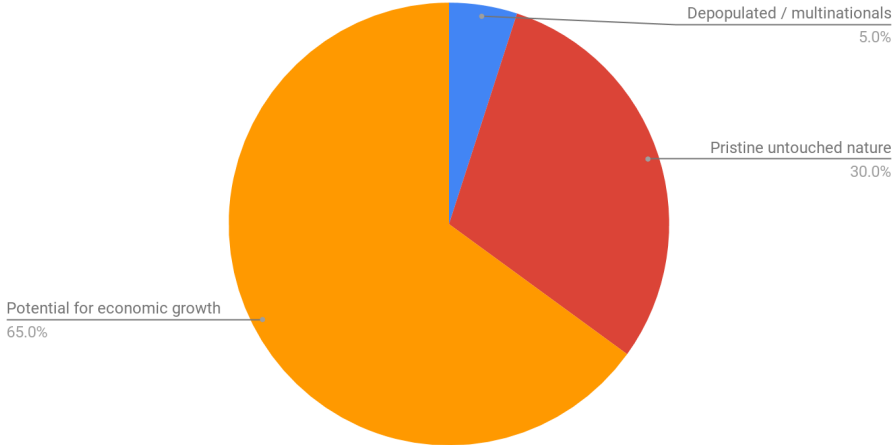


Figure 19: Pre-test. Internal representations held by the pre-test participants of the High North before reading BIN

After reading the report (all pre-test-participants)

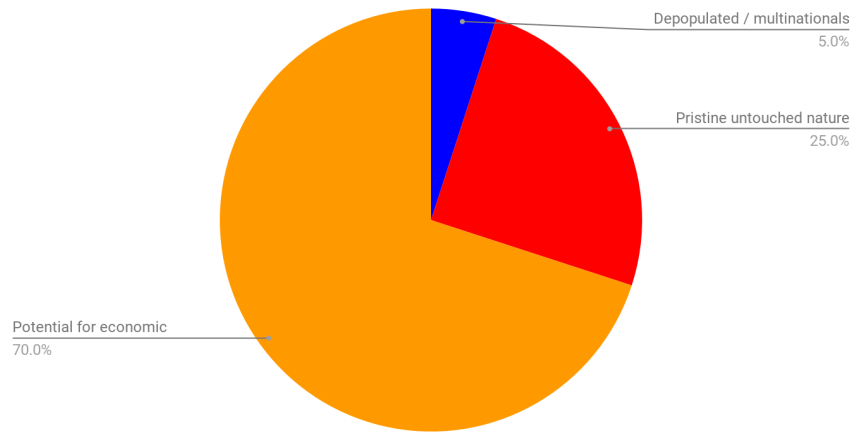


Figure 20: Pre-test. Internal representations held by the pre-test participants of the High North after reading BIN

We can observe only a small change in total from the pre-tests. To most of the Norwegian students, the report just confirmed their already held view: that the High North is an area with a huge economic potential. The change was more visible in the foreign students, where most of them looked at the High North as a place with pristine untouched nature, after BIN most of them changed their view of the High North to a place with economic potential.

Data from the pre-test. (Interest in High North Issues Before and after reading BIN)

Variable	Pre-test subjects (Before reading)			Pre-test subjects (After reading)		
	MEAN	SD	Number	Mean	SD	Number
INTEREST	2,45	0,887	20	2,15	0,745	20

Table 1: Interest in High North issues before and after reading BIN. From the pre-tests of the survey. The closer to 1 they answer, the more they agree with the statement. 1 = Very interested, 2 = Fairly interested, 3 = Slightly interested, 4 = Neither, 5 = Slightly uninterested, 6 = Fairly uninterested, 7 = Very uninterested

We can observe a small improvement in interest in High North interest in the pre-test participants after reading the report.

4.2.3 Data from the main survey

Below is the data gathered from the main survey among the 91 participants in Italy.

4.2.4 Change in mental models of the High North

BIN has changed internal mental representations of the High North significantly. BIN produced both optimism for High North development and worry for global warming among the participants. BIN promote competing views of the High North. I named the participants that answered: *“The High North is an area with a huge potential for economic growth”* the “Potential-group”.

I grouped together those that answered *“The High North is a depopulated area where multinational companies are extracting natural resources, leaving almost nothing for the indigenous people living there.”* with those that answered *“The High North is a place with pristine untouched nature and is threatened by climate”* in what I named the “Sceptic-group”. So, one group became more positive to economic development, and the other became more sceptical to development in the High North. For a minority the report did not influence their thinking at all. And a few wrote their own custom narratives, which are included in the appendix.

In part 1 of the three part survey, this is how they answered:

Of the following narratives, which most resembles your perceived image of the High North?

91 responses

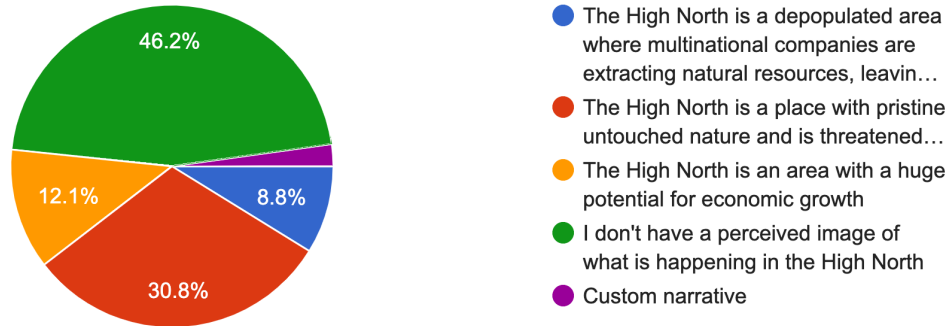


Figure 21: Perceptions of the High North before the three part survey

46,2% of the participants did not have an internal representation of the High North. This is gives meaning, since a majority of the participants have never, worked or travelled in the region, and a majority of the participants never search for any information about the topic.

And this is how they responded after reading the report:

**After reading the report, which narrative do you think is the most correct?
(Choose only one narrative.) (Set a ring around the letter of your narrative)**

91 responses

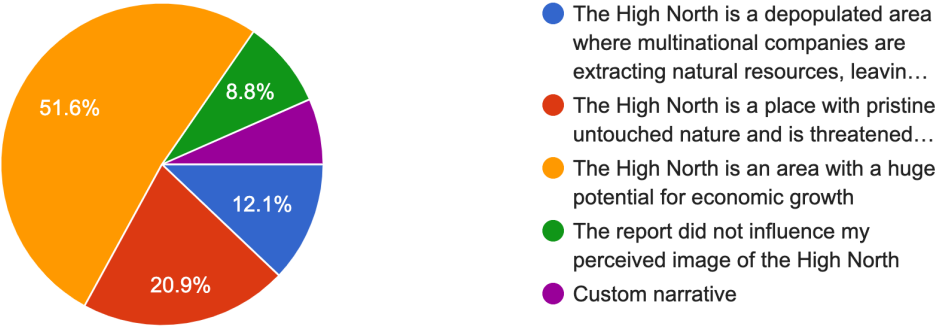


Figure 22: Perceptions of the High North after the three part survey

We can clearly see that the information in BIN has a strong ability to change internal representations. 51,6% answered that their perception of the High North was a place with a huge potential for economic growth, where only 12,1% answered that in part One of the survey. An increase of 39,5%. Maybe it is because their knowledge of what is happening in the High North is quite low, and when exposed to new information with convincing visualizations, they were quick to update their internal representation. However 33% became to view the High North as either in danger of climate change, or as a depopulated area were multinational corporations are extracting natural resources leaving almost nothing behind for the people living there. We can see two groups forming. Those positive to High North development, and those that are a bit more sceptical. How was this dramatic change in perception of the High North possible will be discussed more in chapter 5. And all written comments left by the participants is included in attachment B.

Below is a breakdown of all the groups in a table

Group	Total	Sex	Age	Nationality
Potential-group	47	26 females, 21 males	35 individuals between 18 to 24 years old, 12 individuals between 25 to 34 years old	42 from Italy, the rest from Germany, Iran, Russia and Spain
Sceptic-group	32	24 females, 8 males	27 individuals between 18 to 24 years old, 5 individuals between 25 to 34 years old.	18 from Italy, the rest from Britain, France, Germany, Russia, the Philippines, Nigeria and Greece
Custom narrative-group	4	2 females and 2 males	3 individuals between 18 to 24, 1 individuals between 25 to 34	All from Italy
Did not change narrative-group	8	3 females, 5 males	6 individuals between 18 to 24, 2 individuals between 25 to 34	6 from Italy, the rest from Albania and Nigeria

Table 2: A breakdown of the sex, age and nationality of the test-participants

Below is a graph showing which of the visualizations above made the most impact to change the participants internal mental representations.

What was the most important figure(s) that made you change your mind?

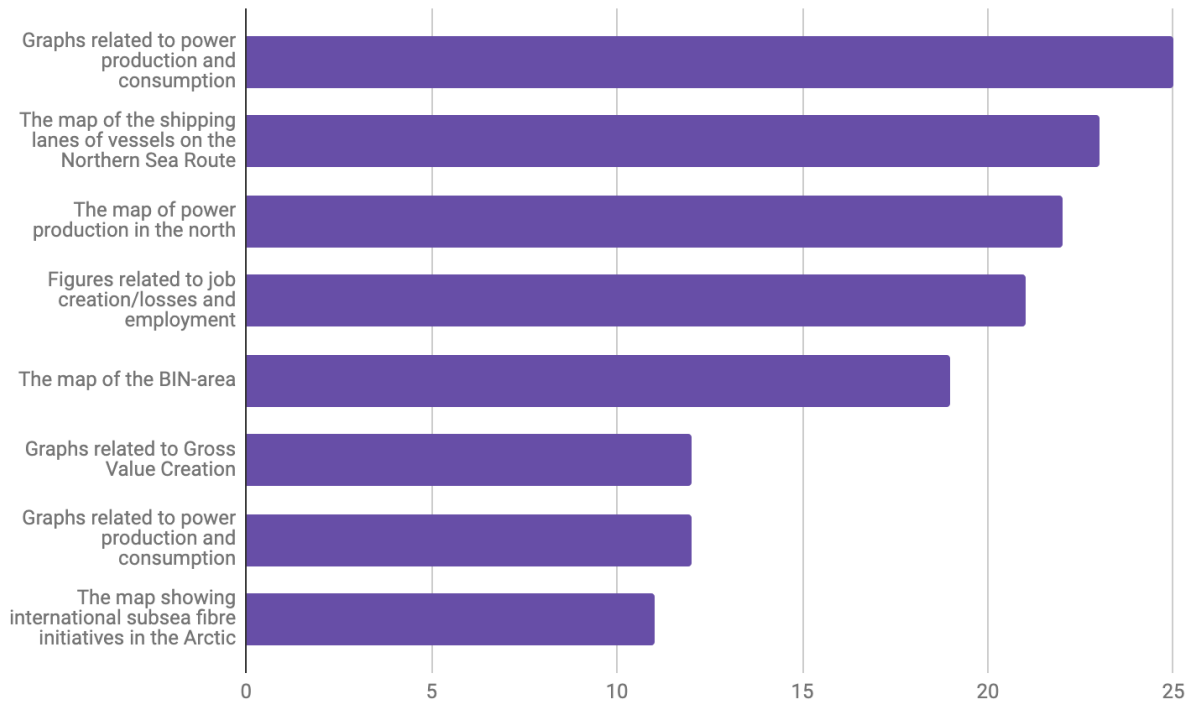


Figure 23: Bar graph of the most important figures that changed the mental models of the participants

Many answered more than one figure. However we can see that both the visualizations of shipping volumes and shipping lanes together with the map of power production in the north did the most impact to change the internal representations of the participants. The map of the power produced provoked several comments. The graphs that generated the most comments was the shipping volumes on the Northern Sea Route (NSR) and map of the shipping lanes of ships traveling the NSR. All comments left by the participants is in attachment B.

4.2.5 How the participants receive information of the High North

We can see from the data material that most of the participants don't search for information about the High North on a regular basis. Internet and TV are the most important mediums. 49% get information from the internet about the High North at least once a month and 40% use TV to

learn something about the High North at least once a month. 56,7% to 86% of them answered that they seldom or never use any of the mediums to learn about the region.

If one actively searches for information this indicates an interest and curiosity in a topic, most of the participants do not seek out any information, most of the information they have about the High North they have received passively. This indicates a low initial interest and curiosity in the High North in the participants.

How often do you use these sources of information to learn about the High North? (Internet)

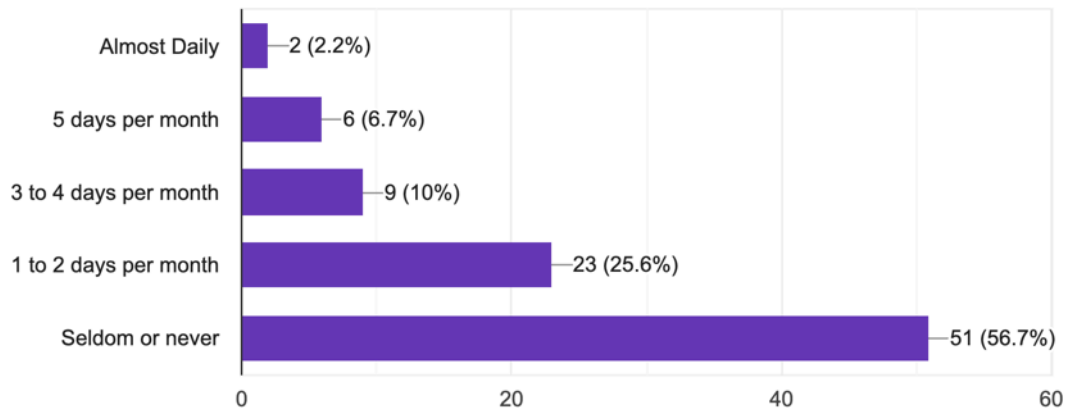


Figure 24: Bar graph of how often the participants use the internet to learn about the High North

How often do you use these sources of information to learn about the High North? (Newspapers)

91 responses

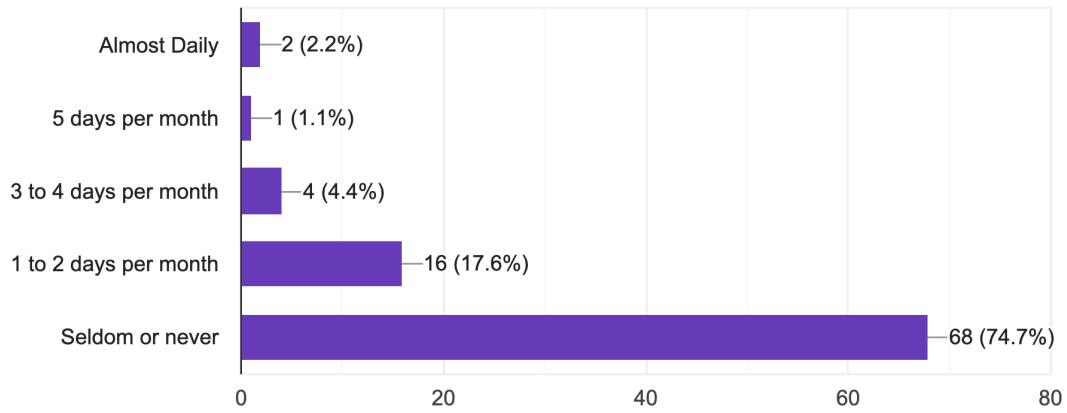


Figure 25: Bar graph of how often the participants use newspapers to learn about the High North

How often do you use these sources of information to learn about the High North? (Books / Magazines)

91 responses

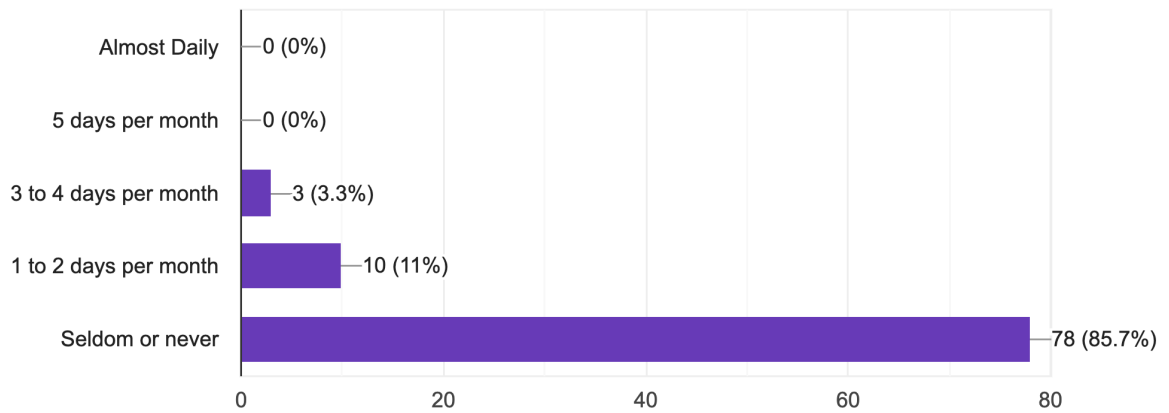


Figure 26: Bar graph of how often the participants use books and magazines to learn about the High North

How often do you use these sources of information to learn about the High North? (Radio)

91 responses

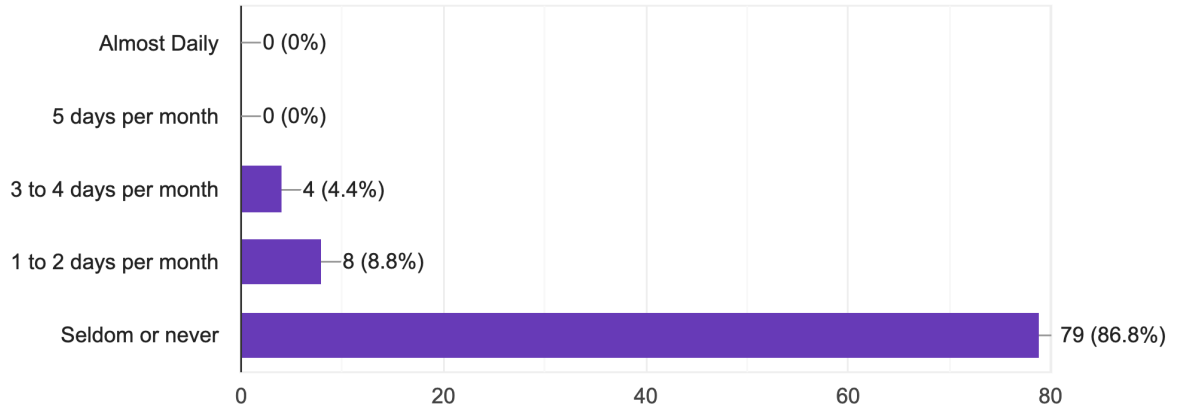


Figure 27: Bar graph of how often the participants use radio to learn about the High North

How often do you use these sources of information to learn about the High North? (TV)

91 responses

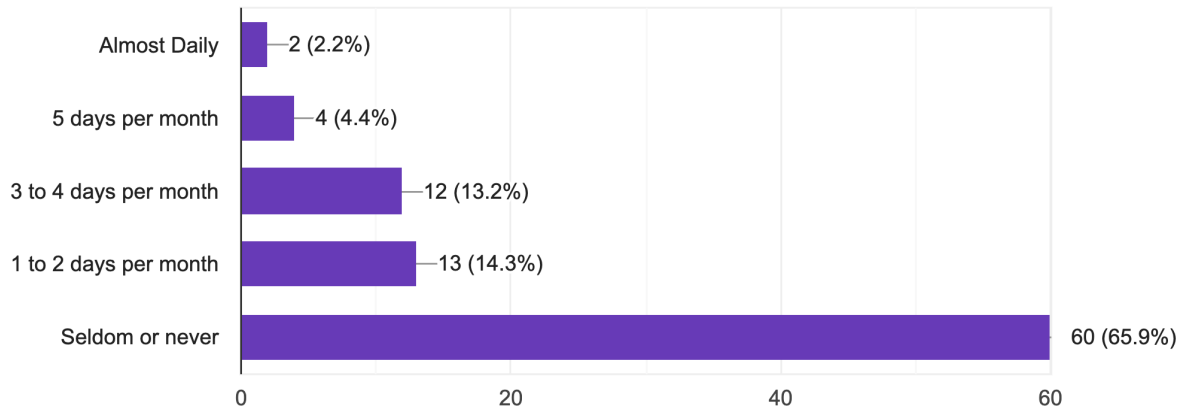


Figure 28: Bar graph of how often the participants use TV to learn about the High North

How often do you use these sources of information to learn about the High North? (Other)

90 responses

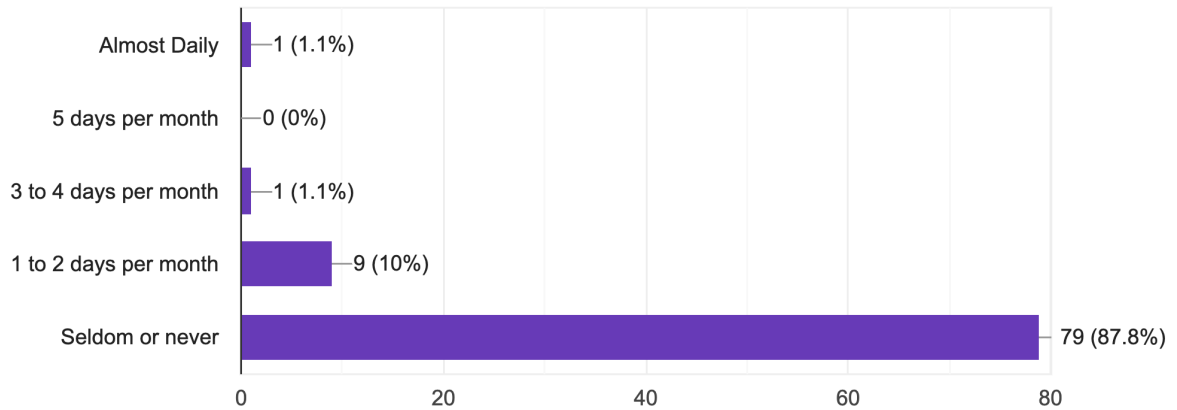


Figure 29: Bar graph of how often the participants use “other” mediums to learn about the High North

4.2.6 Curiosity and interest in the High North

BIN generated an extreme change in interest in the High North and BIN improved curiosity in High North development (low interest initially). Below is how the participants answered on whether the information in the report were surprising, fascinating, and whether the information piqued their curiosity about the High North, and how interested they were in High North issues before and after reading the report and finally how they answered on whether they would like to travel, work or invest in the region before and after reading the report.

How interested are you in High North issues?

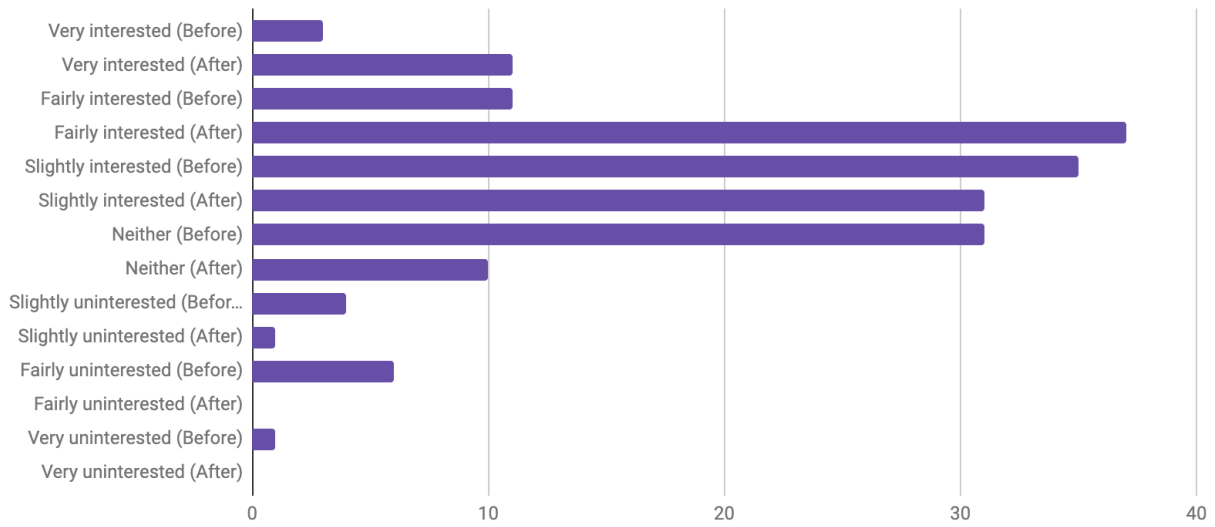


Figure 30: Bar chart of how interested the participants was in High North issues before and after reading BIN

Variable	All participants (Before reading)			All participants (After reading)		
	MEAN	SD	Number	Mean	SD	Number
INTEREST	3,494	1,148	91	2,483	0,892	91

Table 3: Interest in High North issues, before and after reading BIN (All participants). The closer to 1 they answer, the more they agree with the statement. 1 = Very interested, 2 = Fairly interested, 3 = Slightly interested, 4 = Neither, 5 = Slightly uninterested, 6 = Fairly uninterested, 7 = Very uninterested

We can see that the general interest in High North issues have increased among all of the participants.

Different groups compared

Answer	Interest (After reading)		
	Mean	SD	Nr.
Potential-group	2,626	0,85	47
Sceptics-group	2,531	0,82	32
Custom narrative-group	2,5	0,75	4
No change-group	6,642	1,22	8
			91

Table 4: Difference in interest in High North issues (Groups compared) The closer to 1 they answer, the more they agree with the statement. 1 = Very interested, 2 = Fairly interested, 3 = Slightly interested, 4 = Neither, 5 = Slightly uninterested, 6 = Fairly uninterested, 7 = Very uninterested

We can see from the table that the sceptic-group became more interested in High North issues than the ones that see a huge economic potential in the High North. However the difference is quite small, so it is hard to draw any clear meaning from the difference. We can clearly see that the “No change-group” is quite disinterested in High North issues after reading.

“The information was surprising”

91 responses

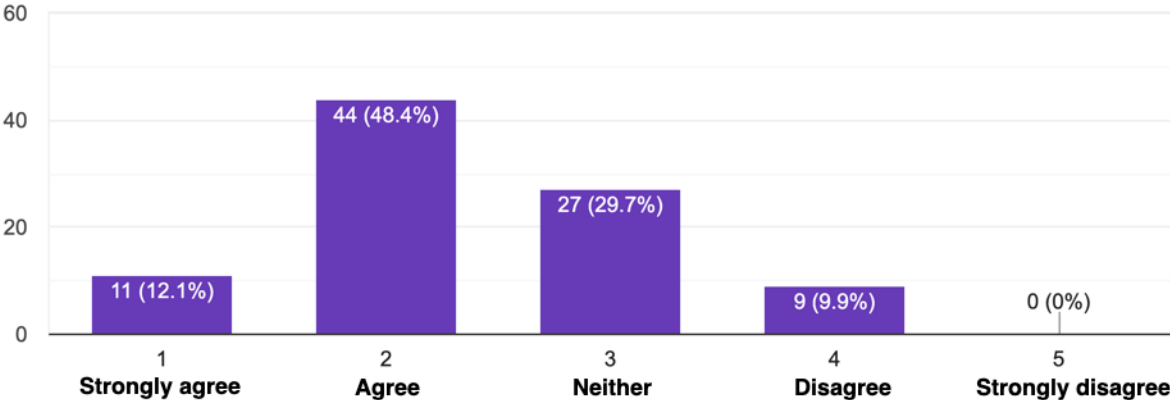


Figure 31: Bar chart of how the participants rated the quality of the information in BIN. (Surprising)

The information in the report is surprising to most of the participants; 60,5% agreed or strongly agreed to the statement «the information was surprising.»

“The information piqued my curiosity about the High North”

91 responses

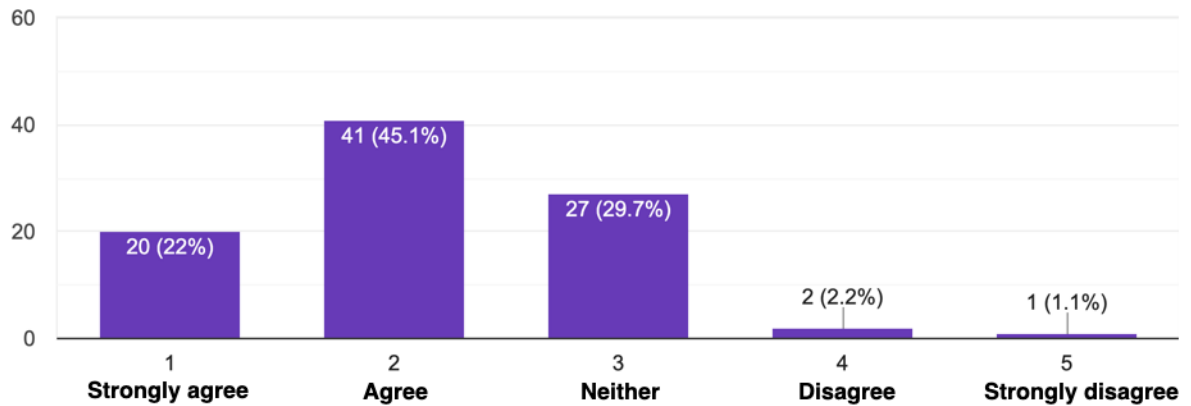


Figure 32: Bar chart of how the participants rated the quality of the information in BIN. (Curiosity)

We can see that the information piqued their curiosity about the High North.

“The information was fascinating”

91 responses

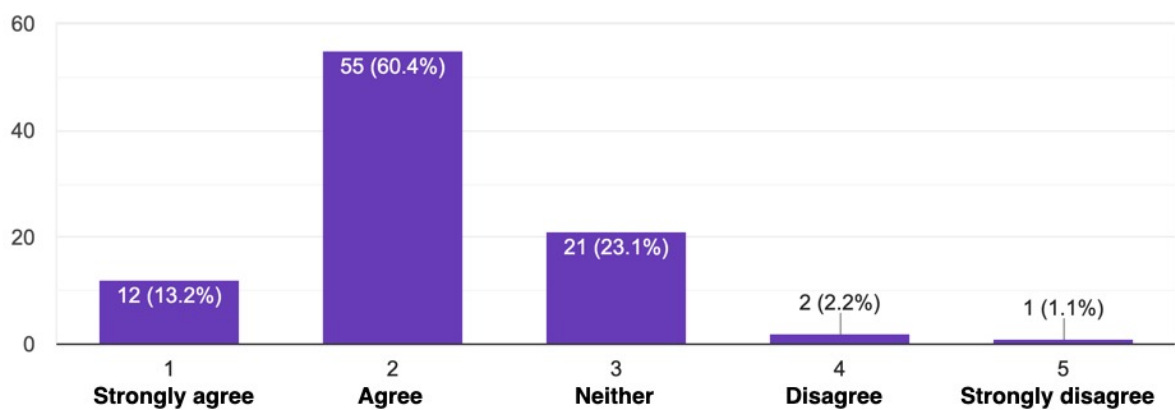


Figure 33: Bar chart of how the participants rated the quality of the information in BIN. (Fascinating)

73,6% agreed or strongly agreed to the statement «the information was fascinating.»

The report greatly increases their interest in High North issues, but this question alone cannot determine their interest and curiosity, how they answered questions regarding travel, work or willingness to invest in the High North is also relevant to determine their actual interest and curiosity. How they answered on their intentions is shown below.

4.2.7 Intentions

The report generally increased their interest in travel, work and investments. A small part become more optimistic about investments and a small part become more scared. The group that became the most optimistic was the Potential-group, and the ones that became less keen to invest is the Sceptics-group.

After reading the report here is how they agreed with the following statements; *“I would like to travel to the High North sometime in the future”*, *“I would like to work in the High North, if a relevant job was available”*, and *“The information in the report made me more open to invest money in companies operating in the High North”*. Below is a summary of the answers.

Willingness to travel, work and invest in the High North before and after reading BIN (All participants)

Here is how the participants answered before and after reading the report how they agreed with the statements above.

	Travel			Work			Invest		
Answer	Mean	SD	Nr.	Mean	SD	Nr.	Mean	SD	Nr.
All participants (Before reading)	2,247	0,940	91	2,924	0,980	91	2,698	0,621	91
All participants (After reading)	2,172	0,951	91	2,666	1,003	91	2,731	0,861	91

Table 5: Differences in intentions regarding interacting with the High North in terms of travel, work and investing (Before and after reading BIN, All participants). The closer to 1 they answer, the more they agree with the statement. 1 = Strongly agree, 2 = Agree, 3 = Neither, 4 = Disagree, 5 = Strongly disagree.

From this table we can see that when looking at all of the participants the report made them a little bit more interested in travelling and seeking work, but a little more sceptical to invest money in the High North.

Different groups compared with each other (After reading)

Here I sort out the different groups, and how willing they were to travel, work and invest, after reading the report.

	Travel			Work			Invest		
Answer	Mean	SD	Nr.	Mean	SD	Nr.	Mean	SD	Nr.
Potential-group	1,91	0,88	47	2,42	1,07	47	2,44	0,68	47
Sceptics-group	2,21	0,75	32	2,90	0,77	32	2,93	0,91	32
Custom narrative-group	2,42	1,21	6	3	1,09	6	3,1	1,47	4
No change-group	3,12	1,24	8	2,87	1,12	8	3,37	0,91	8
			91			91			91

Table 6: Differences between the Potential-group and the Sceptic-group when it comes to interacting with the High North in terms of travel, work and investing. The closer to 1 they answer, the more they agree with the statement. 1 = Strongly agree, 2 = Agree, 3 = Neither, 4 = Disagree, 5 = Strongly disagree.

By looking at how the groups responded to the statements regarding travel, work and investments in the High North, we can see that the potential-group are more positive to engage with the High North than all the other groups, especially when it comes to travel.

(All participants) “I would like to travel to the High North sometime in the future”

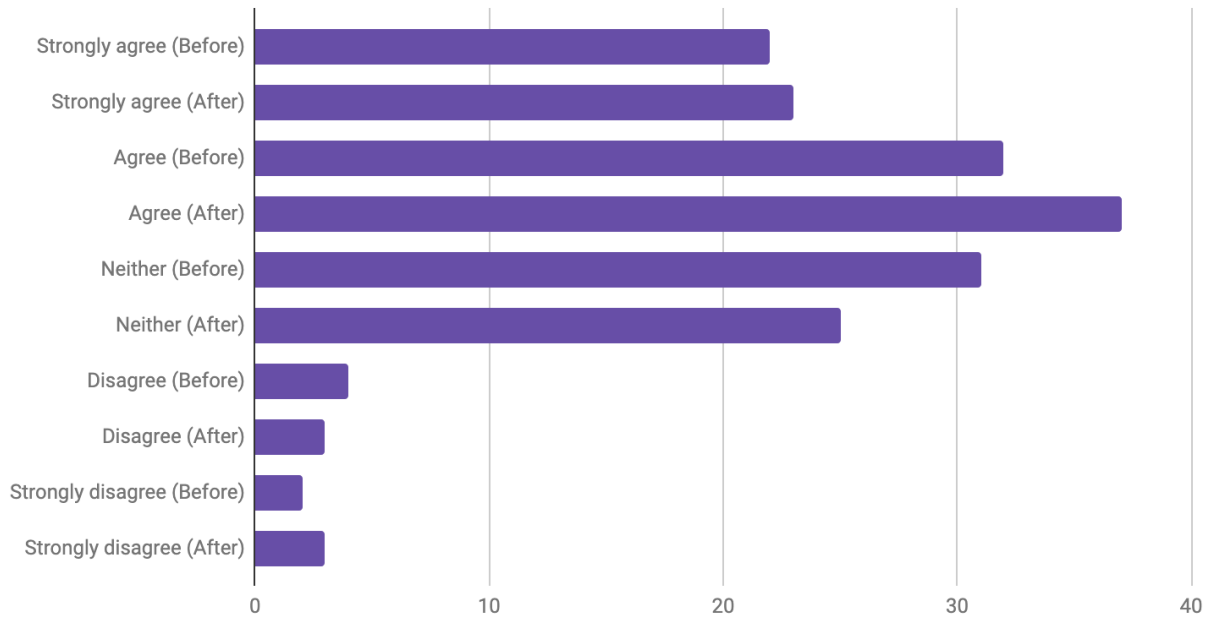


Figure 34: Bar chart of how willing the participants was to travel to the High North sometime in the future before and after reading BIN

Most of the respondents are relatively curious on the region. The report increased their interest in traveling to the High North with 6,6%.

(All participants) “I would like to work in the High North, if a relevant job was available”

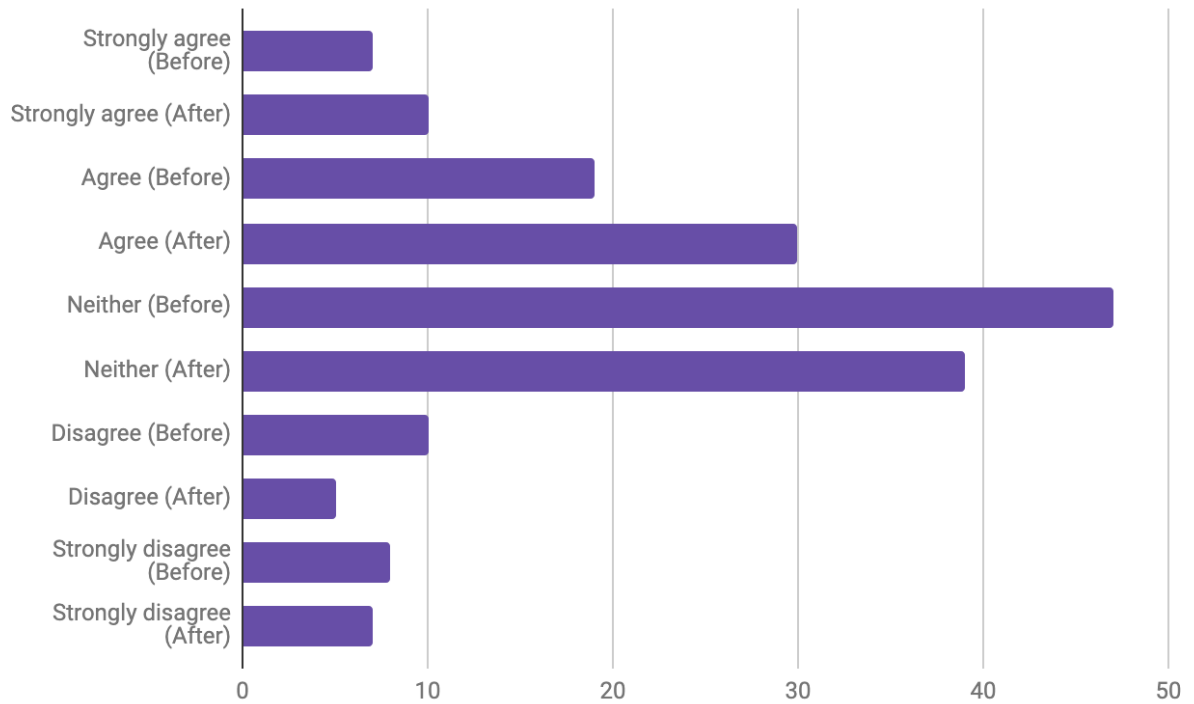


Figure 35: Bar chart of how willing the participants were to seek work in the High North if a relevant job was available before and after reading BIN

The report had only a small effect on their willingness to seek work in the High North.

(All participants) “The High North seems like a good place to invest money” / The information in the report made me more open to invest money in companies operating in the High North”

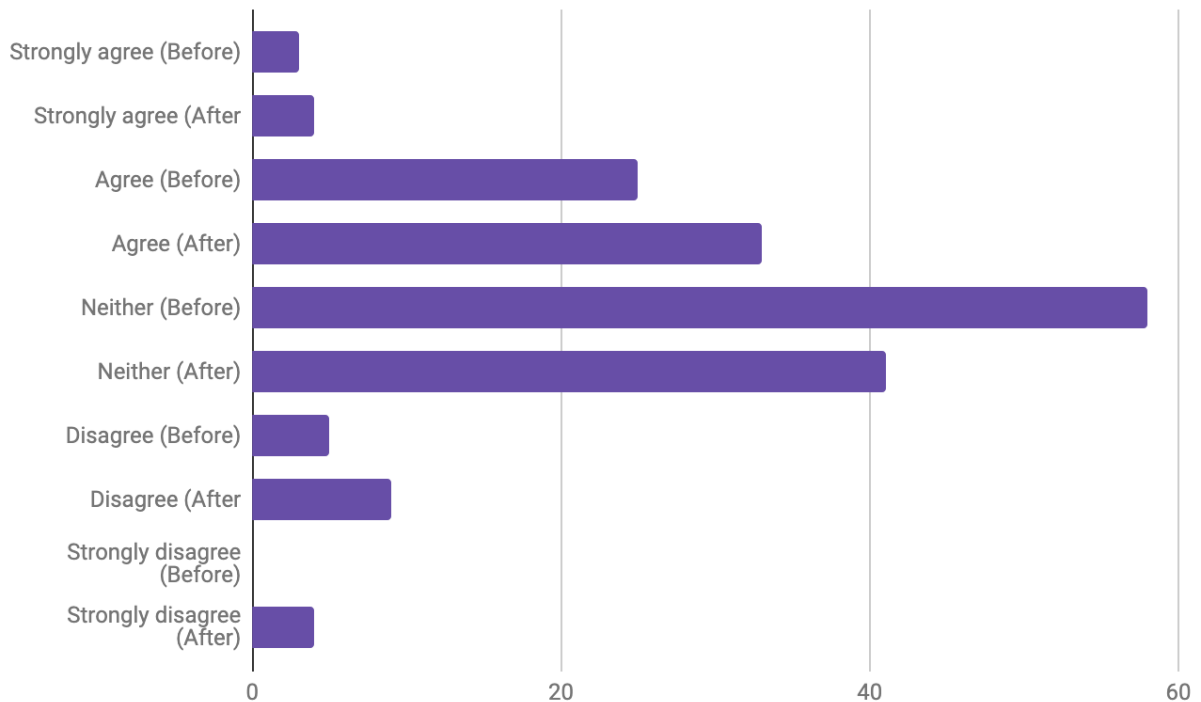


Figure 36: Bar chart of whether the participants think the High North is a good place to invest money before and after reading BIN

Based on the responses to the statements above, the report increased the respondents willingness to invest in some participants, or at least to see the High North as a more attractive place for investments after reading the report; 9,9% increase in people that are positive to investments in the High North. But it also scared some away from investing money as we can see in the increase in people that answered disagree and strongly disagree, that went from 5,5% to 14,3%.

4.2.8 Fact check

To test how well the participants remembered the information in the report a fact check was included in the survey. The information in BIN is easy to remember. The percentage of correct answers from the fact check is in the range of 53 - 80%. That is probably a good result.

Respondents seem to remember correctly.

Of the total wind power produced in the Nordic countries, how much is produced in the BIN-area?

91 responses

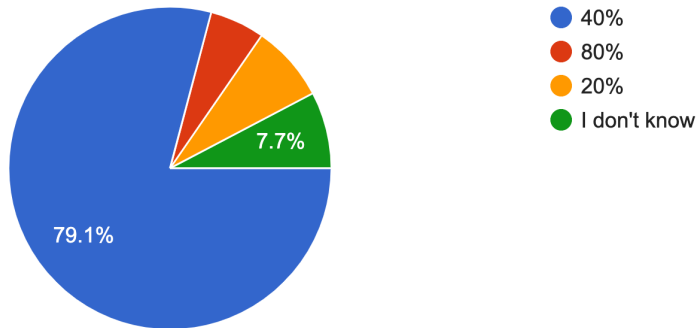


Figure 37: Pie chart of how the participants answered the fact check. (Power production)

Correct answer is 40%. About 80% answered correctly.

The BIN area population growth rate is

91 responses

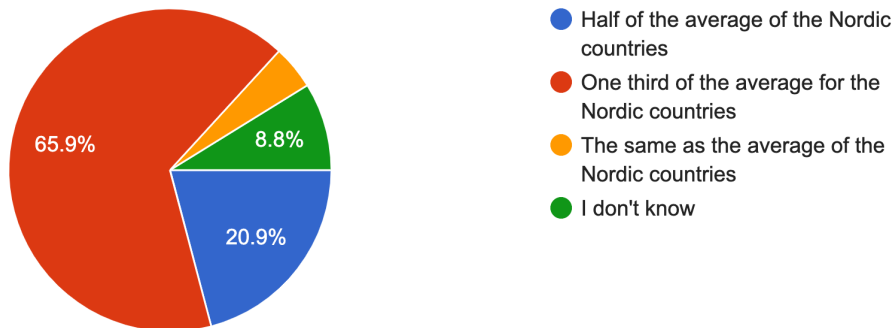


Figure 38: Pie chart of how the participants answered the fact check. (Population growth rate)

Correct answer is one third of the average. About 66% answered correctly.

Which BIN-region had the highest Gross Value Added?

91 responses

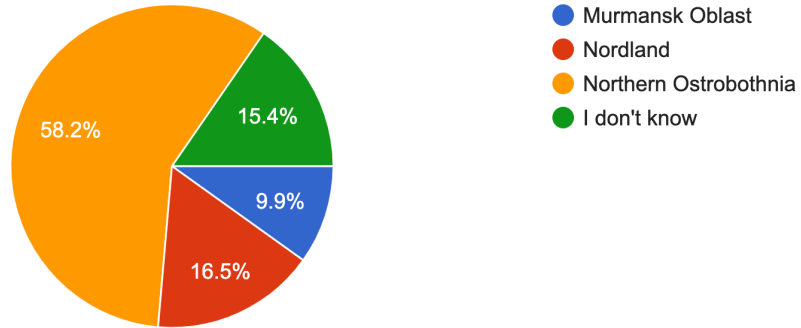


Figure 39: Pie chart of how the participants answered the fact check. (Gross Value Added)

Correct answer is Northern Ostrobothnia. About 58% answered correctly.

Which part of the BIN area had the largest reduction in employment?

91 responses

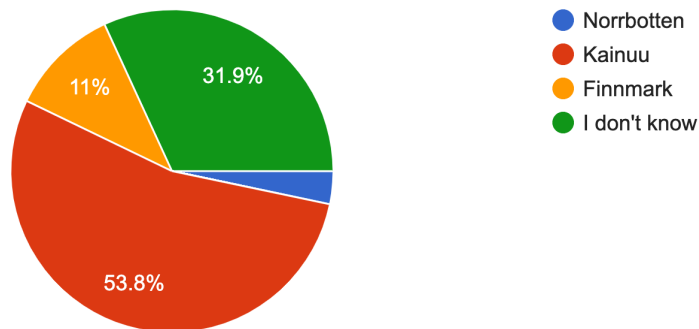


Figure 40: Pie chart of how the participants answered the fact check. (Reduction in employment)

Correct answer is Kainuu. About 53% answered correctly.

How many shipping companies are operating on the Northern Sea Route?

91 responses

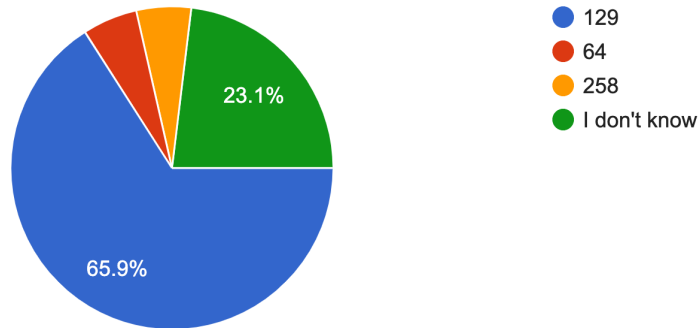


Figure 41: Pie chart of how the participants answered the fact check. (Shipping companies operating the Northern Sea Route)

Correct answer is 129. About 66% answered correctly.

The participants answered mostly right on the fact check, 79,1% answered correct on how much wind power is produced in the BIN-area, which was the fact most got right. 53,8% answered correct on which part of the BIN area had the largest reduction in employment, which is Kainuu, which was the question most got wrong. Based on the fact check we can conclude that the information in the report was in fact quite understandable and that most of the information stuck. What conclusions can be drawn from this will be discussed in chapter 5.

4.2.9 Perceived quality of the information

Below is how the participants rated the quality of the information in the BIN reports. We can see a high perceived quality of the information in BIN. (**High degree of understandability,**

reliability and comparability).

“The information was easy to understand”

91 responses

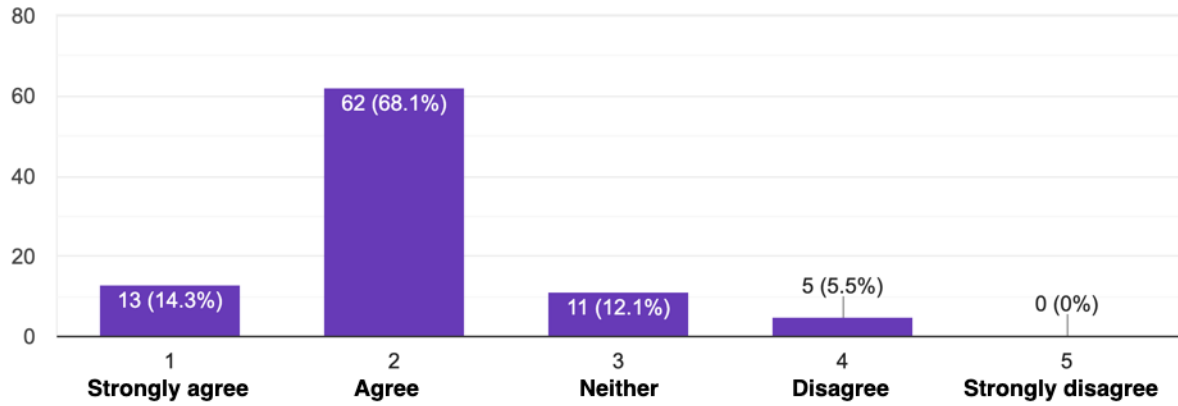


Figure 42: Bar chart of how the participants rated the quality of the information in BIN. (Easy to understand)

“The information seemed objective and true”

91 responses

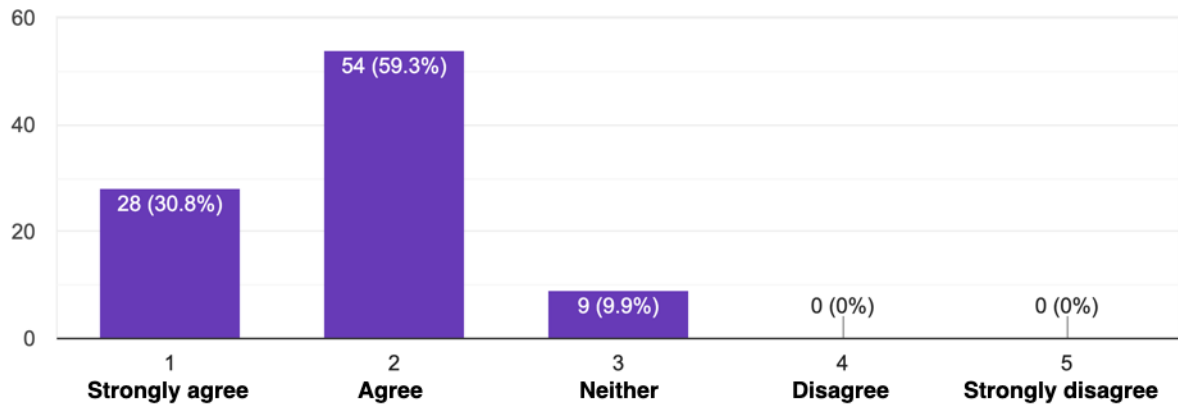


Figure 43: Bar chart of how the participants rated the quality of the information in BIN. (Objective and true)

“The report made comparison between regions in the High North more understandable”

91 responses

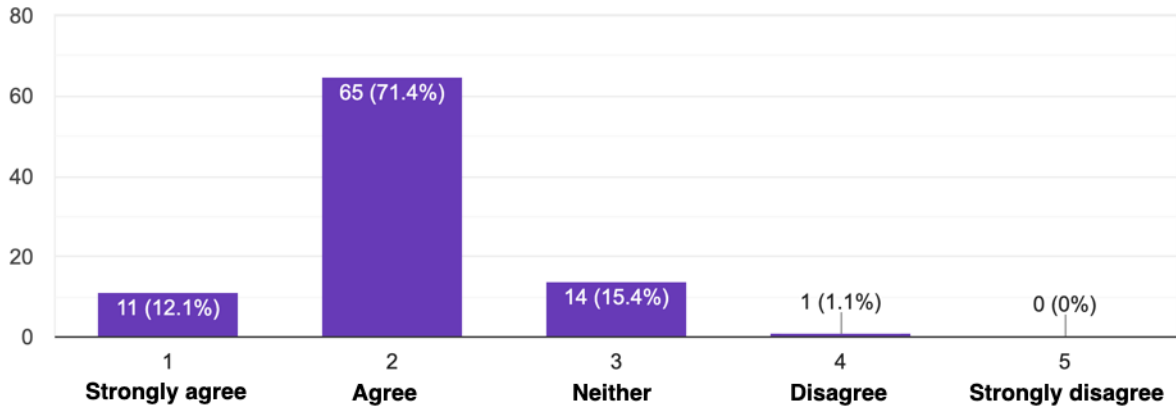


Figure 44: Bar chart of how the participants rated the quality of the information in BIN. (Comparison)

“The report made comparison between regions in the High North more confusing since not all regions of the High North was included”

91 responses

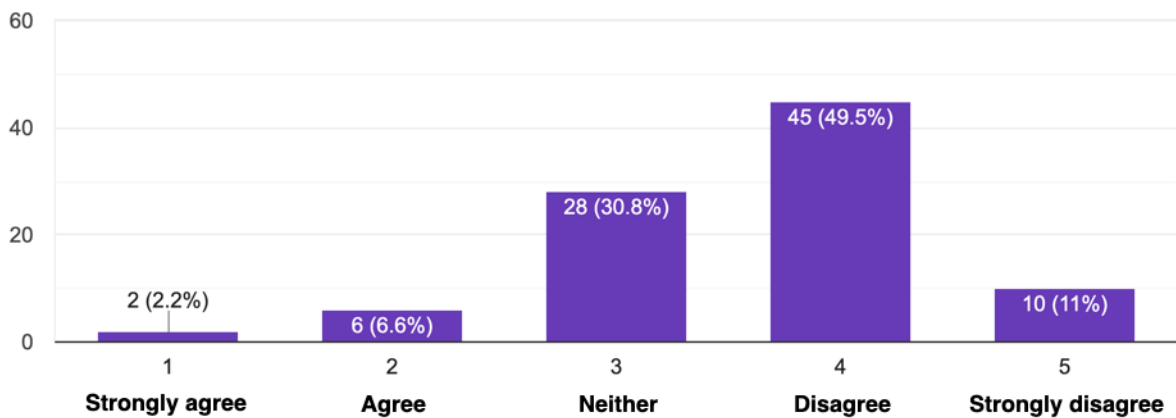


Figure 45: Bar chart of how the participants rated the quality of the information in BIN. (Comparison 2)

“The report contained information that was relevant to my understanding of challenges and opportunities in the High North”

91 responses

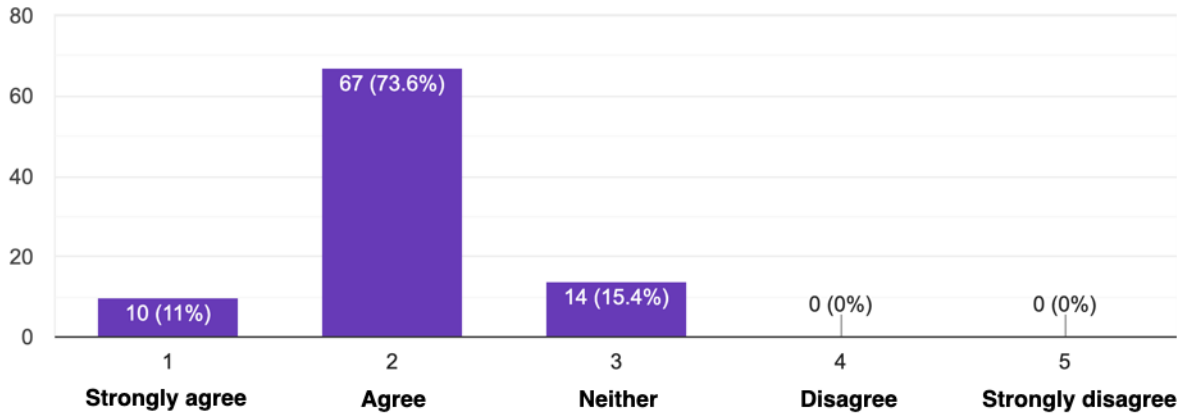


Figure 46: Bar chart of how the participants rated the quality of the information in BIN. (Relevance for understanding)

“The information in the report could be relevant for possible future decisions regarding investments in the High North”

90 responses

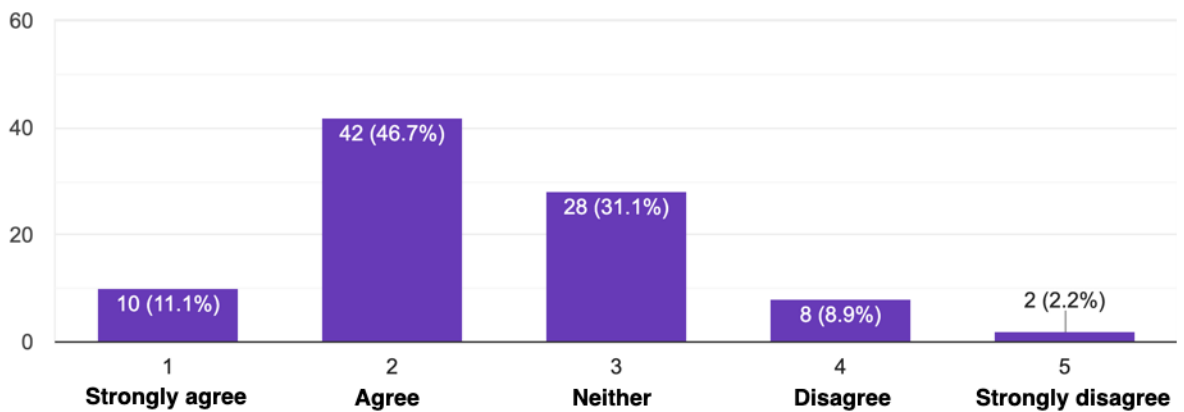


Figure 47: Bar chart of how the participants rated the quality of the information in BIN. (Relevance for investments)

4.3 Written comments left by the participants

In total 31 comments were left by the participants in the surveys. I have sorted them in four after what kind of internal mental representation the BIN report gave the participants. Some of the comments were a bit similar, so I included those that I found most important and relevant. About half of the participants changed their internal representation to viewing the High North as an area with a potential for economic growth. However among some of the participants the report generated more worry for climate change in the High North, and some began to view the High North as a depopulated area where multinationals are leaving almost nothing behind for the natives living there. And a few created their own custom narrative, which mostly were a combination of the High North as a place with economic potential and at the same time a place with pristine nature in danger for climate change. The comments are included in attachment B.

4.4 Summary of findings

- Almost none of the participants had worked, studied or traveled to the High North.
- Most of the participants never receive any information about the High North from any medium. (Internet and TV are the most important sources of information)
- BIN gives extreme change in curiosity of the High North
- BIN has changed internal representations of High North significantly
- The information in BIN is easy to remember. The percentage of correct answers from the fact check is in the range of 53 - 80%. That is probably a good result. Respondents seem to remember correctly.
- High perceived quality of the information in BIN. (High degree of understandability, reliability and comparability), and most of the participants found the information in BIN to be relevant.
- On the group as a whole, BIN made the participants a little bit more interested in travel and seeking work in the High North, however they became a bit more sceptic to making investments.
- BIN divided the participants into two large groups. The first group, the “Potential-group” improved their optimism in the development of the High North. The “Potential-group” became more willing to travel, seek work and invest in the region, than the others. The “Sceptical-group” got more worried in developing the High North, at least in terms of business and economic growth, BIN made them worried about climate change and they did not see the same economic potential in the region as the potential-group.

5 Discussion

In this chapter the findings are discussed. The discussion is structured around these main points:

- Does BIN improve curiosity regarding High North development?
- Does BIN change internal representations of the High North?
- BIN as narrative visualization: from author-driven to reader-driven?

The findings from the three part survey depicted in the research model

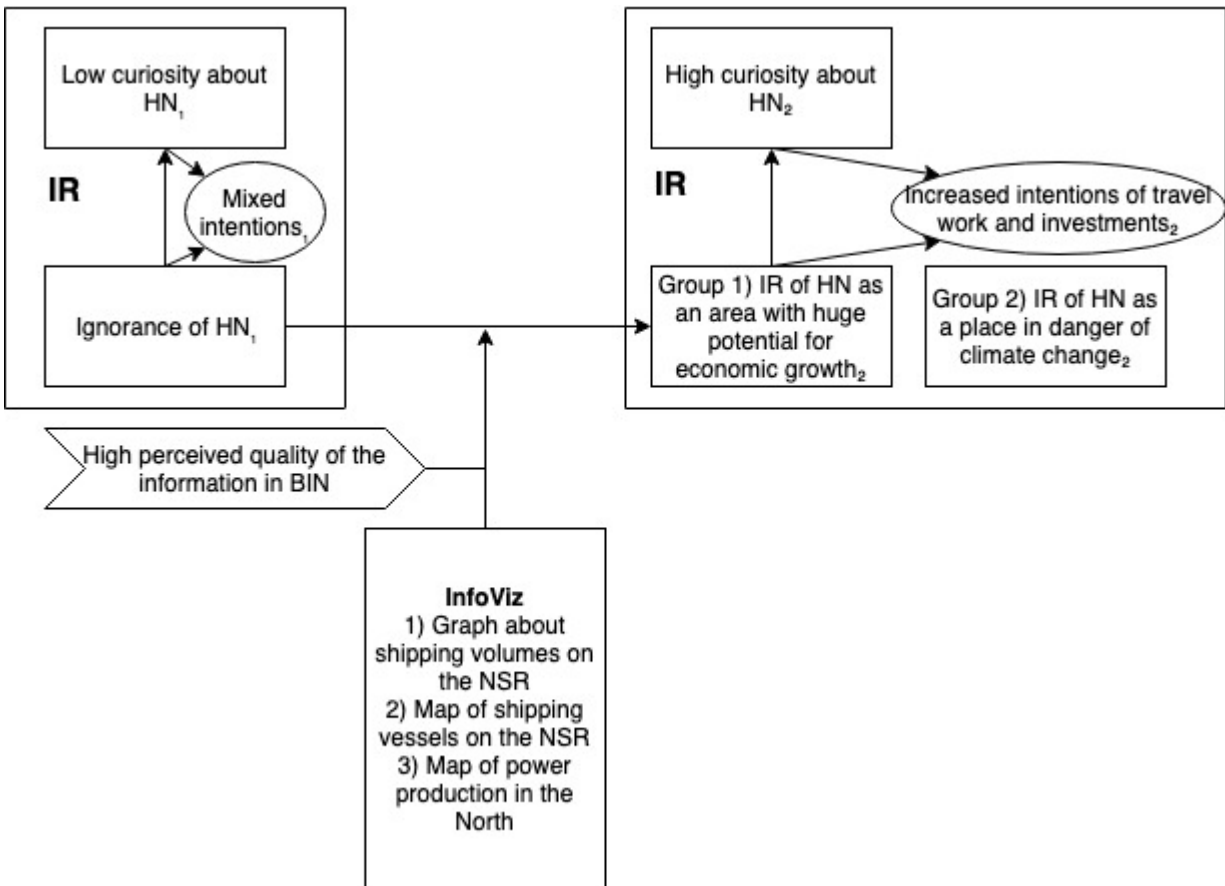


Figure 48: The applied research model with the data from the three part survey

5.1 Does BIN improve curiosity regarding High North development?

BIN dramatically change interest and curiosity in High North issues: from not of interest to high interest. BIN creates mixed intentions regarding travel, work and investments. The “Potential-group” became more interested in travel, work and investments in the High North, than the “Sceptic-group”. BIN fills the information gap and creates “deprivation sensitivity”, which affects the participants' intentions to travel, work and invest. This confirms previous findings that curiosity can be a component to provoke change (Aleksandrov et al. 2018). The findings suggest that some figures in InfoViz can be tailored to create curiosity and can make strong impacts in users.

Information foraging, external anchoring and cognitive offloading

Visualizations can both be used to make it easier to make sense of information, but it can also make information too simple and take away some nuances and reduce the complexity of information. We ended up with two large contrasting groups, the first group became more positive to High North development, and the second group became more negative. They all read the same report so it is interesting why they react different to the same visualizations.

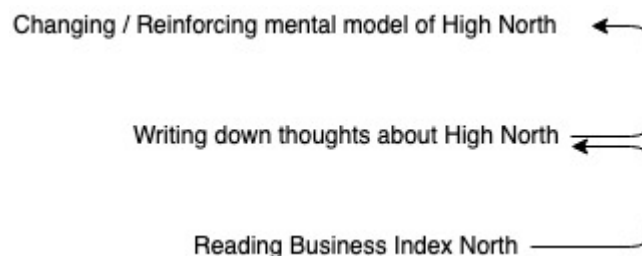


Figure 49: Employing the functions of information foraging, external anchoring and cognitive offloading to the data material from the survey as understood by (Liu & Stasko 2010)

In order to analyze how BIN changed the test-participants internal representations, we look at the data from the survey through the prism of external anchoring, information foraging and cognitive offloading. The test-participants are fed new information and go through information foraging

actions by exploring the BIN report. They restructure their internal representation of the High North by combining what they already know, what they think they know and with the information in the report. Then they go through external anchoring actions by “projecting” and locating. An example of “projection” which is an aspect of external anchoring is that some of the subjects project more information into some of the figures. This mostly happens with the graphs of ship traffic over the NSR; they see that the traffic is increasing, and this makes them more worried about global warming, although there is no information in the report about the state of the natural environment in the High North.

We can see that the process of cognitive offloading is taking place, were the subjects are “changing” their perception of the High North. Before they read the report their “shoebox” of the High North were either quite empty, or they just had a vague idea about what happens there. We can clearly see that they are now throwing more words, images and thoughts into their “High North Shoebox”. We see different kinds of cognitive offloading, most of the test-participants became convinced that the High North is a place with a huge potential for economic growth, they put this “label” on their “High North Shoebox”, while others became more worried for the state of the natural environment in the North, so they put another “label” on their “High North Shoebox”. In cognitive offloading where the users are “creating” new entities and concepts and see new patterns, one could say this is the process of creating a new mental model. The terms “cognitive collage”, “situation model” and “shoebox” are quite similar, either term is applicable to what happens to the test-participants mental model of the High North.

Why some test-participants reinforced their mental model of that the High North is in environmental danger, and why some become convinced that the High North is a place with a huge potential for economic growth can be due to innate disposition and cultural upbringing.

“Each individual's visual thinking ability likely will be the result of mutual influence of innate disposition and cultural upbringing, and may vary in terms of performance depending on the features of visualization and tasks at hand” (Liu & Stasko 2010 p. 8)

Thus depending on variables such as culture, education, political views and so on, the test-participants will react differently to any information they are presented. Even though there is no information regarding the environmental situation in the High North region, some of the test-participants project more information than there actually is into the graphs.

Information, curiosity and mental models

The biggest change BIN made is that they become more interested and concerned with High North issues. Those who have never thought of High North as a business area are beginning to think a little differently. By reading the BIN report they become more interested in High North development, but this does not necessarily entail that they will act out decisions based on the information. They became a little more willing travel, invest or work in the region. The “Potential-group” became most interested in engaging with the High North in terms of travel, work and investments, compared to the “Sceptics-group”. The biggest change in intention came from the potential-group regarding their interest in travelling to the region. This happened because the Information (BIN) and its visualizations were able to change the internal representations of the participants and how they think about the region. Before reading the report only 12% thought of the region as an area with a huge economic potential, and after reading the report over 51% held this view. 33% of the participants became to view the High North as either in danger of climate change, or as a depopulated place, the sceptics became more worried. This is illustrated through comments left by some participants:

“All the marine traffic in the High North makes me worried for global warming”

And

“After reading the report, I was worried that the environment in the High North is not taken into account, too much attention is paid to business”

BIN creates images of the High North, but those images can go both ways; both an area with a huge potential for economic growth, and also area threatened by climate change, so BIN had the intended effect; to create positive attention to High North development and attract business, but also a not intended effect; make people worried about climate change. BIN can change internal mental representations and increase curiosity about the High North, but how the participants interpreted the information cannot be controlled.

It is clear from the survey that the participants became more interested and curious about the High North. Is curiosity the effect, or is curiosity the cause of change in their internal representations. Is curiosity the end result, or is it really the visualizations that promotes curiosity, and when they get more curious it is this that creates a change in their mental understanding of BIN? In (Aleksandrov et al. 2018), where the authors look at institutional work, they focus on how people change institutions through everyday work, which means that people are getting institutionalized through rules, producers, culture and so on. This change is called “reflexivity schemes” in institutional theory. The authors looked at how participatory budgeting was implemented in an organization in a time period of four years. The first ones that started working with participatory budgeting was from employees that got a rash of curiosity. Curiosity is a trait in all humans, which is latent, and is activated when something new and different is presented or introduced, this leads to something happening psychologically that can change people's mental models and internal representations. To explain what happened with the participants I look at the findings in the light of «Joyous Exploration» and «Deprivation Sensitivity» (Kashdan et al. 2018). The picture BIN paints of the High North is different from what the participants believed before they read the report, this created a feeling of «deprivation sensitivity» (information gap) and this creates curiosity. Curiosity occurs when someone receives new information and see things differently. For those that already new about the High North, BIN does not surprise them with anything new, then curiosity does not happen, since they did not learn anything new or surprising.

The KPIs in BIN created deprivation sensitivity and this deprivation sensitivity makes them crave for more knowledge and they want to fill their information-gap, they become curious, they start to think a little differently (change in internal representation), and then one way to fill this gap is to interact with the High North in some way, making them change intentions.

This confirms previous findings that curiosity can be a component to provoke change (Aleksandrov et al. 2018). Thus we see the pattern: KPI > promotes curiosity > change in internal representation > change in intention

Institutionalized views are what people take as a given, things that are not questioned.

Deinstitutionalization means that people get rid of their earlier held views, procedures and their previous way of doing things. They get more critical, and more curious about new things.

Curiosity is an interesting concept for developing new things, and developing businesses and organizations in a new direction, and for regional development in the High North.

The information in BIN created an information-gap in most of the participants. The participants become more curious on High North issues because BIN was able to promote socio-economic information in such a way that is was interesting and relevant. Some figures can be tailored to create curiosity, and make an intended impact. Not all the figures were equally interesting to the participants. The figures showing that there are lots of renewable energy being produced in the Arctic was very interesting to many, and the figures showing that there is a lot of freight being moved in the Northern Sea Route was one of the highest ranked figures.

In cognitive fit theory it is assumed that the actors are rational and know what they want, and what decisions they are supposed to make. Cognitive fit theory seems impossible, people don't necessarily know what kind of information they need. When you present surprising information, only then do they realize that this information could be valuable. Curiosity occur when the information and the mental model does not fit. We get a new mental model which contradict earlier held beliefs.

5.2 Does BIN change internal representations of the High North?

Yes, but not uniformly. BIN created different groups with different reactions to the information in the report. Pro economic development (Potential-group) vs. Worry for climate change and depopulation (Sceptics-group). 51,6% of the participants are in the potential-group, and 33% are in the sceptics-group. the last 15,4% did not change their narrative, or they wrote custom narratives. How and why did some become easily convinced that the High North is an area with huge economic potential, and why did some go into their trenches and argue that the High North is in environmental danger? This could have happened because they had different reactions to information foraging, cognitive offloading and external anchoring, and because they have different user characteristics.

On an overall level, InfoViz may not be so easy to use to change mental models or internal representations, because worry about global warming is latent in some people, and BIN had no chance of convincing these people, because they were probably already worried about global warming and climate change on the planet as a whole. Identity beliefs and cultural values are the hardest ideas to change in people (Chong & Druckman 2007).

Those that are already view the High North as a place filled with pristine nature and see the visualizations in BIN, it enhances their already held image, this could be due to cognitive bias: the information in the report just confirms previously held beliefs. From the data material it is clear that the “Potential-group” was quite more positive to engaging with the High North in terms of travel, work and investments, compared with the “Sceptics-group”.

From the demographics of the two groups it is hard to draw any clear conclusions, a majority of both groups is Italians between 18 to 24 years old. However, of the 32 people that the Sceptics group consists of 24 are female and 8 are male, but since the group is so small, it is hard to make any clear conclusions from that.

The data from the three part survey revealed that the internet and TV were the most important sources of information about the High North. This finding should be used by the BIN-project; if the project wants the information in the reports to reach more people they should create a

dynamic website with visualizations from the reports which can be disseminated more effectively than the reports in their current form. It could be fruitful for the project to change from an author-driven approach to an reader-driven approach.

5.3 BIN as narrative visualization: from author-driven to reader-driven?

It could be that in order for BIN to make an even stronger impact on its users, it must change into a more reader-driven medium. BIN in its current author-driven form have trouble convincing the sceptic-group, they are already instilled in the view that the planet is facing environmental trouble, and BIN reinforced their worry about climate change.

A problem with author-driven narratives is that it gives less opportunity to explore the narrative that fits their internal representation, this could hinder some to change their minds.

It could that a reader-driven approach could help convert the sceptics into pro High North development. An author-driven approach is in danger of enhancing the earlier held beliefs that the participants had, such an approach is fixed, it is inflexible, thus it can be harder to convince people that already have a strong opinion of something. When the figures in the report are static, and it is not possible to explore the figure in any more detail, for example comparing information in some figure with some other data. Exploring information by allowing customization could be more effective when it comes to changing internal representations in some people.

By allowing customization and comparisons the readers could move through the actions of external anchoring, information foraging and cognitive offloading in a different way. A reader-driven approach gives the users an opportunity to explore the data material themselves and it gives the users an opportunity to challenge their own beliefs and their internal representations, this is probably more difficult to do in an author-driven approach.

For example, if it was possible to view all the omissions that the sea-traffic on the Northern Sea Route create, and compare it with other ways of transportation, like heavy transport with trailers, it could be that this would make the Sceptic's more positive to sea-traffic on the NSR. Thus it could be that a reader-driven approach to communicating the information in BIN would be more effective in convincing the Sceptics. One possible conclusion is that a reader-driven approach can reduce cognitive bias in users.

6 Conclusion

The purpose of this study is to better understand the relationship between information, visualizations, curiosity and internal (mental) representations. The context is the High North and the Business Index North reports about socio-economic development in the region. This is done by answering the problem statement: *«How does Business Index North, as an Information visualization tool, interact with users mental models in terms of changing internal representations, promoting curiosity and intentions towards High North development»*.

In this thesis a qualitative exploratory research method was applied and most of the data was gathered by distributing a three-part survey among Italian students at the University of Siena in Italy. It would be hard or impossible to do conventional experiments with a control group, since the independent variable is the Business Index North reports. It would give no meaning to compare one group, which read the report, with another group that did not read the report. In Part One, they answered questions regarding their held beliefs and impressions of the High North, and their interest in travel, work and investments in the region, then in Part Two, they read BIN, and then finally in Part Three they were asked the same questions again, to see how the report influenced their thinking and their internal representation of the region. Our analytical approach builds upon cognitive fit theory, studies on mental models, research on curiosity and accounting theory. By employing all the theoretical concepts into a research model I was able to get a meaningful overview of the findings.

The three part survey revealed that the BIN reports are able to generate a lot of curiosity and a quite strong interest in High North issues in users that had a modest initial interest in the topic. The KPIs in BIN created deprivation sensitivity (information-gap) in the participants, this makes them crave for more knowledge, they want to fill their information gap, this makes them curious, this makes them start to think a little differently and this makes them change intentions. Thus we see the pattern: KPI > promotes curiosity > change in internal representation > change in intention.

The findings show that the BIN reports as an external representation of the High North are able to alter internal mental representations in users to a strong degree, however not uniformly: The BIN reports promote contrasting narratives of the High North in different users.

Most of the participants changed their internal representation of the High North into thinking about the High North as the following narratives: «*The High North is an area with a huge potential for economic growth*», «*The High North is a place with pristine untouched nature and is threatened by climate change*», «*The High North is a depopulated area where multinational companies are extracting natural resources, leaving almost nothing for the indigenous people living there*». Some wrote custom narratives, and among a very few the report did not influence their thinking at all. I named and grouped those that answered the “pristine nature in danger of climate change” narrative and the “depopulated” narrative together into the «Sceptic-group», and I named those that answered the “economic potential” narrative, the «Potential-group». 51,6% of the participants are in the potential-group, and 33% are in the sceptics-group. the last 15,4% did not change their narrative, or they wrote custom narratives.

The report is relevant to the users, however relevant in different ways for the different groups. We can see that the Potential-group are more eager to interact with the High North in terms of travel, work and investments, than the Sceptic-group. Overall BIN made most of the participants more interested and curious about High North issues. However overall the report created mixed intentions regarding travel, work and investments.

To answer why some became easily convinced that the High North is an area with huge economic potential, and why some went into their trenches and argued that the High North is in environmental danger, I looked at the data material through the prism of external anchoring, information foraging and cognitive offloading. The two groups reacted differently to the same figures, and they “projected” more information into the figures themselves. The sceptics-group saw that the increasing traffic in the Northern Sea Route was a sign of global warming, and the potential group saw this as a sign that the region was thriving. These different reactions to the same information could be due to different reactions to information foraging, cognitive offloading and external anchoring, different user characteristics and cognitive bias.

It is clear that BIN has an appeal to unsophisticated readers, and it is clear that some figures are more relevant than others. We can see that the information and visualizations in BIN are easy to understand, the fact check confirmed that the participants answered mostly correct. The participants rated the understandability, comparability and reliability as high. They also rated the information as relevant.

Finally, our findings suggest that the BIN project should change from an author-driven approach and adopt a more reader-driven approach to presenting the information if they want to convince more people of the economic potential in the region. In a reader-driven approach the users can play and customize themselves how they view and what they compare the data with, and this makes it easier for the user to challenge his or her convictions. Thus one possible conclusion is that a reader-driven approach can reduce cognitive bias in users, although more research is needed.

6.1 Suggestions for further research

How economic information is visualized is a subject that probably does not get enough attention in management control research. How to make sense of economic information is of great importance, especially today when the world is becoming more and more complex, more and more variables are being reported. How can big data be shrank and visualized so that it is easier for humans to understand it? KPIs is also becoming harder to make sense of, since KPIs only tell parts of a whole truth, how to balance and put together all this information? More research on other socio-economic reports would be of interest, does Konjunkturbarometer for Nord-Norge for example change the internal representations of the High North in a similar way as BIN? More research should be done on how we go from curiosity to making actual decisions. More research on how reader-driven presentations of information can reduce cognitive bias is also needed.

7 Appendix

Attachment A: The survey

A Survey about the High North

Dear participant, the purpose of this study is to investigate how the High North is perceived in non-Arctic states, and to see how the presentation of socio-economic information can influence your understanding of the High North. You do not require any prior knowledge of the High North to participate.

The terms the Arctic and the High North are used interchangeably. The High North / The Arctic are names for the arctic circumpolar area between the North Pole and the Polar Circle, including the Barents region and the Barents sea.

The Arctic Circle passes through: Northern Norway, Northern Sweden, Northern Finland, Northern Russia, Iceland, Denmark (Greenland), USA (Alaska) and Northern Canada.

This survey consists of eleven (11) pages. (double sided print)

The report you are supposed to read consists of fifteen (15) pages. (mostly graphs and pictures)

This survey will take about 30 minutes of your time.

We ask you to answer all the questions honestly, and if you don't know the answer to a question choose the option for «neither» or «I don't know».

This is a double sided print, so please see the first question of the survey on the back of this page.

Sincerely,

Peter Bakkemo Danilov

Part 1

Q1

What is your nationality?

Q2

Where do you currently live?

Q3

What is your age?

- 18 - 24 Years old
- 25 - 34 Years old
- 35 - 49 Years old
- 50+ Years old

Q4

What is your gender? (**Set ring**)

Male / Female

Q5

What do you study or what do you work with?

Q6

Have you ever worked with or studied something related to the High North? (**Set ring**)

Yes / No

Q7

Have you ever visited the High North? (**Set ring**)

Yes / No

Q8

How interested are you in what is happening in the High North?

(Set a cross behind the number)

1)	2)	3)	4)	5)	6)	7)
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Very interested	Fairly interested	Slightly interested	Neither	Slightly uninterested	Fairly uninterested	Very uninterested
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Q9

Please indicate your response to the following statement:

“I would like to travel to the High North sometime in the future”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q10

Please indicate your response to the following statement:

“I would like to work in the High North, if a relevant job was available”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q11

Please indicate your response to the following statement:

“The High North seems like a good place to invest money”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q12

Now you will be presented with different sources of information.

We want to know where you learn and receive information about what is happening in the High North. If you never receive information about the High North, choose the «Seldom or never» option.

How often do you use these sources of information to learn about the High North?

(Set crosses in the boxes. One cross for each source)

Source / Frequency	Almost Daily	5 days per month	3 to 4 days per month	1 to 2 days per month	Seldom or never
Internet					
Newspapers					
Books / Magazines					
Radio					
TV					
Other					

Q13

Now you will be presented with three perceptions/narratives of the High North.

If you don't have a perception of the High North choose option D.

If none of the narratives fits your perceived image of the High North, you can write your own in option E.

Of the following narratives, which most resembles your perceived image of the High North?

(Choose only one narrative.)

- A. The High North is a depopulated area where multinational companies are extracting natural resources, leaving almost nothing for the indigenous people living there.
- B. The High North is a place with pristine untouched nature and is threatened by climate change
- C. The High North is an area with a huge potential for economic growth
- D. I don't have a perceived image of what is happening in the High North
- E. If none of the above, write own narrative (few sentences):

(Please check that you answered all of the questions in part 1)

Part 2

Please read the Business Index North report before answering the next part of this survey.

Part 3

Part 3.1

Here are five factual questions from the report. We ask you kindly to answer as good as you remember.

Q1

Of the total wind power produced in the Nordic countries, how much is produced in the BIN-area?

- 1) 40%
- 2) 80%
- 3) 20%
- 4) I don't know

Q2

The BIN area population growth rate is

- 1) Half of the average of the Nordic countries
- 2) One third of the average for the Nordic countries
- 3) The same as the average of the Nordic countries
- 4) I don't know

Q3

Which BIN-region had the highest Gross Value Added?

- 1) Murmansk Oblast
- 2) Nordland
- 3) Northern Ostrobothnia
- 4) I don't know

Q4

Which part of the BIN area had the largest reduction in employment?

- 1) Norrbotten
- 2) Kainuu
- 3) Finnmark
- 4) I don't know

Q5

How many shipping companies are operating on the Northern Sea Route?

- 1) 129
- 2) 64
- 3) 258
- 4) I don't know

Part 3.2

Now you will be presented with the same narratives as in the first part of this survey.

Have you changed your understanding of the High North after reading the report?

(You can choose the same narrative if you have not changed your mind)

Q1

After reading the report, which narrative do you think is the most correct? (**Choose only one narrative.**)

- A. The High North is a depopulated area where multinational companies are extracting natural resources, leaving almost nothing for the indigenous people living there.
- B. The High North is a place with pristine untouched nature and is threatened by climate change
- C. The High North is an area with a huge potential for economic growth
- D. The report did not influence my perceived image of the High North
- E. If none of the above, write own narrative (few sentences):

Q2

Now you will be presented with some questions regarding the quality of the information in the report.

Q2.1

Please indicate your response to the following statement:

“The information was easy to understand”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q2.2

Please indicate your response to the following statement:

“The information was fascinating”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q2.3

Please indicate your response to the following statement:

“The information seemed objective and true”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q2.4

Please indicate your response to the following statement:

“The information was surprising”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q2.5

Please indicate your response to the following statement:

“The information piqued my curiosity about the High North”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q2.6

Please indicate your response to the following statement:

“The report made comparison between regions in the High North more understandable”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q2.7

Please indicate your response to the following statement:

“The report made comparison between regions in the High North more confusing since not all regions of the High North was included”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q2.8

Please indicate your response to the following statement:

“The report contained information that was relevant to my understanding of challenges and opportunities in the High North”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q2.9

Please indicate your response to the following statement:

“The information in the report could be relevant for possible future decisions regarding investments in the High North”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q3

If you changed your perception/narrative of the High North. What was the most important figure(s) that made you change your mind? (You can choose more than one.) Answer option I if you did not change your perception.

- A. The map of the BIN-area
- B. Graphs related to Gross Value Creation
- C. Figures related to job creation/losses and employment
- D. Graphs related to population in the north
- E. The map of power production in the north
- F. Graphs related to power production and consumption
- G. The map of the shipping lanes of vessels on the Northern Sea Route
- H. Graph about shipping volumes on the NSR
- I. The map showing international subsea fibre initiatives in the Arctic
- J. The report did not change my mind

Q4

If you **changed** your narrative/perception of the High North, do you have an extra comment to why?

Q5

If you **did not** change your narrative/perception of the High North, do you have an extra comment to why?

Q6

How interested are you in High North issues after reading the report?

(Set a cross behind the number)

1)	2)	3)	4)	5)	6)	7)
Very interested	Fairly interested	Slightly interested	Neither	Slightly uninterested	Fairly uninterested	Very uninterested

Q7

Please indicate your response to the following statement:

“I would like to travel to the High North sometime in the future”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q8

Please indicate your response to the following statement:

“I would like to work in the High North, if a relevant job was available”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q9

Please indicate your response to the following statement:

“The information in the report made me more open to invest money in companies operating in the High North”

(Set a cross behind the number)

1)	2)	3)	4)	5)
Strongly agree	Agree	Neither	Disagree	Strongly disagree

Q10

After reading the report, do you have any remarks? (Few sentences)

Please check all the pages to make sure you have answered all the questions!

Thank you for your participation!

Attachment B: Written comments left by the participants

<p>The High North is an area with a huge potential of economic growth</p>	<p>The Arctic is a place with pristine untouched nature and is threatened by climate change</p>	<p>The Arctic is a depopulated area where multinational companies are extracting natural resources, leaving almost nothing for the indigenous people living there.</p>	<p>Custom narrative</p>
<p><i>“had no idea that so much renewable energy was generated so far north I think it will be an important region for power production.”</i></p>	<p><i>“After studying the info, I was worried that the environment in the High North is not taken into account, too much attention is paid to business”</i></p>	<p><i>“It seems that money is being made in the region, but, as I understand the report, people are leaving and large companies make profit leaving little behind”</i></p>	<p><i>“The increase in traffic on the North Sea Route made me think about two things: ice melting and increasing economic growth in the region”</i></p>
<p><i>“Before reading the report I thought of the High North as a cold desolate place where nothing happened after reading the report, the power map and the map of all ships traveling along the northern route made me think — this is an area of economic growth where there is a danger of climate change and a huge potential for creating renewable energy”</i></p>	<p><i>“All the marine traffic in the High North makes me worried for global warming”</i></p>	<p><i>“Media portrays that High North is a wealthy union and their standards of living is way better than any other countries in Europe. Didn’t come across that employment reduction and decreasing population would affect this. I thought the region was a place with a huge potential for economic growth, but the report revealed that the High North is really struggling”</i></p>	<p><i>“That graph with the big ship, I think all the ships going over the arctic sea is a sign that the ice is going away, but also a sign that a lot of things are happening up there”</i></p>
<p><i>“Definitively the map of the power production, the age of oil is ending, but it seems there is many possibilities for environmental friendly energy production in the North”</i></p>	<p><i>“want to learn more about the region”</i></p>		<p><i>“People are moving away from the region, I don't think this is a place where economic growth will happen very soon”</i></p>
<p><i>“More information, previous opinion based on stereotypes”</i></p>			<p><i>“my impression that the High North is a combination of the narratives presented, an area with potential for economic growth and an area threatened by global warming”</i></p>

<i>“I study innovations, and I want to start my own business, This information could be applicable for me sometime”</i>			
<i>“found the magazine interesting, this report, because my knowledge of the High North were low, and now I am aware of the problems and the potential in the High North”</i>			
<i>“made me curious and willing to go there, or even work”</i>			
<i>“this is an area with great unrealized potentiality, especially regarding power production and shipping”</i>			
<i>“the rapport made me aware that many things are happening in the north”</i>			
<i>“It was interesting, now I know more about Arctic issues, especially from an economic point of view”</i>			
<i>“This information is useful to learn something about a part of the planet that I didn’t know anything about.”</i>			
<i>“I did not expect such potential”</i>			

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