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Sports Facility Statistics

Overview of built sports facilities and analysis of sports hall costs in Norway

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Abstract

Sports facility statistics: Overview of built sport facilities and analysis of sports hall costs in Norway

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The current statistics on sports facilities suggests that 4 billion NOK (divided on 700 facilities) are planned to be used annually for new sports facility projects and renovation projects of old sports facilities. These statistics are based on planned projects and not on realized projects. In addition, it is not distinguished between new facility projects and facility renovation projects. The current statistics is based on applications for so-called gaming funds, which are all registered in a sports facilities information system. The information system is complicated to use, and the data in the register is not perfect: it is inconsistent and sometimes incorrect or incomplete. This thesis provides an overview of the number of built sports facilities in Norway between 1996 and 2016. Further, it provides cost statistics for sports halls, based on extracted data from the information system, which was preprocessed and then analyzed using regression models and ANOVA. This work shows that, in average, 560 sports facilities have been built each year between 1996 and 2015 (1 000 facilities if one includes so-called local activity facilities). In average 24 sports halls have been built each year, with an average cost of 36 million NOK. Sports halls built in Oslo have in average costed 14 to 23 million NOK more to build than sports halls in the rest of Norway.

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Populärvetenskaplig sammanfattning

Hur många nya idrottsanläggningar byggs det egentligen i Norge, och har det kostat lika mycket att bygga en idrottshall i en stor kommun som i en liten? I Norge finns det en bidragsordning där de som bygger idrottsanläggningar kan ansöka om att få pengar. Dessa pengar kallas *spillemidler* och kommer från överskottet från Norsk Tipping. Ansökningarna om spillemidler finns samlade i ett IT-system, sorterade under idrottsanläggningen det ansökts om pengar till. De allra flesta idrottsanläggningarna som finns i Norge är registrerade i det här IT-systemet. En stor del av den information som finns i IT-systemet om de olika idrottsanläggningarna återges i *Idrettsanleggsregisteret*, som är offentligt och nedladdningsbart från det norska kultur-departementets hemsidor.

Utöver rena idrottsanläggningar finns det också olika typer av närmiljöanläggningar, friluftslivsanläggningar och kulturbyggnader registrerade i Idrettsanleggsregisteret. Det är framförallt små närmiljöanläggningar som har byggts i Norge de senaste 20 åren, som till exempel aktivitetsområden vid skolor och bostadsområden, och näridrottsplatser där man kan spontanidrotta. Av de idrottsanläggningarna som används för organiserad sport är det främst konstgräsfotbollsplaner som har byggts de senaste åren.

I ansökningarna om att få spillemidler anges idrottsanläggningens kostnadsöverslag, och genom att samla ihop dessa uppgifter samt uppgifter om idrottsanläggningen, kommunen och fylket (norskt län), går det att ta fram sambandsmodeller mellan kostnaden och bakomliggande faktorer, för att förklara vad variationerna i kostnader kan bero på. I det här arbetet har det gjorts för en typ av idrottsanläggning, nämligen idrottshallar. Storleken på hallens aktivitetsyta påverkar föga överraskade priset. Resultaten från det här arbetet pekar på att det har varit skillnader i kostnaden för att bygga en idrottshall mellan olika regioner i Norge, och att det har varit dyrast i Oslo. Inom en och samma region verkar det ha varit något dyrare i en större kommun än i en mindre. Det har också generellt i landet varit en kostnadsökning för att bygga idrottshallar under de senaste åren, som har varit betydligt större än inflationen.

Tyvärr är registret till och från bristfälligt uppdaterat, vilket gör att uppgifterna som finns om idrottsanläggningarna måste undersökas för att se om de verkligen stämmer, och ibland saknas uppgifter i registret, som eventuellt har kunnat hittas i bifogade dokument till ansökan. Det är svårt att säga om det förarbete som har lagts ned på att ”tvätta” datauppgifterna i det här arbetet räcker för att man ska kunna lita helt på resultaten.

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1. Introduction

The Centre for Sport Facilities and Technology (SIAT) at the Norwegian University of Science and Technology (NTNU), the Norwegian Ministry of Culture (KUD), and the Norwegian Olympic and Paralympic Committee and Confederation of Sports (NIF) cooperate in the project *godeidrettsanlegg.no* (translated as *good sports facilities*). The purpose of *godeidrettsanlegg.no* is to increase competence in the areas of planning, engineering, building, and operating of sports facilities, and to create a platform for exchange of information and experiences of building and operating sports facilities. One part of the project is to investigate how much the different kinds of sports facilities cost, both to build and to operate. The findings could then be used to create better sports facilities for the future, which are suitable for its sporting purpose, energy effective and worth the building cost.

In Norway, sports facilities are built and renovated for a total sum of more than four billion NOK annually[1]. Seventy percent is covered by the public sector, where the National Lottery of Norway (through KUD) is one of the greatest contributors through the *gaming funds* (Busland & Kristiansen, 2015). Municipalities and others building sports facilities can apply for gaming funds and KUD distributes the gaming funds to the counties, which then distribute the money to the applicants (Det Kongelige Kulturdepartement, 2015).

KUD and NIF provide information about built sports facilities in their annual reports on gaming funds and the sports facility situation (The Norwegian Olympic and Paralympic Committee and Confederation of Sports, 2015). However, there is no overview of costs for different sports facilities in these reports, and the overview of built facilities is based on applications for both new facilities and renovation of old facilities, and hence it does not give an overview of how many *new* sports facilities that in fact *are built*.

Nearly all sports facilities in Norway are registered in the Sports Facility Register, which was established in 1992 to give a regularly updated overview of sports facilities and distributed gaming funds from KUD (Idrettsanleggsregisteret, 2015). In this register, one can for example find *construction year* and *status*, where the status denotes whether the facility exists or for example is planned or closed down. In the applications for gaming funds, one can find *estimated costs* for the building projects, and in combination with the Sports Facility Register, it is possible to create an overview of the estimated costs for the actually built facilities, and to analyze variations in costs based on location, time, and facility properties. Further, it would be interesting to compare the building costs with operational costs, to see if there is a relationship between these two.

1.2 Aim

The aim of this study is to investigate which kind of *sports facilities* have been built in Norway, and to see if there have been any changes in the number of yearly built facilities of each kind, during the last 20 years. Further, the aim is to give a more detailed picture of one of the sports facility groups, i.e. *sports hall*, and its construction cost, and to compare how different factors

[1] Based on approved costs from the new applications for gaming funds to sports facilities in 2015 (Busland & Kristiansen, 2015).

associated with location, facility properties, and other factors may have affected the costs during the last 20 years. In addition, the aim is to investigate the differences in the sports facilities operational costs.

In short, this study will address the following questions:

- What kind of *sports facilities* have been built during the last 20 years?
    - Have the number of built facilities within any kind of sports facility group increased or decreased remarkably during this period?
- What has the spread in *sports hall* costs been during the last 20 years?
    - Which factors have been influential on the cost (e.g. location, type of sports hall, and construction year)?
    - Have the costs changed over time?
- How much does it cost to operate a sports facility?

Furthermore, this study will demonstrate possibilities and limitations in the use of data from the Sports Facility Register.

This study does not investigate how different materials, building techniques or other technical factors influence the costs, and only includes sports facilities found in the Sports Facility Register.

The results from this thesis will be presented within the project *godeidrettsanlegg.no* as a complement to the annual reports on gaming funds and the sports facility situation from KUD and NIF.

1.3 Method

The planning part of a statistical project is very important, as the statistical approach is crucial if one wants to be able to draw meaningful conclusions from the data. Data must be collected and analyzed by statistical methods to make the results valid and objective (Montgomery, 2013). Therefore, the statistical thinking should be present from day one of the project.

The procedure for this statistical study is, in short:

1. Defining the purpose and questions
2. Collecting data
3. Preprocessing the data
4. Analysis of the data: Descriptive statistics, Hypothesis testing, Regression and ANOVA
5. Results and interpretation

The first part, purpose and questions, has already been described in section 1.2. The other parts are presented in the following sections.

For the first question in *Aim*, regarding the number of built sports facilities in general, the analysis part consists of descriptive statistics on what can be found in the Sports Facility Register. For the second question in *Aim*, regarding sports hall costs, the analysis part consists

of all four methods mentioned under the fourth point, based mostly on the gaming fund applications and the Sports Facility Register. The third and last question in *Aim*, regarding sports facility operational costs, is only covered in the data collection and the discussions.

The statistics package Minitab 17 is used for the preprocessing and the analyses.

1.4 Overview of the report

In section 2, sports facility and gaming fund background is presented, and in section 3 information on municipalities and counties in Norway is given. Section 4 presents some of the statistical theory for the analysis parts of this report, as well as how the costs can be adjusted for inflation. In section 5, the different data sources are described. Section 6 deals with the number of built sports facilities between 1996 and 2015. Section 7 treats the costs for sports halls, starting with the application data preprocessing, continuing with descriptive statistics on what is found as well as tests and suggested models to explain the costs. The last two sections, section 8 and 9, consist of discussion of results and conclusions.

2. Sports facilities and gaming funds

Sport as a leisure activity arose in Norway around 1900, and with the new activities, special facilities for the different activities became necessary. Some sport organizations were given financial support from the government and from municipalities, for instance to facility building, due to the social benefits of sports (Goksøyr, 2008). In 1922, the parliament decided that sports should receive a part of the governmental Money Lottery (Pengelotteriet) (Rafoss, 2011), and in 1928 it was decided that a majority of these funds should be used for sports facility buildings, but the governmental support decreased in the following years, and sports facilities were mainly supported by the private sector (Goksøyr, 2008).

In 1946, the parliament opened up for sports betting. Since 1948, betting funds (profits from sport betting), and later on from the gaming funds (profits from sport betting, lotteries etc. provided by the National Lottery of Norway), have been the financial foundation of sports in Norway. From 1965 to 1985, the sports share of the gaming funds increased from 12 million NOK to 324 million NOK and a massive amount of sports facilities were built (Goksøyr, 2008). In 1992, the parliament decided that all profits from betting/lotteries administrated by KUD should be shared by sports, research, and culture purposes. In 2002, the parliament decided that from 2005, only sport and culture purposes should receive money from the profit (Goksøyr, 2008).

2.1 Distribution of gaming funds

The Ministry of Culture (KUD) is responsible for the distribution of gaming funds. The distribution of gaming funds for sport purposes (the so-called main distribution) takes place once a year. A major part of these funds is assigned to sports facilities. In 2015, 1 058 977 000 NOK was assigned *sports facilities in the municipalities*, corresponding to 46.8 % of the total sum. In addition, 6.0 % (136 577 000 NOK) of the total sum was given to other sports facility building purposes (Fordeling av Spillemidler til idrettsformål (Hovedfordelingen), 2015).

Each county is assigned a part of the sum assigned for *sports facilities in the municipalities*, where the county's share is based on different criteria (which have been modified several times by the administration at KUD). The different criteria and their weighting are given in Table 1. The weighting formula for 2015 was

$$\begin{matrix} fund \\ share\ to \\ county\ A \end{matrix} = 0.50 \frac{\begin{pmatrix} approved \\ application \\ sum\ for \\ county\ A \end{pmatrix}}{\begin{pmatrix} approved \\ application \\ sum\ for \\ all\ counties \end{pmatrix}} + 0.25 \left(\frac{\begin{matrix} inhabitants \\ in\ county\ A \end{matrix}}{\begin{matrix} inhabitants \\ in\ Norway \end{matrix}} \right) + 0.25 \left(\frac{\begin{matrix} facility \\ coverage \\ in\ county\ A \end{matrix}}{\begin{matrix} facility \\ coverage \\ for\ all \\ counties \end{matrix}} \right) = C, \quad (1)$$

where C is a number between 0 and 1. Hence, in 2015, county A would have received C·1 058 977 000 NOK. The distribution of the gaming funds to the counties in 2015 is given in Table 2.

Table 1: The distribution weights for the division of gaming funds to the counties within the category "sports facilities in the municipalities".

Year	Total approved application sum in the county	Number of inhabitants in the county	Number of inhabitants spread in the county	Facility coverage in the county
1996 - 2000	50 %	25 %	15 %	10 %
2001 - 2009	50 %	25 %	-	25 %
2010 -	50 %	25 %	-	25 %

Table 2: Distribution of the gaming funds to the counties within the category "sports facilities in the municipalities" in 2015.

County	Sum received
Akershus	101 208 000 NOK
Aust-Agder	37 001 000 NOK
Buskerud	65 367 000 NOK
Finnmark	23 170 000 NOK
Hedmark	39 802 000 NOK
Hordaland	97 052 000 NOK
Møre og Romsdal	63 998 000 NOK
Nordland	61 227 000 NOK
Nord-Trøndelag	47 132 000 NOK
Oppland	49 856 000 NOK
Oslo	35 210 000 NOK
Rogaland	93 234 000 NOK
Sogn og Fjordane	37 130 000 NOK
Sør-Trøndelag	74 733 000 NOK
Telemark	37 648 000 NOK
Troms	40 455 000 NOK
Vest-Agder	51 476 000 NOK
Vestfold	56 089 000 NOK
Østfold	47 189 000 NOK

The criterion *facility coverage* is based on its own weighting system, where the different facilities are given a weight based on cost and use potential (Fuglås, et al., 2009) (Kristiansen, 2015). The definition of the formula for calculating *facility coverage* has been changed between the gaming funds distributions in 2009 and 2010 (Kristiansen, 2015). In addition, small changes were applied to the weighting-system between 2010 and 2015. Some counties are entitled to extra funding (Det Kongelige Kulturdepartement, 2015).

The purpose of the weighting is to create a fair funds distribution to the counties. The counties on their hand have their own priority list of the facilities in their municipalities. In practice, the counties can divide the funds to facilities that do not increase their facility coverage (by giving funds to facilities that have a low weight/are not included in the facility coverage formula), and hence the next year have the same coverage for the main distribution.

2.2 Sports facility statistics

Statistics from KUD and NIF on sports facility construction are based on incoming applications for the governmental controlled gaming funds, i.e. not real costs. According to the statistics from 2015, most sports facilities were built by sport clubs (1 141 applications with approved costs[2] of 4.8 billion NOK), but the public sector (mainly municipalities) was the biggest investor (960 applications with 12.4 billion NOK approved costs) (Busland & Kristiansen, 2015). NIF have since 2011 (from 2014 in cooperation with KUD) published annual reports on gaming fund applications for sports facilities, where the number of applications are used to give an overview of which kind of sports facilities that are built. These numbers include both applications regarding new facilities and applications regarding renovation of existing facilities. The numbers for the applications in total and applications regarding *sports halls* from the annual reports from 2011 to 2015 are given in Table 3. The reported numbers are the total number of applications, and from 2014, including the number of new applications that year. Some applications are re-sent year after year until the project is assigned funds. For example, in 2015, there were a total of 269 applications regarding sports halls; 78 of these were new applications regarding sports halls, and 191 applications were re-sent applications, that in 2014 either did not receive any of the money applied for, or did not receive all of the money applied for.

Table 3: The figures presented under the titles "Key Figures from the gaming fund applications" and "What is built?" in the reports from NIF and KUD.

	Total number of applications	New applications, sports facilities	Total number of applications regarding sports halls (and percentage of total number of applications)	New applications regarding sports halls (and percentage of total number of new applications)
2011	2 027	588	196 (10 %)	-
2012	2 122	758	204 (10 %)	-
2013	2 222	757	233 (10 %)	-
2014	2 221	681	251 (11 %)	52 (8 %)
2015	2 375	903	269 (11 %)	78 (9 %)

[2] The *approved cost* is a term from the gaming fund applications, meaning the cost for the project, including approved elements as described in the regulations for the gaming funds (Det Kongelige Kulturdepartement, 2015).

3. Municipalities, counties, municipality groups, and regions

The location of the sports hall is one of the potential factors that has influenced the building costs. In Norway, there are 428 municipalities, divided in 19 counties. For analysis of regional and geographical differences, it was convenient to group both municipalities and counties. For the municipalities, the so-called municipality groups from Statistics Norway were used. To be able to compare municipalities within different municipal services, Statistics Norway has grouped the municipalities into 15 different groups[3] based on *number of inhabitants*[4], *tied costs per inhabitant*[5], and *free disposable income per inhabitant*[6] (Langørgen, Løkken, & Aaberge, 2013). The characteristics of the groups are given in Table 4.

Table 4: Information on the municipality groups from Statistics Norway.

	Number of municipalities	Number of inhabitants	Tied costs per inhabitant	Free disposable income per inhabitant	Other
Group 1	21	Low	Middle	Low	
Group 2	60	Low	Middle	Middle	
Group 3	35	Low	Middle	High	
Group 4	15	Low	High	Low	
Group 5	40	Low	High	Middle	
Group 6	47	Low	High	High	
Group 7	31	Middle	Low	Low	
Group 8	23	Middle	Low	Middle	
Group 10	21	Middle	Middle/ High	Low	
Group 11	53	Middle	Middle	Middle	
Group 12	19	Middle	Middle/ Low	High	
Group 13	49	High	Low/ Middle	Low/Middle/ High	
Group 14	3	High	-	-	Bergen, Stavanger, and Trondheim
Group 15	1	High	-	-	Oslo
Group 16	10	-	-	-	The ten municipalities with the highest free disposable income

[3] There is no group 9.
[4] Number of inhabitants are categorized: Low 0 - 4 999, Middle 5 000 - 19 999, and High 20 000 or more.
[5] Tied costs per inhabitant are categorized with indexes: Low 0.76 - 0.86, Middle 0.87 - 1.07, and High 1.08 - 2.64.
[6] Free disposable incomes per inhabitant are categorized with indexes: Low 0.61 - 0.89, Middle 0.90 - 1.02, and High 1.03 - 1.47.

Not all municipalities have stayed in the same group during the period of interest (1996 to 2015); for example, 52 % of the municipalities have switched group within at least one of the categories (number of inhabitants, tied costs per inhabitants, or free disposable income per inhabitant) from 1998 to 2003.

For the counties, the so-called *helseregioner* (*health regions)*[7] from 2002 (Statistics Norway, 2016d) are chosen for grouping, but with Oslo extracted to its own group. In the health regions, Oslo is included in *East*. The used regions are given in Table 5.

Table 5: Regions used for county grouping.

Region	Counties included in region
East	Østfold, Akershus, Hedmark, and Oppland
Oslo	Oslo
South	Buskerud, Vestfold, Telemark, Aust-Agder, and Vest-Agder
West	Rogaland, Hordaland, and Sogn og Fjordane
Mid-Norway	Møre og Romsdal, Sør-Trøndelag, and Nord-Trøndelag
North	Nordland, Troms, and Finnmark

[7] Norway is divided into health regions, which have the regional responsibility to offer health services. There were five health regions in 2002 (East, South, West, Mid-Norway, and North); today South and East are merged into South-East.

4. Theory

4.1 Data preprocessing

Data preprocessing is a necessary action, since "low-quality data will lead to low-quality mining results" (Han & Kamber, 2006, p. 47), or as in this case, low-quality analysis, and "(…) real world data tend to be dirty, incomplete, and inconsistent" (Han & Kamber, 2006, p. 50). Minimizing these factors makes the data analysis more reliable. Therefore, the different collected data sets were preprocessed before analysis to improve the quality. The preprocessing can consist of several parts. In this thesis, some of the methods described by Han and Kamber (2006) were used:

- Data cleaning: handling missing values and removing errors
- Data integration: combining multiple data sources (for example different registers)

For the first preprocessing step, Han and Kamber (2006) suggest six methods to handle missing values in a data set, where number 3 - 6 bias the data:

1. Ignore the tuple
2. Fill in the missing value manually
3. Use a global constant to fill in the missing value (i.e. *unknown*)
4. Use the attribute mean to fill in the missing value
5. Use the attribute mean for all the samples belonging to the same class as the given tuple
6. Use the most probable value to fill in the missing value

Mainly the methods 1 - 3 have been used in this thesis, since most attributes in the data sources were categorical. Method 6 was used for filling in missing activity surface area when it was stated which *facility type* (i.e. size category for sports halls) the sports hall belonged to.

To identify errors in the data sources, outlier values were investigated. When possible, the incorrect values were replaced with correct values, found in documents in the information system. If the value could not be found nor computed from other attributes (missing area could be computed using length and width), the observation was ignored/removed from the data set.

Different data sources were integrated by merging the collected/created registers by unique values (for example identification numbers or municipality names) that occurred in both registers of interest. By integrating different data sources, more information on each sports facility became available. All these steps are described in detail in later sections.

4.2 Regression analysis

Regression is a very useful method for statistical analysis of relations between data, how one or more *independent variables* explain *the dependent variable.* The meaning of simple linear regression is to fit a function

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \epsilon \quad (2)$$

to data, where y is the dependent variable, $x_1, \dots, x_k$ are the independent variables, α is a constant, $\beta_1, \dots, \beta_k$ are the regression coefficients of the independent variables and ϵ is an error term, catching the variation in y that is not explained by the independent variables or the constant (Montgomery, 2013).

The difference between the true observation value y_i and the value predicted by the model $\widehat{y_i}$ is called the residual,

$$e_i = y_i - \widehat{y_i}. \tag{3}$$

To find the coefficient values in a regression model, it is common to use a method called Ordinary Least Squares, OLS. The purpose of OLS is to minimize the sum of squared residuals to find the optimal coefficients β. For the simplest linear regression model $y_i = \alpha + \beta x_i$ with n observations in the data, this is done by minimizing the expression

$$Q = \sum(y_i - \hat{y}_i)^2 = \sum(y_i - \alpha - \beta x_i)^2 \tag{4}$$

by using partial derivatives and finding the solutions to the equation system

$$\frac{\partial Q}{\partial \alpha} = 2\sum(y_i - \alpha - \beta x_i) = 0 \tag{5}$$

$$\frac{\partial Q}{\partial \beta} = 2x_i\sum(y_i - \alpha - \beta x_i) = 0, \tag{6}$$

which have the solutions

$$\alpha = \frac{\sum y_i}{n} - b\frac{\sum x_i}{n} \tag{7}$$

$$b = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{n\sum x_i^2 - (\sum x_i)^2}. \tag{8}$$

For a regression model with more than one explanatory variable x, the number of equations with partial derivatives increase and there will be a larger equation system to solve (Andersson, Jorner, & Ågren, 2007).

There are several assumptions that should be met for OLS regression, here as described by Minitab 17 support:

- *The regression model is linear in the coefficients. Least squares can model curvature by transforming the variables (instead of the coefficients). You must specify the correct functional form in order to model any curvature.*

- *Residuals have a mean of zero. Inclusion of a constant in the model will force the mean to equal zero.*

- *All predictors are uncorrelated with the residuals.*
  Residuals are not correlated with each other (serial correlation).
  Residuals have a constant variance.

- *No predictor variable is perfectly correlated (r = 1) with a different predictor variable. It is best to avoid imperfectly high correlations (multicollinearity) as well.*

- *Residuals are normally distributed. (Minitab Inc., 2016)*

The assumptions must be validated when preforming regression analysis on data. This can be done by the three following model-checking tools provided by Minitab 17:

- Examining residual plots
  - Checking behavior of residuals
- Using lack-of-fit tests
  - A low p-value (chosen level of significance) for lack-of-fit indicates that the model does not fit the data; a higher value indicates that there is no evidence that the model does not fit the data.
- Viewing the correlation between predictors using VIF (variance inflation factor)
  - $VIF = 1$: Predictors are not correlated
  - $1 < VIF < 5$: Predictors are moderately correlated
  - $VIF > 5\ to\ 10$: Predictors are highly correlated

The fitting from the resulting regression model can be measured using the coefficient of determination,

$$R^2 = 1 - \frac{\sum(y_i - \hat{y}_i)^2}{\sum(y_i - \bar{y})^2} = \frac{SSR}{SST} = \frac{by\ the\ regression\ explained\ variation\ in\ y}{total\ variation\ in\ y}. \quad (9)$$

However, since the R^2 always increases when adding explanatory variables to the regression model, one needs another measure for comparing models. There is an adjusted coefficient of determination, R^2_{adj}, which compensates for the number of data points, and in general does not always increase as variables are added to the model (Montgomery, 2013). The adjusted coefficient of determination is computed as

$$R^2_{adj} = 1 - (1 - R^2)\frac{n-1}{n-p}. \quad (10)$$

The letter p stands for the total number of explanatory variables in the model.

Other important values are the p-values for the coefficients, which correspond to tests of the null hypothesis that the coefficient is equal to zero. A low p-value indicates that the null hypothesis can be rejected. This can also be used to determine which variable in a regression should be eliminated. The value of the coefficient indicates the average change in the response variable for one unit of change in the explanatory variable, when the other explanatory variables in the model are held constant (Andersson, Jorner, & Ågren, 2007).

For non-numerical explanatory variables, one can use indicator variables, with value 0 if false and 1 if true, as

$$y_i = \alpha + \beta_1 x_{1i} + \beta_2 D_{2i} + \epsilon_i \tag{11}$$

$$D_{2i} = \begin{cases} 1 \; if \; y_i \; is \; an \; observation \; where \; D \; is \; true \\ 0 \; otherwise \end{cases}. \tag{12}$$

For example, one could model the cost y for a sports hall i depending on activity surface area and if it is built in Oslo or not. Then $D_{2i} = \begin{cases} 1 \; if \; i \; is \; built \; in \; Oslo \\ 0 \; if \; i \; is \; not \; built \; in \; Oslo \end{cases}$.

4.3 The analysis of variance (ANOVA)

In analysis of variance, the total variance in a data material is split up into different sources of variation (Körner & Wahlgren, 2006). One looks at the total variation, the variation between groups (sources), and variation within the groups (sources). The groups are often called treatments. ANOVA is "the appropriate procedure for testing the equality of several means (…)" (Montgomery, 2013, p. 68).

A simple ANOVA-model for testing the equality of means for different groups that have received different treatments is

$$y_{ij} = \mu + \tau_i + \epsilon_{ij} \; \begin{cases} i = 1, .., a \\ j = 1, \dots, n \end{cases}. \tag{13}$$

This model is called the effects model for a one-way/single-factor ANOVA. y_{ij} is the j:th observation of treatment i, μ is called the overall mean, that is, the mean for all the observations independent of group (treatment), τ_i is the treatment effect for treatment i, and ϵ_{ij} is the error for observation (i, j). n is the number of observation from treatment i, and a is the number of treatments.

The two-way/two-factor ANOVA effects model includes two treatment factors, and the effects model is

$$y_{ijk} = \mu + \tau_i + \beta_j + \epsilon_{ij} + \begin{cases} i = 1, \dots, a \\ j = 1, \dots, b \\ k = 1, \dots, n \end{cases} \tag{14}$$

where the new parameter β represents the new treatment factor with b levels. The model can be extended further in the same manner to an n-way/n-factor ANOVA.

4.4 Consumer price index (CPI)

To be able to see if there has been a real change in costs for sports halls during the last 20 years, the costs found in the gaming fund applications need to be adjusted for inflation. This is done using the *consumer price index*, which is often used as a measure of inflation (Norges Bank, 2016). The conversion factors in Table 6 are computed with the price calculator found at Statistics Norway's Consumer Price Index webpage (Statistics Norway, 2016a), using the option *All (average)* for month. It was chosen to describe the costs with 2015 as base year.

When, for example, comparing three sports halls with a cost of 30 million NOK with different construction years (1996, 2005, 2015), the inflation-adjusted costs would be:

- 1996: $30\ million \cdot 1.4669 \approx 44\ million$
- 2005: $30\ million \cdot 1.2146 \approx 36\ million$
- 2015: $30\ million \cdot 1 = 30\ million$

In other words, if a sports hall costed 30 million NOK in 1996, this would correspond to 44 million NOK in 2015, and if a sports hall costed 30 million NOK in 2005, this would correspond to 36 million NOK in 2015.

Table 6: Consumer price index conversion factors for the years 1996 to 2015.

Year	Conversion factors to 2015 price level
1996	1.4669
1997	1.4294
1998	1.3980
1999	1.3666
2000	1.3251
2001	1.2861
2002	1.2698
2003	1.2394
2004	1.2339
2005	1.2146
2006	1.1878
2007	1.1788
2008	1.1357
2009	1.1122
2010	1.0854
2011	1.0721
2012	1.0639
2013	1.0417
2014	1.0212
2015	1.0000

5. Data collection

In this project, both primary data and secondary data are used. The data sources are:

- The Sports Facility Register (Idrettsanleggsregisteret)
- Gaming fund applications from the information system associated with *idrettsanlegg.no* and the Sports Facility Register
- Operational data from the municipalities in Norway

The first two sources are registers and the third source is data collected by a survey. When using a register as a data source, it is important to have knowledge about the actualization and the structure of the records (Dahmström, 2011). Therefore, detailed information about the registers is included in the following sections.

5.1 The Sports Facility Register

KUD has a public register over sports facilities, culture houses, and outdoor recreation facilities, established in 1992 (Idrettsanleggsregisteret, 2015), which can be found at *idrettsanlegg.no*. The register is called *the Sports Facility Register* and is updated frequently by the municipalities in Norway (at minimum once a year). The municipal updating is a prerequisite for receiving gaming funds for future sports facility and outdoor installation projects (Det Kongelige Kulturdepartement, 2015). The register can be downloaded in CSV format (comma-separated value) to for example Microsoft Excel. SIAT downloaded the register for further work on June 2, 2015. An updated version of the Sports Facility Register was sent from KUD to SIAT in March 2016, and used from then on. For the analysis of built sports facilities during the last 20 years, this is the only data set used.

In the Sports Facility Register, each facility has the attributes *facility name*, *facility number* (which is unique for each facility and hence the identification number), *status*, *owner*, *operator*, *facility class*, *facility group, facility type, universal design*, *construction year*, *rebuilding year*, *coordinates, sum awarded*, *sum paid out*, *sum withdrawn*, and some measurements (as for example length, size, capacity).

The *facility number* consists of ten digits. The first four digits correspond to the municipality where the facility is situated (the two first digits correspond to the county). Once downloaded, county and municipality was added to the register, using the first four digits. Some municipalities have been merged since the register was created in 1992, without the municipality changing the facility number, and some of the older municipality numbers were added, made to correspond to the new municipality.

The *status* can be either *existing, not in operation, temporary closed, closed, planned, deleted,* or *unrealized*. *Facility class* is either *county facility*, *inter-municipal facility*, *municipal facility*, *national arena*, *local facility,* or *national facility*. *Facility group* can be 25 different categories, for example *football facility*, *map,* or *motorsports facility*. *Facility type* is a subgroup for *facility group*, and for example *football facility* can be divided in to the types *grass pitch, gravel pitch, artificial turf, mini hall 40 x 20 m, large hall 100 x 60 m, training hall 70 x 50 m,* or *undefined*. *Universal design* (called *uu* in the file) describes if the facility is accessible to people with/without disabilities, and can be *yes*, *no* or *not rated*. *Sum awarded*, *paid out,* and *withdrawn*

refers the sum of gaming funds associated with the facility. An example from the register is shown in Table 7, but with columns for facility name, rebuilding year, measurements, and coordinates left out.

Table 7: Example of extract from the Sports Facility Register.

Facility number	Status	Owner	Operator	Facility class	Facility group	Facility type	UU	Construction year	Awarded	Paid out	With-drawn
1504000404	Existing	Emblem IL	Emblem IL	Municipal facility	Map	Orienteering map	Not rated	1996	11000	11000	0
0706000608	Planned	Sandar IL	Sandar IL	Municipal facility	Sports hall	Large sports hall	Yes		0	0	0
0706004905	Unrealized	Fevang Nærmiljø-utvalg	Fevang Nærmiljø-utvalg	Local facility	Activity facility	Miniature golf	Yes	2010	200000	200000	0
0704007601	Existing	Tønsberg kommune	Tønsberg kommune	Local facility	Activity facility	Mini pitch, open	Not rated	1970	0	0	0

In July 2015, the register included data on 69 427 facilities (70 850 facilities in March 2016), with 54 944 facilities (55 543 facilities in March 2016) categorized as *existing*. Even though it is required from KUD that the municipalities keep the register updated to be able to receive new gaming funds (Det Kongelige Kulturdepartement, 2015), many facilities are missing information on attributes; for example, the field *operator* is left blank for 18 806 (17 080 facilities in March 2016) *existing* facilities in the register. Other deficiencies in the data are:

- All attributes, for example the *construction year* or *measurements*, are not filled in.
- The given *coordinates* are wrong; more than 2 900 facilities are according to the coordinates not even located in Norway (Reikvam, 2016).
- The *facility name* is not the real name of the facility.
    - The reasons could for example be that the facility name has been changed in reality but not updated in the system, or that the facility name has been changed to the name of the most recent application (for example to "renovation of floor in the sports hall").
- The *construction year* is sometimes stated to be later than the *rebuilding year*.
- The *rebuilding year* can be missing for facilities that in fact have been rebuilt.
    - This is easily discovered on artificial football turfs. According to the register, some artificial football turfs have been built long before the artificial turfs were first introduced in Norway. Most likely, these football facilities used to be gravel or a grass pitches, but were then rebuilt to an artificial turf.
- Many facilities are categorized in the wrong *facility group*.
    - When it comes to sports halls, the Norwegian name in the register is *flerbrukshall* that, translated directly, means something like *multipurpose hall*. This has probably led to misunderstandings when registering sports facilities with several possible uses.
    - There is a problem found with indoor athletics stadiums, where the inner zone could be used for handball and other sports hall sports. These have sometimes been registered as sports halls, even though there is another facility group in the register for indoor athletic stadiums.

- It seems like there are no clear rules of how to register sports facilities where for example one part of the facility is a dance hall and another part is for martial arts. Many of these have been registered as sports halls, other as two facilities.
- There is not a consistent way of registering large sports halls where the activity surface can be used for several full size handball games. Some are registered as large sports halls; some are registered as two normal sports halls.

The municipalities might have had troubles understanding and working with the information system associated with the Sports Facility Register. Some of the issues are discussed in the section 8.4 Problems working with the sports facility information system.

5.2 Cost data from the gaming fund applications

KUD, the counties, and the municipalities use an information system associated with the Sports Facility Register, when working with applications for gaming funds and registering new sports facilities. The information system is a web-based platform reached from the website *kkd-idrettsanlegg.no/growbusiness*. KUD gave SIAT a user account on this platform, which gave us the opportunity to see all the information in the system. In this system, it is possible to find *estimated building costs* associated with the sports facilities, and the sports facilities have the same identification number, *facility number*, in both this system and the Sports Facility Register. A facility can have several applications associated with it. Application data from this register was used for the analysis of costs.

On the platform, there is a menu called *reports*, from where it is possible to export pre-defined summaries, for example of all the applications. However, the exporting options are limited since all the reports are pre-defined. It is possible to export all the applications from a certain year, but it is not possible to export all the titles from the searching criteria, which makes the data collecting very time consuming. The titles that are included in the export are given in Table 8, and the titles that are excluded in the export are given in Table 9.

Table 8: Titles in the export of data that are included from search criteria.

Norwegian title	English title
Anleggsnummer	Facility number
Anleggsnavn	Facility name
Delprosjekt	Subproject
Søker	Applicant
Søknadsgruppe	Application group
Anleggskategori	Facility group
Anleggstype	Facility type
Kostnads-overslag	Estimated cost
Søkers søknadssum	Application sum
Godkjent kostnad	Approved cost
Godkjent søknadssum	Approved application sum

Table 9: Titles in the export of data that are excluded from search criteria.

Norwegian title	English title
Søknadsperiode	Application period
Anleggsklasse	Facility class
Søknaden gjelder	The application regards

Since the missing titles were considered necessary for the analysis of sports hall costs, the data export was repeated 960 times, with different settings for *application period* (1996 to 2015, 20 choices), *facility class* (six choices), and *the application regards* (eight choices). The search criterion values were added to the exported document (for example *application period = 2015, facility class = county facility*, and *the application regards = new facility*), and thereafter all exported applications were merged into a new document.

Furthermore, the search function has a feature where it is possible to count applications, given a search criterion, but this number does not always match the number of applications one gets in the export. It is therefore not possible to control the exact number of missing applications when exporting with some certain criteria.

Another challenge is that some definitions for the facilities seem to have changed over the years, and some titles do not seem to have been there from the first version of the system. When it comes to the title *the application regards*, the possible choices (*new Facility, renovation, etc*.) do not cover all of the applications from the start to 2007, but do from 2008 - 2015.

In total, there was per November 2015, a number of 117 855 gaming fund applications in the system, with the earliest one from 1947. Because of the time consuming manner to export data from the system, only applications from the period 1996 to 2015 were exported. The number of exported applications was 67 765. The exported data described above is from now on called the application data.

It is important to emphasize that the application data represents only the received applications and the numbers found in the applications are not always reliable:

- *Approved application sum* does not say anything about how much money the application returned: it is just verifying that the application fulfilled the formalities (Kristiansen, 2015).
- *Estimated cost* can sometimes be the actual cost (when the application regards an already built facility), but sometimes it is just as the name says; the estimated cost, before construction of the facility.
- In some situations, the *estimated cost* does not include the entire facility cost: instead, only the parts that are approved for gaming funds by the *Regulations for gaming funds to Sports Facilities* (Det Kongelige Kulturdepartement, 2015) are used as cost data. For example, through the work with the application data, it is found that it is not consistent if for example an audience platform cost (which is not included in the sum that can be approved for gaming funds) is included or excluded from the *estimated cost*.
- The facilities are not always built. An application (approved or not approved), is no guarantee for a building project to be implemented, and additional information is

necessary to verify if the facility actually has been realized. However, this information can (most of the time) be found in the Sports Facility Register.
- The costs for a facility can be divided into several applications, or collected into one application. This makes it hard to compare facility costs.

Therefore, the application data must be processed before analysis, and the analysis itself can just be used as a guidance. Still, the *estimated costs* from the application data are what is available; therefore, they are the best estimate possible.

Manual preprocessing of the 67 765 applications would have been too time consuming. On the other hand, automatic preprocessing of the whole data set was not considered an option, since the different *facility groups* are so diverse in for example costs. In addition, to establish rules for automatic data cleaning, one must have deep knowledge about the data. Therefore, it was decided to focus on just one facility group and analysis of its estimated costs due to different attributes. It is left as a suggestion to further studies to use the findings of this thesis to develop a general method to preprocess and analyze the other *facility groups*.

In the Sports Facility Register (as well as in the information system), the group *sports hall* is one of the *facility groups* with most facilities and fewest subcategories (i.e. *facility types)*. Also, sports hall, as a *facility group*, is one of the least diverse groups in the register: The different types could be seen as different sizes of the same facility, in contrast to swimming facilities, for example, where the types are leisure pools, indoor/outdoor diving platforms, or indoor/outdoor swimming pools. This, in addition to the fact that sports halls are one of the current focuses from SIAT, led to the choice of sports hall as the group to concentrate on. In the application data, 3 492 out of 67 765 applications regarded sports halls.

5.3 Operational data from the municipalities

The municipalities are responsible for operation of many sports facilities (a quick search in the Sports Facilities register yielded 18 307 hits on the word *kommune* (*municipality*) in the *operator* colon, which indicated that approximately 26 % of all the facilities are operated by the municipalities). SIAT sent out an e-mail to all the sport consultants in the counties, asking them to collect operational data on sports facilities from their municipalities, and send it to SIAT. This did not yield any particular response, and hence it was included in this work to collect operational data from the municipalities. Due to the Principle of publicity (Lovdata, 2006), this data should be possible to get, but might be quite hard to get on time. SIAT had already received data from Trondheim municipality and therefore, no new e-mail was sent to Trondheim municipality.

The approach for data collection mainly followed the steps described by Dahmström (2011). The step with a test survey was skipped, since the wanted operational data from Trondheim municipality was received upon request without misunderstandings.

A copy of the e-mail with its associated files can be found in Appendix A: E-mail to the municipalities. The e-mail, including the introduction letter, was designed to fulfill the criterions from Dahmström (2011), particularly:

- Describing the purpose of the survey and stating the sender(s) with contact information
- Describing the subject of interest

The e-mail addresses to all the municipalities were found in *Kommunenøkkelen* (Kommuneforlaget, 2015). Some of the e-mail addresses were replaced by addresses given from one of the supervisors of this project. The first e-mail was sent November 18th, 2015, stating that answers were wanted before December 18th. By January 4th, 2016, only 34 of 427 asked municipalities had answered; 16 of them answered with some kind of data and the other 18 without, nearly all giving a reason to why they did not send any data (some of the reasons are talked over in the Discussion).

To the rest of the municipalities, a reminder was sent January 6th. By February 4th, 44 municipalities had answered, whereof 27 with data and 17 without, but with a reason not to.

In total, operational costs were received from 43 municipalities (44 including Trondheim). The lack of response from the municipalities together with the variety in the received data formats made it hard to make any meaningful overall analysis on the operational costs in municipalities, and therefore further analysis of operational costs for sports facilities is excluded from this thesis.

6. Number of built sports facilities 1996 - 2015

The analysis of the number of built sports facilities is based on what can be found in the Sports Facility Register, without any preprocessing. The data in the Sports Facility Register was sent to SIAT from the Ministry of Culture (KUD) in a worksheet in March, 2016 (later the same data was uploaded at *idrettsanlegg.no*). All facilities with a construction year from 1996 to 2015 were saved in a new worksheet. In this data set, there were 19 501 *existing* facilities, and 389 *closed down* facilities (of which 100 are marked as *not in operation*, 28 are marked as *temporary closed down* and 261 are marked as *closed down*). Not all facilities in the register (or in the exported data set) have been built; 1 092 sports facilities have *not been realized*, and 2 398 facilities are still marked as *planned*. Since these *planned* facilities have a construction year in the register, it is doubtable that all of them in fact are still planned. It is more likely that the status has not been updated (881 of the 2 398 planned facilities have construction year between 1996 and 2010). There are 299 facilities marked as *wrongly registered*. Of *all* the facilities in the Sports Facility Register (including existing and closed down facilities), 3 % (1 779 of 63 095 facilities) are lacking their construction year. It is hard to say how many of these should have had a construction year between 1996 and 2015. The number of built sports facilities each year between 1996 and 2015 is presented in Figure 1.

In average, 995 facilities have been built each year between 1996 and 2015. The number of built sports facilities for 2015 (and probably for 2014 as well) might be lower than the number of actually built facilities, assuming that the municipalities have not changed the status from planned to existing for a larger proportion of facilities these years than the earlier years.

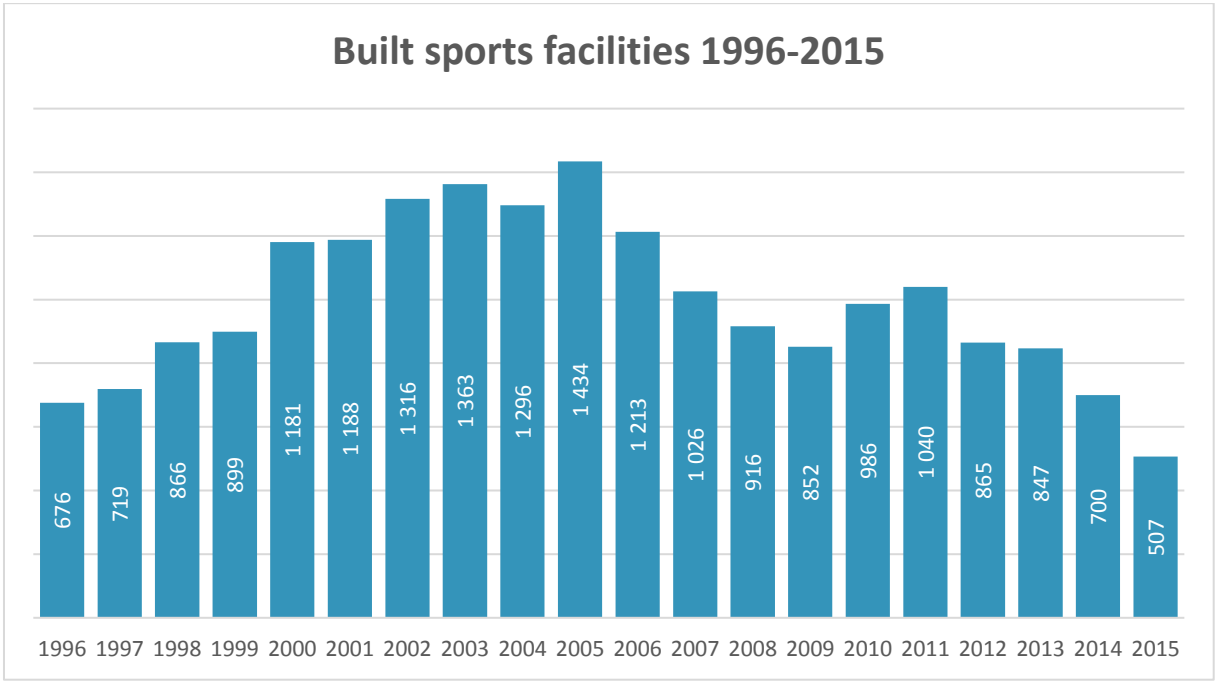

Figure 1: The number of built sports facilities 1996 to 2015.

Overall, there are 25 *facility groups* in the Sports Facility Register. In the period 1996 to 2015, there have been built 19 890 facilities in 24 of the different groups (no Sami sports facility has been built during this period). The groups and the number of built facilities in each group are presented in Table 10. Most of the groups have subgroups, i.e. *facility types*. *Facility types* where 500 or more facilities have been built between 1996 and 2015 are in Table 11 extracted from their group.

Table 10: The number of built sports facilities within each facility group in the Sports Facility Register 1996 - 2015.

Facility group	Norwegian name	Number of built facilities	
Activity facility	Aktivitetsanlegg	8 701	43.7 %
Outdoor recreation facility	Friluftsliv	2 454	12.3 %
Map	Kart	1 479	7.4 %
Football facility	Fotballanlegg	1 368	6.9 %
Sports house	Idrettshus	1 336	6.7 %
Skiing facility	Skianlegg	784	3.9 %
Shooting facility	Skyteanlegg	704	3.5 %
Culture house	Kulturbygg	505	2.5 %
Sports hall	Flerbrukshall	482	2.4 %
Other sports facilities	Diverse anlegg	426	2.1 %
Equestrian facility	Hestesportanlegg	265	1.3 %
Athletics facility	Friidrettsanlegg	246	1.2 %
Activity room	Aktivitetssal	214	1.1 %
Golf facility	Golfanlegg	191	1.0 %
Swimming facility	Bad og svømmeanlegg	164	0.8 %
Motorsports facility	Motorsportanlegg	159	0.8 %
Ice facility	Isanlegg	132	0.7 %
Watersports facility	Vannsportanlegg	120	0.6 %
Tennis facility	Tennisanlegg	95	0.5 %
Gymnastics facility	Turnanlegg	21	0.1 %
Squash facility	Squashanlegg	17	0.1 %
Bowling facility	Bowlinganlegg	13	0.1 %
Archer facility	Bueskytteranlegg	9	0.0 %
Air sports facility	Luftsportanlegg	5	0.0 %
Sami sports facility	Samiske anlegg	0	0.0 %
All		19 890	100 %

Table 11: The number of built sports facilities within each facility group from 1996 to 2015, with the most frequent built facility types extracted.

Facility group, with some types extracted	Norwegian name	Number of built facilities	
Activity facility: *different small facilities*	Aktivitetsanlegg: *ulike småanlegg*	2 126	10.7 %
Activity facility: *mini pitch, enclosed*	Aktivitetsanlegg: *ballbinge*	1 692	8.5 %
Outdoor recreation facility	Friluftsliv	1 525	7.7 %
Activity facility: *mini pitch, open*	Aktivitetsanlegg: *balløkke*	1 375	6.9 %
Sports house	Idrettshus	1 336	6.7 %
Activity facility	Aktivitetsanlegg	988	5.0 %
Football facility: *artificial turf*	Fotballanlegg: *kunstgressbane*	968	4.9 %
Outdoor recreation facility: *trail*	Friluftsliv: *tursti*	929	4.7 %
Skiing facility	Skianlegg	784	3.9 %
Activity facility: *beach volleyball court*	Aktivitetsanlegg: *sandvolleyballbane*	754	3.8 %
Activity facility: *marked-up ball pitch*	Aktivitetsanlegg: *ballbane*	734	3.7 %
Shooting facility	Skyteanlegg	704	3.5 %
Map: *orienteering map*	Kart: *orienteringskart*	684	3.4 %
Map: *neighborhood/school map*	Kart: *nærmiljøkart*	578	2.9 %
Activity facility: *skateboard facility*	Aktivitetsanlegg: *skateboardanlegg*	526	2.6 %
Activity facility: *ski play*	Aktivitetsanlegg: *skileikanlegg*	506	2.5 %
Culture house	Kulturbygg	505	2.5 %
Sports hall	Flerbrukshall	482	2.4 %
Other sports facilities	Diverse anlegg	426	2.1 %
Football facility	Fotballanlegg	400	2.0 %
Equestrian facility	Hestesportanlegg	265	1.3 %
Athletics facility	Friidrettsanlegg	246	1.2 %
Map	Kart	217	1.1 %
Activity room	Aktivitetssal	214	1.1 %
Golf facility	Golfanlegg	191	1.0 %
Swimming facility	Bad og svømmeanlegg	164	0.8 %
Motorsports facility	Motorsportanlegg	159	0.8 %
Ice facility	Isanlegg	132	0.7 %
Watersports facility	Vannsportanlegg	120	0.6 %
Tennis facility	Tennisanlegg	95	0.5 %
Gymnastics facility	Turnanlegg	21	0.1 %
Squash facility	Squashanlegg	17	0.1 %
Bowling facility	Bowlinganlegg	13	0.1 %
Archer facility	Bueskytteranlegg	9	0.0 %
Air sports facility	Luftsportanlegg	5	0.0 %
Sami sports facility	Samiske anlegg	0	0.0 %

The number of built sports facilities each year are presented in Appendix C: Overviews of built sports facilities, except for sports halls, where the overview is given in the following section. One can for example see that the number of yearly built athletics facilities has increased during the investigated period, and the number of yearly built shooting facilities has decreased, both when looking at real and relative numbers.

Of the sports facilities for *organized sports*, artificial football turfs have been the most frequently built *facility type* between 1996 and 2015, with 968 pitches, corresponding to 4.9 % of the total number of built facilities. In average, it has been built 48 artificial football turfs a year. In Figure 2, there is a yearly overview over built artificial football turfs. Figure 3 shows the built artificial football turfs-percentage of the total number of built sports facilities that year. In 2009, 11 % of the built sports facilities were artificial football turfs. In 2000, less than 1 % of all the built sports facilities were artificial football turfs. It is interesting to compare this to the number of yearly built grass/gravel pitches versus artificial turfs, given in Figure 4. There one sees that the increasing number of built artificial turfs does not only compensate for the decrease in the number of built grass/gravel pitches: there has been a general increase in built football facilities.

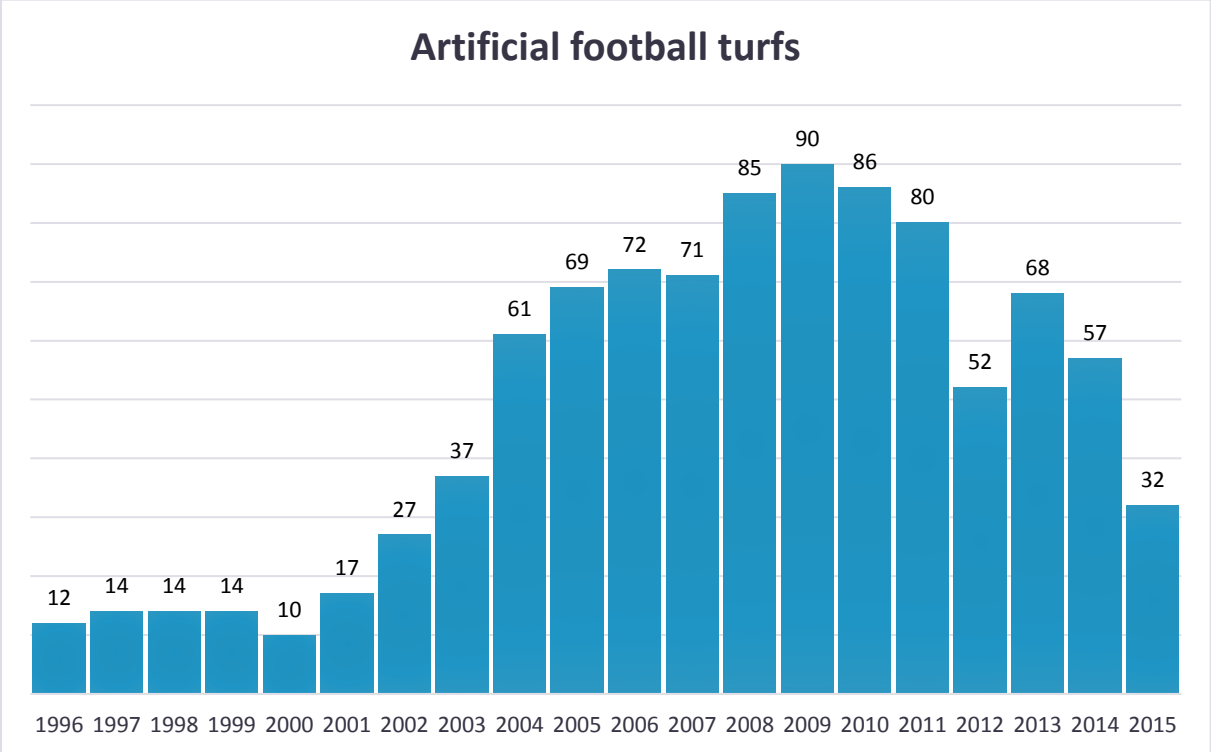

Figure 2: Number of built artificial football turfs from 1996 to 2015.

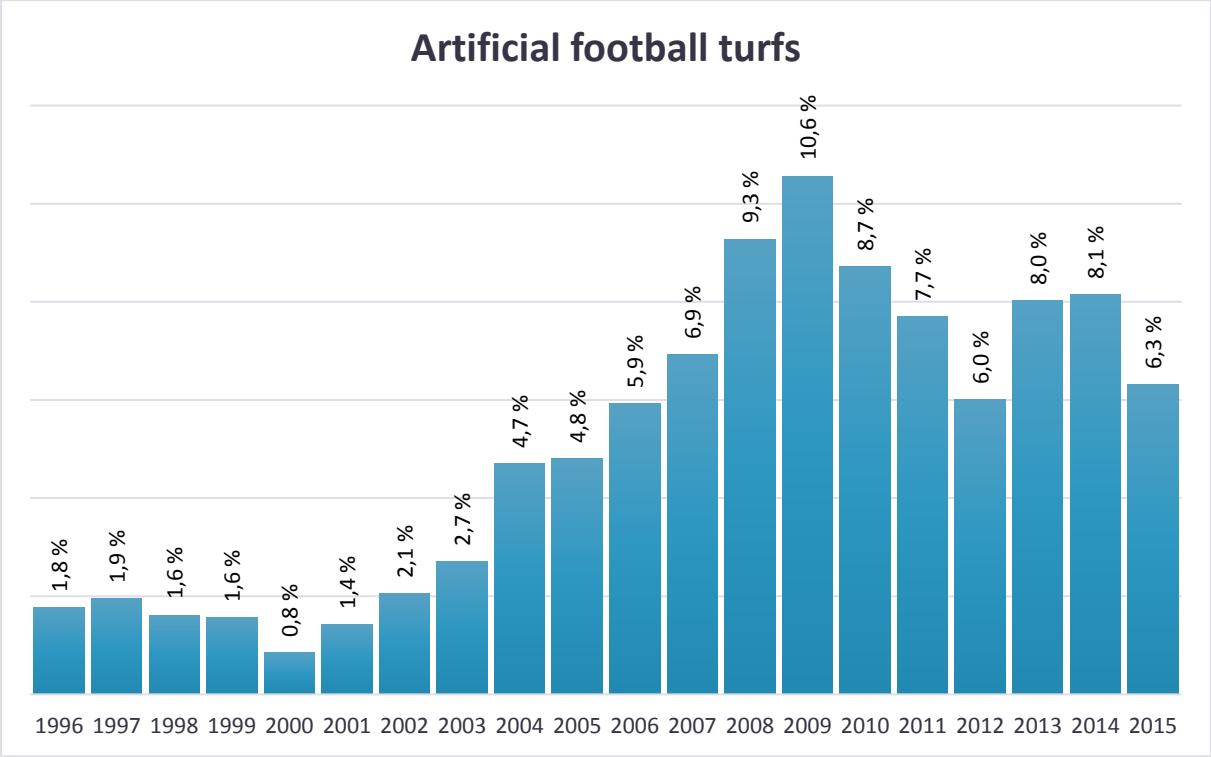

Figure 3: The artificial football turf proportion of total number of built sports facilities the same year.

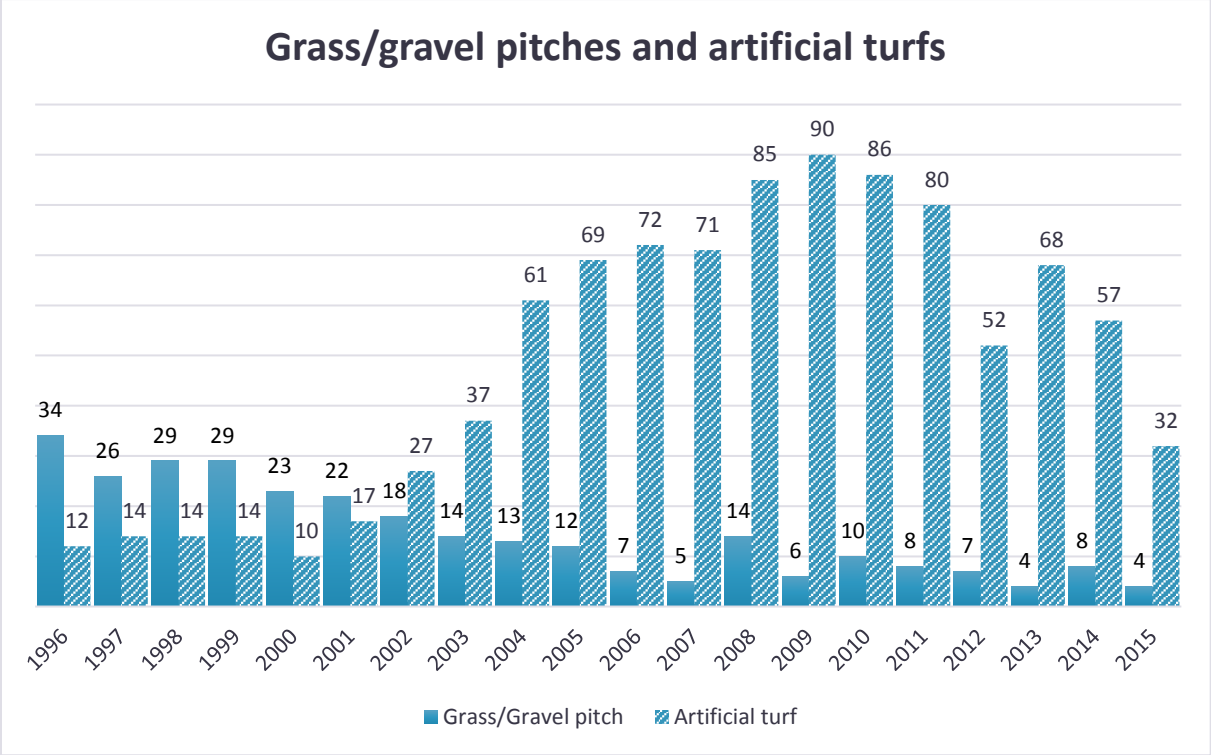

Figure 4: Number of built grass/gravel pitches and artificial turfs between 1996 and 2015.

6.1 Sports halls

According to the Sports Facility Register, 482 sports halls have been built in Norway between 1996 and 2015. Two of these halls have been closed down during the same period (these two are not included in Figure 5). The number of built sports halls per year is shown in Figure 5. In average, 24 sports halls have been built each year during the last 20 years. In 2011, 42 sports halls were built while there were only 10 built in 1996. In average, 2.5 % of the built sports facilities have been sports halls. At most, sports halls have constituted 4.4 % of the built sports facilities one year (in 2012 and 2014). At minimum, sports halls have constituted 1.5 % (in 1996). The sports hall proportion of total number of built sports facilities is shown in Figure 6.

The number of built sports halls in 2015 (and perhaps in 2014) is most likely larger than given by the data shown in Figure 5, assuming that the municipalities have not changed the status from planned to existing for all sports halls built in 2015 (and in 2014).

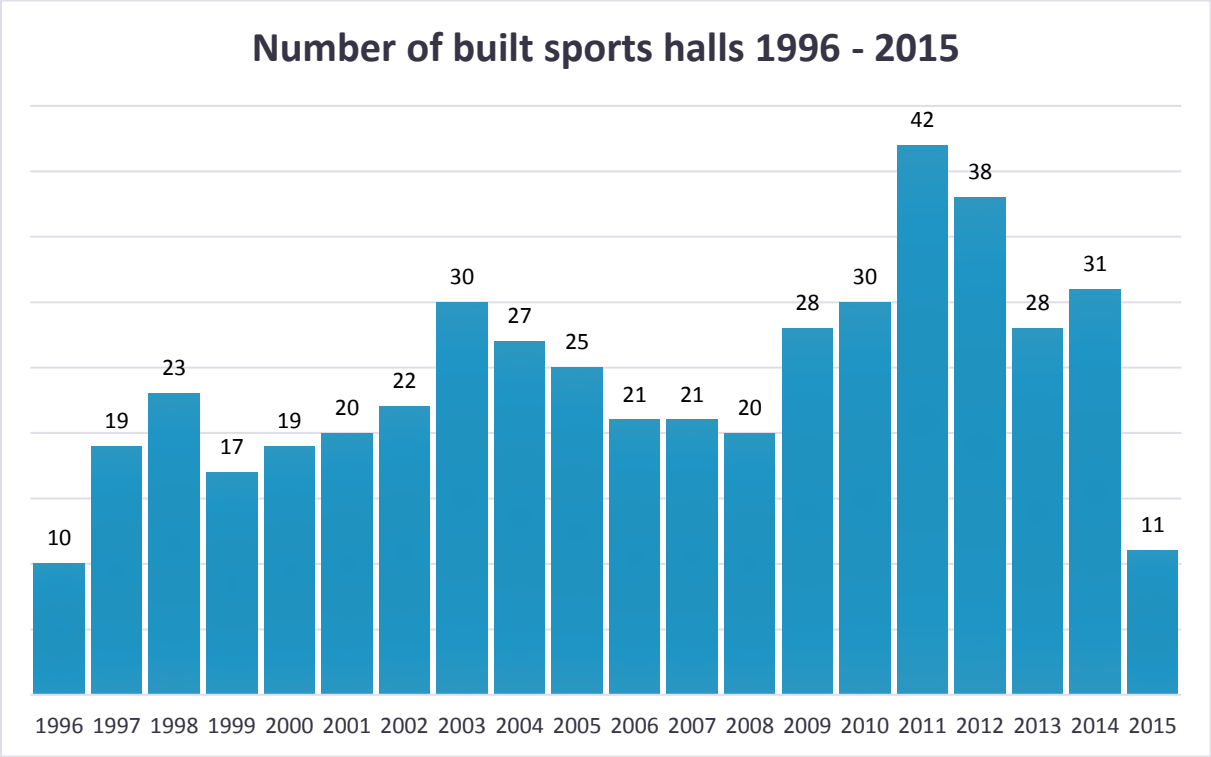

Figure 5: The number of built sports halls from 1996 to 2015.

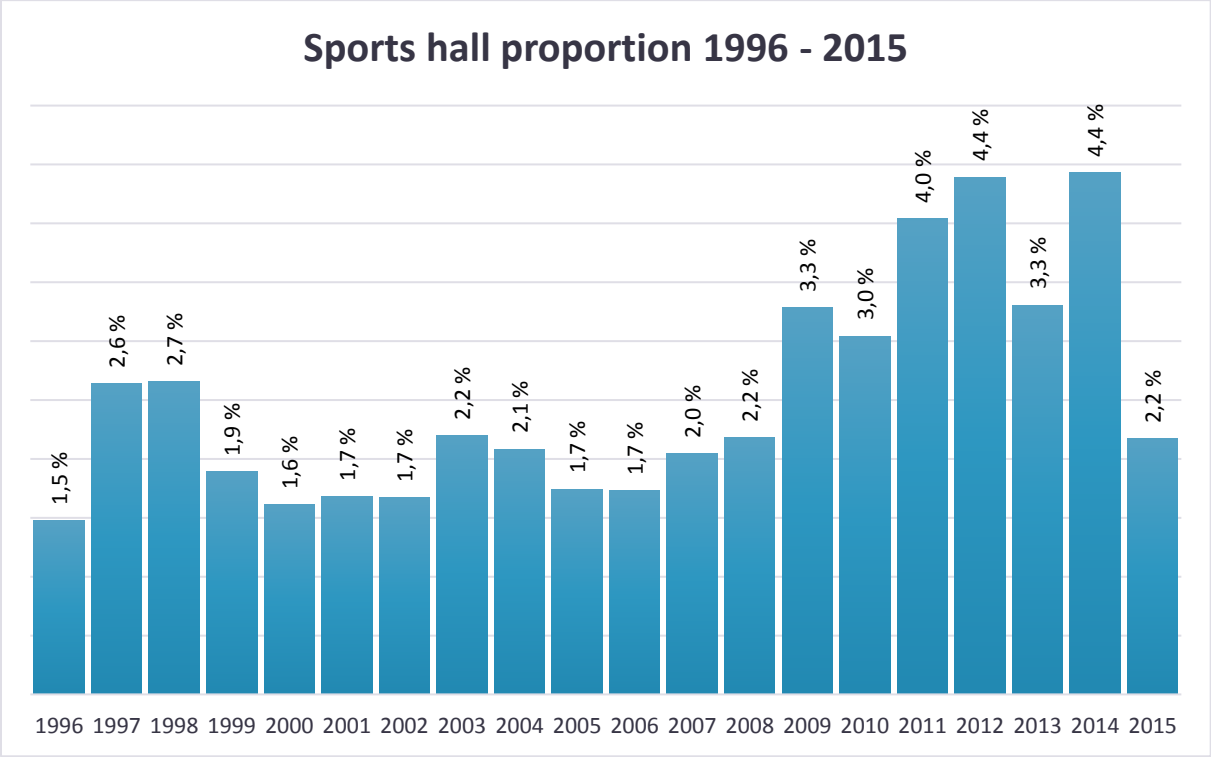

Figure 6: The sports hall proportion of total number of built sports facilities the same year.

7. Sports hall costs

7.1 Data preprocessing

The analysis of costs for building sports halls is primarily based on the applications for gaming funds, which had to be preprocessed before analysis. There were 3 492 of the 67 765 applications that regarded sports halls between 1996 to 2015. The following sections describe the preprocessing of the sports hall application data in form of different steps of data cleaning and data integration.

7.1.1 Missing values in the application data

As mentioned before, the attribute *the application regards* was not filled in for all the applications. For all applications lacking this attribute, the global constant *unknown* was used initially to replace the missing value. In the following processes, this constant was edited to either *new facility* or *renovation*, based on information in other applications on the same facility. The applications missing the value for estimated costs were deleted if the estimated cost was not easily found (for example in an attached file) in the administrator program. Other cases of missing values were taken care of when necessary later on.

7.1.2 Extraction of new facilities and elimination of duplicates

The first step was to distinguish the applications regarding new facilities from the applications regarding renovation of existing facilities. Some of the applications from the period 1996 to 2012 had *renovation of sports facilities* as *application group*, and this was used to change *the application regards* from *unknown* to *renovation*. It was not considered wise to change the other applications marked as *unknown* to *new facility*, since the category *renovation of sports facilities* has neither been used during all application periods, nor consequently used during the periods of use.

The second step was to remove duplicates, i.e. to remove additional applications where the facility had more than one application regarding it in the data set. This was done manually and therefore very time consuming. Before this step, there were 3 492 applications regarding sports halls in the data set. All applications marked as *repeated* or *renewed* were removed, reducing the data set to 1 873 applications. The repeated/renewed applications could be removed since both marks indicated that there had been an application on the same project the year before, that consequently was included in the data (marked as *new*) if the previous application was from 1996 or later.

All the *new facilities* with two or more applications were looked through. In some situations, the application regarded a subproject at the facility (for example extra dressing rooms or meeting areas), and these were then removed. In other situations, some applications should have been categorized as *renewed*, but underway in the process, it was discovered that this option did not exist in the first versions of the system. The facilities with more than one application regarding the actual sports hall were investigated in the information system, leading to an evaluation of which application (i.e. which estimated cost) to keep, and which to remove. After this, the 1 873 applications were reduced to 1 313, where 460 of them regarded *new facilities*. The 157 applications still marked as *unknown* were left out, since it was considered too much

work to go through each of them to find out whether they were new facilities or renovation of old facilities.

7.1.3 Data cleaning

The next step of the data preprocessing was to inspect the estimated costs: were they reasonable? The estimated costs were put in boxplots to identify outliers and potential errors. This was done in two parts:

- Part 1: Plotting all the estimated costs for sports halls together and then editing costs when possible (i.e. when finding correct value, otherwise leaving it as it is). The boxplot for all the estimated costs before editing is shown in Figure 7. It can be seen that there are several outliers, with extremely high estimated costs. Each of the outliers had to be investigated further.

- Part 2: Plotting all the estimated costs for the different facility types in subgroups, and then look at the outliers in each subgroup, just as in Part 1 above. The subgroups are:
    - Volleyball halls and small sports halls in one group due to same hall size
    - Basketball halls in one group
    - Normal sports halls in one group
    - Large sports halls in the last group

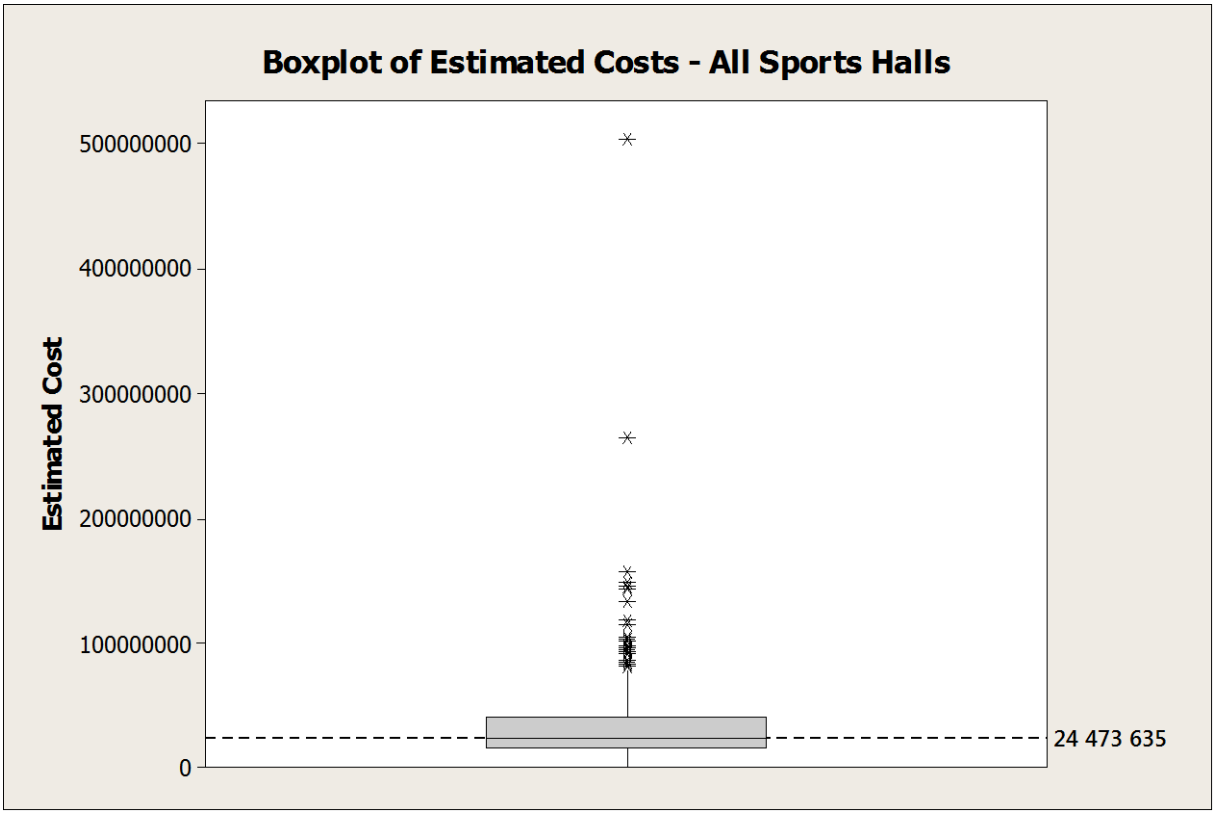

Figure 7: The estimated costs for all sports hall types.

However, one had to be careful in this process. According to my supervisor, there are high diversities in sports hall costs depending on for example region. It is not possible to sort the sports halls into size groups using the cost alone.

In the first part, the median value for estimated cost was 24 473 632 NOK, and the mean was 33 326 518 NOK. The largest outlier had the value 503 825 647 NOK. One encountered problem was that some estimated costs regarded the entire building project (for example, a school or a multi-facility with sports hall, football stadium and swimming pool), and not just the sports hall. In a few cases where the cost was remarkably high, it was possible to find another estimated cost from another application for the same facility, and when so, this cost replaced the original one. For example, in Figure 7, it can be seen that one sports hall has an estimated cost around 500 million NOK. It was found, looking closer at the value in the administrator program, that this was a project including much more than just a sports hall, and the estimated cost for the sports hall was replaced with the estimated cost from a later application on the same facility (where only the cost for the sports hall was used as *estimated cost*).

Even though no outliers with low estimated cost can be detected in Figure 7, these values need to be examined as well. According to *Norsk Prisbok* (Norconsult, 2013), a sports hall costs approximately 35 million in 2013, which in 1996 would correspond to approximately 25 million using the Consumer Price Index service from Statistics Norway (Statistics Norway, 2016a). After a discussion with my supervisor, it was decided to set a lower limit to 15 million with respect to some known low-cost sports halls (as for example Rollaghallen, with an estimated cost of 15 500 000 NOK (Mauno, 2014)). If a sports hall had lower estimated cost than 15 million NOK, it was doubtable that it actually was a new sports hall, and not an extension to the original one. Twenty-three applications with estimated costs lower than 15 million NOK were deleted due to being registered in the wrong *facility group* or due to not being a new facility (but an extension to or renovation of an old facility). However, not all applications where the sports hall had lower estimated cost than 15 million NOK were removed.

The boxplot *after* outlier checking can be seen in Figure 8. The median value for estimated cost was 25 819 726 NOK, and the mean was 33 031 642 NOK. The largest outlier had value 155 977 755 NOK.

The boxplot for Part 2, before outlier checking, is shown in Figure 9. As in Part 1, the outlier values were investigated and if an error was found, this was corrected. Only a few outlier values could be corrected, and the boxplot after outlier checking is shown in Figure 10. A comparison of the means and medians is given in Table 12.

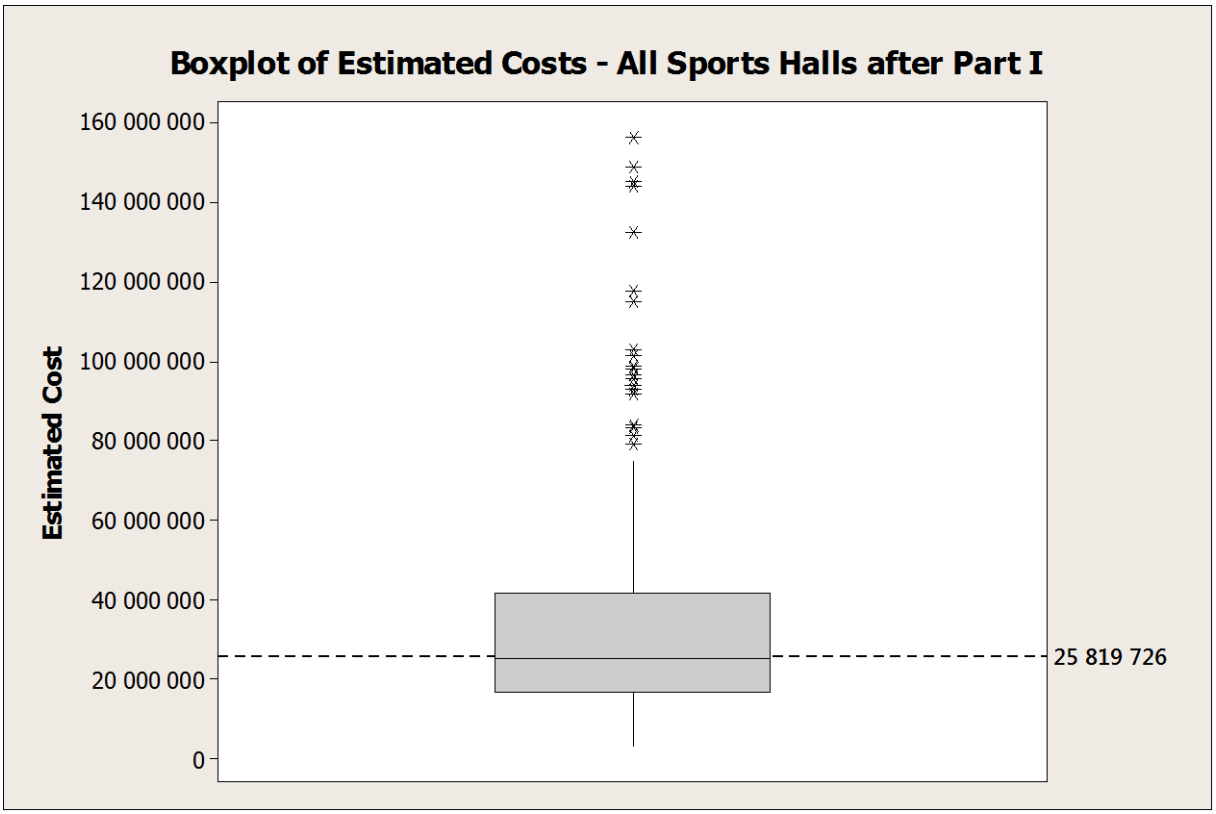

Figure 8: Estimated costs for all different sports halls, after outlier check.

Table 12: Comparison of median and mean values before and after outlier check for estimated cost by facility type.

Facility type	Median before outlier check	Median after outlier check	Mean before outlier check	Mean after outlier check
Small sports hall or volleyball hall	16 654 000 NOK	16 547 500 NOK	19 337 540 NOK	18 744 473 NOK
Basketball hall	30 141 000 NOK	30 141 000 NOK	36 136 059 NOK	36 136 059 NOK
Normal sports hall	27 442 500 NOK	27 200 000 NOK	32 881 257 NOK	32 436 866 NOK
Large sports hall	58 600 000 NOK	58 973 459 NOK	66 330 363 NOK	68 696 683 NOK

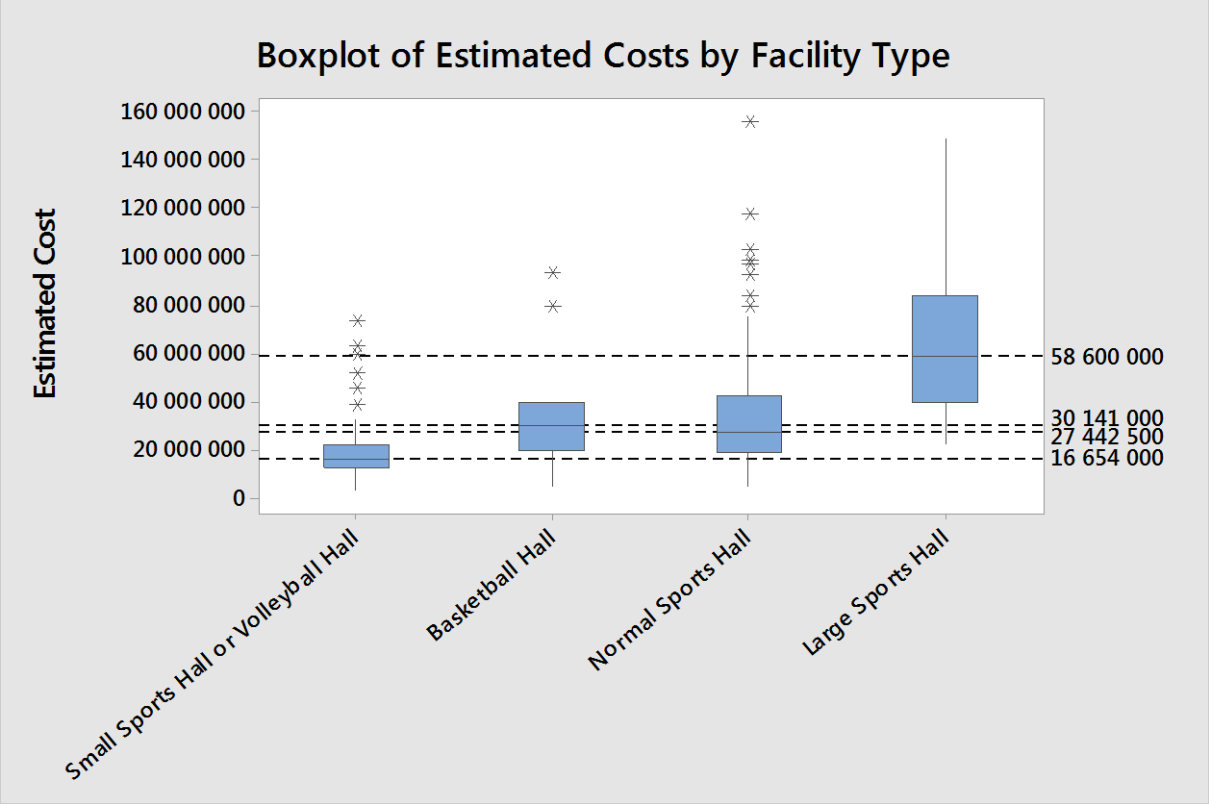

Figure 9: Boxplot of the estimated costs for the different sports hall types, before outlier check.

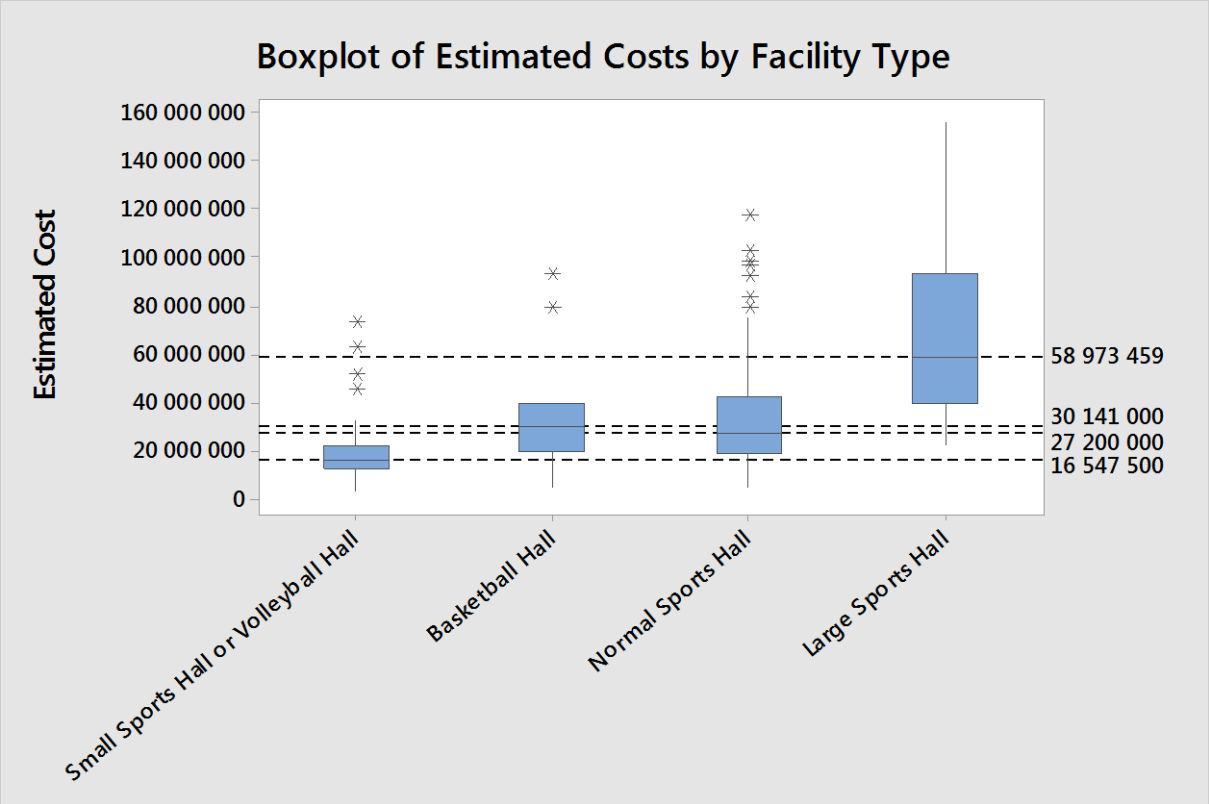

Figure 10: Boxplot of the estimated costs for the different sports hall types, after outlier check.

7.1.4 Data integration

By merging the application data with data from the Sports Facility Register, it was possible to get more information about the sports halls, for example activity surface area, construction year, and more explicit to which municipality the hall belonged. The applications were matched with the facilities in the Sports Facility Register using the *facility number*. With this added information on the sports halls, it was possible to edit the applications further:

- The facility type was changed for those sports halls where the given area for the activity surface indicated that the stated facility type was wrong.
- Facilities where the status was *unrealized* or *planned* (after double-checking with register online) were deleted.
- Facilities with *construction year* before 1996, or after 2015, were deleted. Six facilities were lacking *construction year* and the year for the *application period* was used for imputing the construction years.

Some of the facilities had measures for length and width, which in that case were used to compute the area of activity surface in the hall (if area was missing). For those facilities where the area was specified, but not the length or width, the length and width were estimated to match the given area. All of the sports halls where the size was missing were looked up in the information system associated with *idrettsanlegg.no*, or online, to find the size.

The different sizes for the *facility* types, according to the *Regulations for gaming funds to sports facilities* (Det Kongelige Kulturdepartement, 2015), are given in Table 13. Both volleyball hall and basketball hall are from now on included in small sports hall. However, not all sports halls have the exact activity surface area as the facility type standard, and instead the suggested size intervals based on the defined sizes, also given in Table 13, are used.

Table 13: The defined sizes for each facility type of sports halls, with suggested division in size intervals.

Facility type	Defined size[8]	Size interval, suggestion	Facility type by activity surface area
Small sports hall, volleyball hall, or basketball hall[9]	16 x 24 m (384 m^2)	< 800 m^2	Small sports hall
Normal sports hall	23 x 44 m or 25 x 45 m (1 012 m^2 or 1 125 m^2)[10]	800 - 1 600 m^2	Normal sports hall
Large sports hall	2 x normal sports hall or more (approx. more than 2 000 m^2)	≥ 1600 m^2	Large sports hall

[8] Size according to the *Regulations for gaming funds to Sports Facilities* (*Bestemmelser om tilskudd til anlegg for idrett og fysisk aktivitet)* (Det Kongelige Kulturdepartement, 2015).
[9] The size for a Basketball hall is in fact 19 x 32 m (or 608 m^2, according to the Measurement Book (Målbok for idrettsanlegg (Kulturdepartementet, 2015)).
[10] The defined size from KUD has changed in the period from 1012 m^2 to 1125 m^2 (Det Kongelige Kulturdepartement, 2015).

The interval limits can be discussed, but the strategy was to base the intervals on the *normal sports hall*, which has a size suitable for a handball court. A handball court is 40 m x 20 m (i.e. 800 m^2), and 44 m x 22 m (968 m^2) including safety zones. Thus, the lower limit for a normal sports hall was set to 800 m^2, to make sure that halls where the given area refers to the activity surface area within the lines, and not the activity surface area including the space outside the lines, were included as normal halls. The upper limit was set to the activity surface area of two handball courts.

When using the registered area to decide *facility type* (instead of the registered facility type), 40 sports halls categorized as small, normal or large sports hall in the Sports Facility Register changed facility type. Four of the sports halls categorized as volleyball hall or basketball hall in the Sports Facility Register changed to either normal or large sports hall; the remaining had sizes included in the suggested size interval for small sports hall.

The estimated cost by the new facility type classification is given in Figure 11. The median for small sports hall is 17 000 000 NOK, 27 685 000 NOK for normal sports hall, and 45 000 000 NOK for large sports hall. The mean value for small sports hall is 20 018 442 NOK, 32 703 700 NOK for normal sports hall, and 53 371 413 NOK for large sports hall. These values are not entirely similar to the values found in Table 12.

As last steps, inflation-adjusted estimated costs, inflation-adjusted estimated cost per square meter activity surface, the county regions and the categories behind the municipality groups were added to the material.

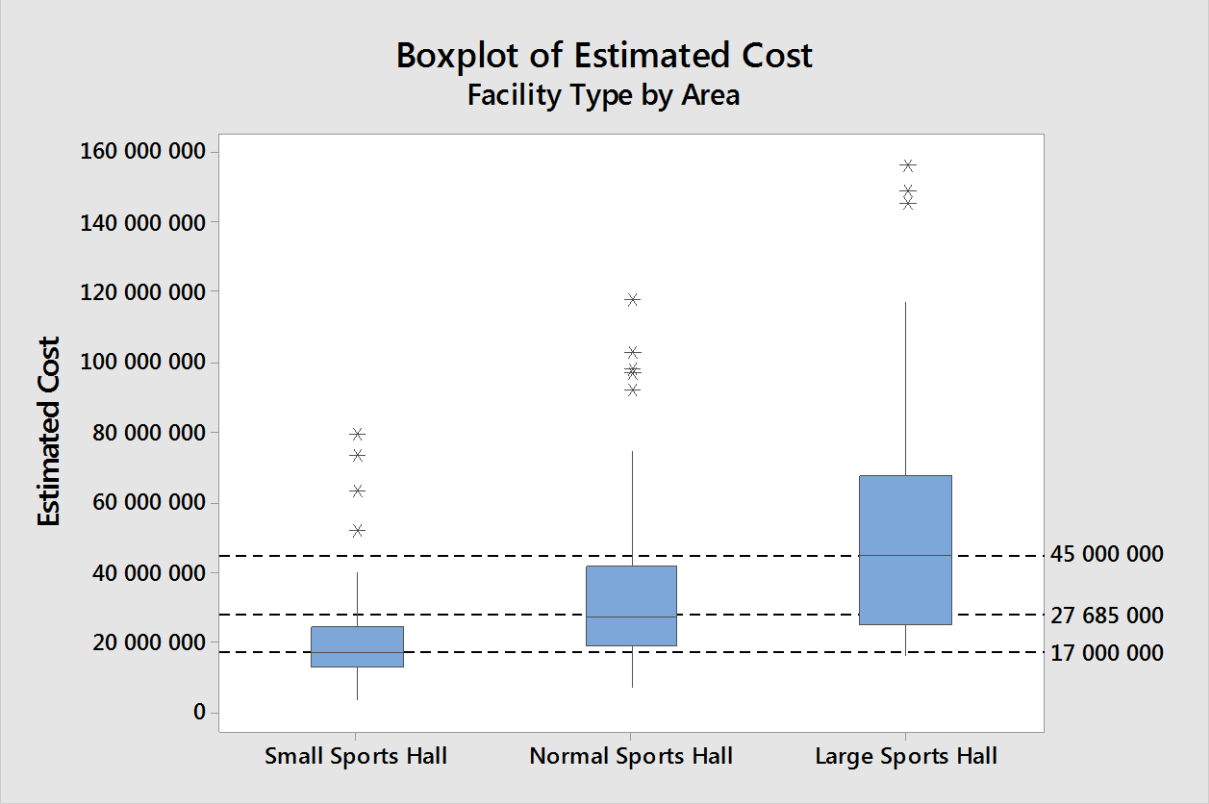

Figure 11: Overview of estimated cost by facility type, using the area intervals.

7.2 Descriptive statistics on the preprocessed data

The sports hall data material that was further analyzed included 357 facilities. The Sports Facility Register, on the other hand, included 480 sports halls[11]. Including the six sports halls with imputed construction year, there would be 486 sports halls: that is, 74 % of the sports halls in the period of interest are included for analysis.

The reasons behind the 26 % missing facilities are many, already given implicitly in previous sections; explicitly some of the reasons are:

- *The estimated cost* in the application is not registered in the information system.
- The facility is incorrectly categorized as a *sports hall*, when it in fact is an addition such as a changing room, a weight training room, a fitness annex, a social area etc., or another kind of sports facility, as an indoor football hall or an indoor athletics stadium etc.
- The application from the information system lacks the field *the application regards*[12].

There can also be facilities in the Sports Facility Register, wrongly registered as sports halls, which have been removed from the application data during the preprocessing.

In the Sports Facility Register, 240 municipalities have one or more sports halls built between 1996 and 2015, to be compared to 193 municipalities in the material. As can be seen in Table 14, all counties are represented with six or more sports halls. The county of Telemark can be considered best in reporting sports hall figures, due to 94 % coverage in the preprocessed data of the actual number of sports halls. Apart from Svalbard, the county of Troms has the smallest proportion covered with only 33 %. If one instead looks at the regions in Table 15, the coverage is more even, varying between 63 % - 78 %.

[11] Sports halls built between 1996 and 2015, marked as *existing* in the register per March 20, 2016.
[12] *All* applications between 2008 and 2015 have the field *the application regards* filled in. Between 1996 and 2007 there are just 103 of 1 590 sports hall applications with *the application regards* filled in.

Table 14: Number of the counties' sports halls built between 1996 and 2015 that are represented in the preprocessed data.

County	Number of sports halls in the preprocessed data	Number of sports halls in the Sports Facility Register built between 1996 and 2015	
Akershus	42	54	78 %
Aust-Agder	10	12	83 %
Buskerud	21	29	72 %
Finnmark	7	10	70 %
Hedmark	13	15	87 %
Hordaland	51	65	78 %
Møre og Romsdal	19	25	76 %
Nord-Trøndelag	10	15	67 %
Nordland	19	23	83 %
Oppland	7	12	58 %
Oslo	22	29	76 %
Rogaland	36	46	78 %
Sogn og Fjordane	11	15	73 %
Svalbard[13]	0	1	0 %
Sør-Trøndelag	22	32	69 %
Telemark	16	17	94 %
Troms	6	18	33 %
Vest-Agder	21	26	81 %
Vestfold	11	19	58 %
Østfold	13	23	57 %

Table 15: Overview of the number of sports halls per county-region built between 1996 and 2015 represented in the preprocessed data.

Region	Counties	Number of sports halls in the preprocessed data	Number of sports halls in the Sports Facility Register built between 1996 and 2015	
East	Østfold, Akershus, Hedmark, and Oppland	75	104	72 %
Oslo	Oslo	22	29	76 %
South	Buskerud, Vestfold, Telemark, Aust-Agder, and Vest-Agder	79	103	77 %
West	Rogaland, Hordaland, and Sogn og Fjordane	98	126	78 %
Mid-Norway	Møre og Romsdal, Sør-Trøndelag, and Nord-Trøndelag	51	72	71 %
North	Nordland, Troms, and Finnmark	32	51	63 %

[13] Svalbard is not a municipality in Norway, but included in the Sports Facility Register.

All of the 15 municipality groups are represented with at least 50 % coverage of the built sports halls during the specified time, as can be seen in Table 16. All of the five sports halls built in municipalities belonging to group 16 (which are the ten municipalities with the highest free disposable income per inhabitant) are represented.

Table 16: Overview of the number of sports halls built in the different municipality groups between 1996 and 2015 that are represented in the preprocessed data.

Municipality group	Number of municipalities in the group	Number of sports halls in the preprocessed data	Number of sports halls in the Sports Facility Register built between 1996 and 2015	
Group 1	21	8	10	80 %
Group 2	60	15	25	60 %
Group 3	35	11	16	69 %
Group 4	15	4	6	67 %
Group 5	40	12	17	71 %
Group 6	47	19	21	90 %
Group 7	31	30	41	73 %
Group 8	23	26	32	81 %
Group 10	21	6	12	50 %
Group 11	53	31	50	62 %
Group 12	19	14	20	70 %
Group 13	49	117	150	78 %
Group 14	3	37	51	73 %
Group 15	1	22	29	76 %
Group 16	10	5	5	100 %
Without group	1	0	1	0 %

Less than half of the sports halls in the Sports Facility Register built in 1997, 1999, and 2007, were possible to include in the preprocessed data. A full overview for each year is given in Table 17. *All* of the sports halls built in 2009 (and almost all built in the adjacent years 2008 and 2010) are represented in the preprocessed data. Only a third of the built sports halls in 2007 are represented.

The different types of sports halls (as stated in the applications, and not as imputed by the area) are covered with 60 % or more, as can be seen in Table 18. If the smaller types, i.e. basketball hall, volleyball hall, and small sports hall, are looked upon as a group, the types are covered with 70 % (large sports hall), 73 % (normal sports hall), and 77 % (the group of the smaller sports halls).

Table 17: Overview of the number of sports halls built each year that are represented in the preprocessed data.

Construction year	Number of sports halls in the preprocessed data	Number of sports halls in the Sports Facility Register built between 1996 and 2015	
1996	6	11	55 %
1997	9	19	47 %
1998	13	22	59 %
1999	8	17	47 %
2000	15	19	79 %
2001	15	20	75 %
2002	16	22	73 %
2003	15	29	52 %
2004	16	28	57 %
2005	22	25	88 %
2006	17	22	77 %
2007	7	21	33 %
2008	20	22	91 %
2009	28	28	100 %
2010	30	31	97 %
2011	32	42	76 %
2012	32	38	84 %
2013	22	28	79 %
2014	25	31	81 %
2015	9	11	82 %

Table 18: Overview of the number of the different sports hall types built between 1996 and 2015 that are represented in the preprocessed data, according to original facility type.

Facility type, original	Number of sports halls in the preprocessed data	Number of sports halls in the Sports Facility Register built between 1996 and 2015	
Basketball hall	6	10	60 %
Large sports hall	26	37	70 %
Normal sports hall	232	320	73 %
Small sports hall	66	83	80 %
Volleyball hall	27	36	75 %
Small sports hall, basketball hall or volleyball hall	*99*	*129*	*77 %*

7.3 Average costs and hypothesis testing of equal means

In the following sections, the average estimated costs per activity surface area, and average estimated costs for the three different *facility types* (small, normal, and large sports halls) are presented and tested. Although, the statistics from the registers are *fixed* since they have been extracted from a complete register (i.e. census): the average estimated costs per activity surface and the average estimated costs for the different facility types have been what they have been. Nevertheless, the tests can give an indication that the differences have been remarkably large.

7.3.1 Estimated cost per activity surface area for the different facility types

In the preprocessed application data for sports halls, there are 46 large sports halls, 207 normal sports halls, and 104 small sports halls. The inflation-adjusted estimated costs per square meter activity surface are presented for each sports hall type in Figure 12. As can be seen in the figure, there have been a larger spread in square meter activity surface costs for the small sports halls than it has been for the other two types. The average and the median square meter costs are given in Table 19. Small sports halls have had an average square meter activity surface cost twice as big as the cost per square meter activity surface for a large sports hall.

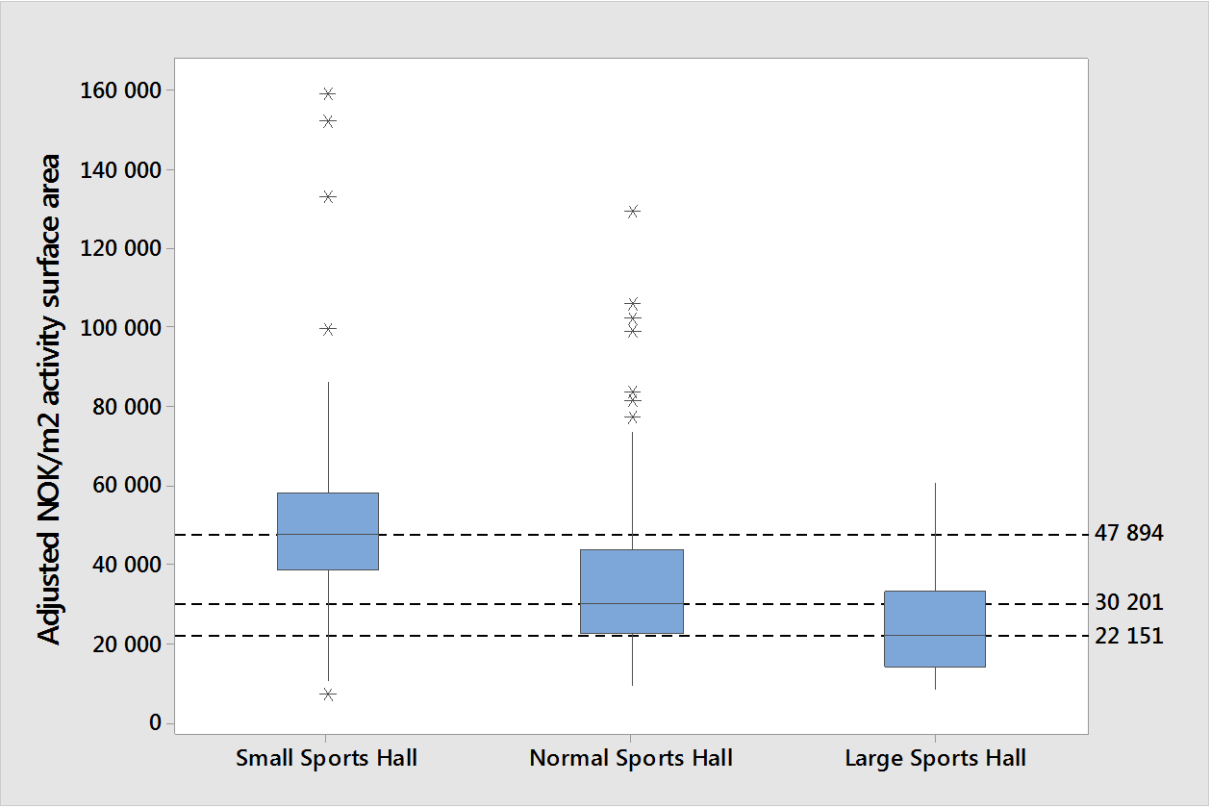

Figure 12: Inflation-adjusted cost per square meter activity surface for the different types of sports halls.

Table 19: Average and median square meter activity surface costs.

Facility type	Mean value	Median value
Small sports hall	50 810 NOK/m^2	47 894 NOK/m^2
Normal sports hall	35 439 NOK/m^2	30 201 NOK/m^2
Large sports hall	24 975 NOK/m^2	22 151 NOK/m^2
Sports hall, overall	**38 568 NOK/m^2**	**33 961 NOK/m^2**

The costs can be compared to those from Holte (2014), and from Norconsult (2013), found in Table 20. These figures are given together with inflation-adjusted figures in parenthesis. The activity surface area as well as the cost per square meter activity surface in the table are not from the firms, but estimated within this work. The inflation-adjusted costs from the two firms are between 32 300 NOK - 51 400 NOK per square meter activity surface, and in Figure 13, one can see these limits together with boxplots for the sports halls.

Table 20: Consultant firms cost examples, with inflation-adjusted costs (to 2015) in parenthesis.

		BTA [m^2]	Assumed activity surface [m^2]	Cost per BTA [NOK/m^2]	Cost [NOK]	Cost per square meter activity surface [NOK/m^2]
Holte 2014	Simple standard sports hall	2 482	*1 125*	16 443 (16 792)	40 811 526 (41 676 730)	*36 277 (37 046)*
	Regular standard sports hall	2 482	*1 125*	19 893 (20 315)	49 374 426 (50 421 164)	*43 888 (44 818)*
	High standard sports hall	2 482	*1 125*	22 814 (23 298)	56 624 348 (57 824 784)	*50 333 (51 400)*
Norconsult 2013	Sports hall (including changing rooms and café)	5 500	*2 250*	16 453 (17 139)	90 492 600 (94 266 141)	*40 219 (41 896)*
	Sports hall (just the hall)	1 400	*1 125*	24 921 (25 960)	34 888 980 (36 343 850)	*31 012 (32 305)*
	Sports hall passive house (just the hall)	1 400	*1 125*	26 285 (27 381)	36 798 300 (38 332 789)	*32 710 (34 074)*

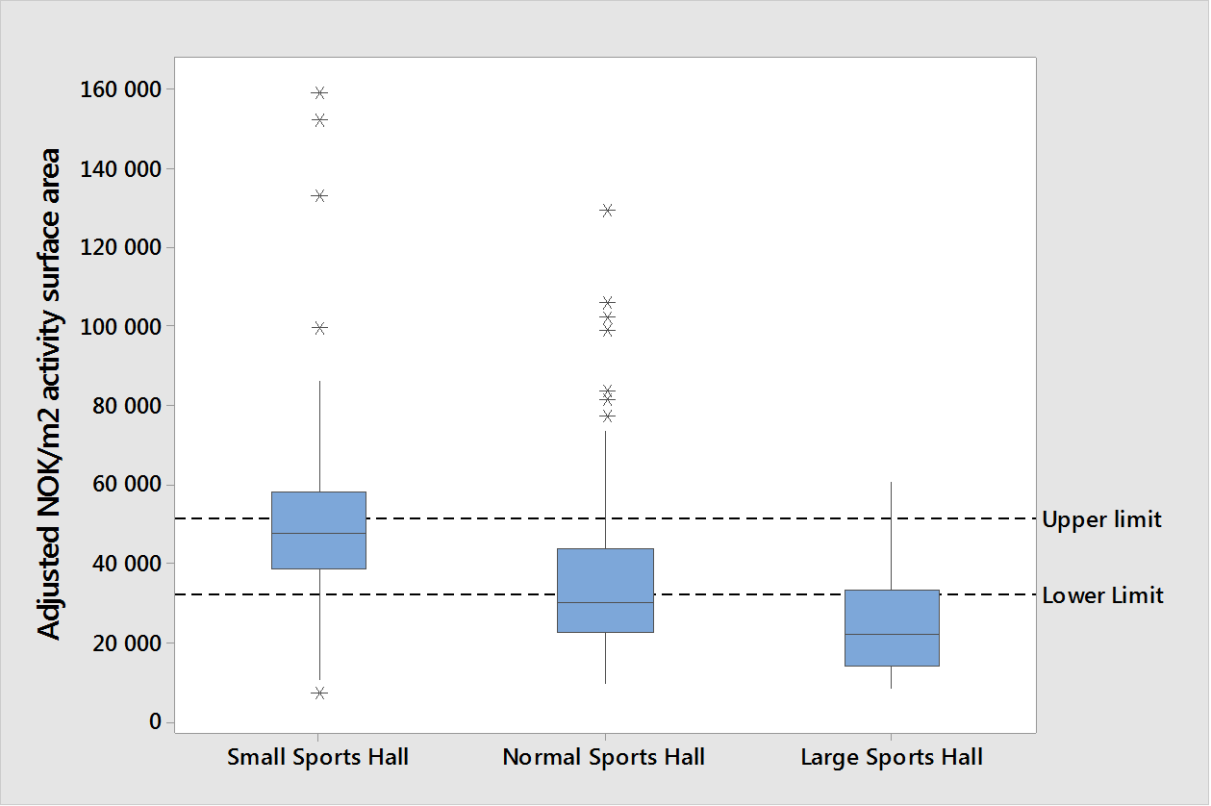

Figure 13: Inflation-adjusted cost per square meter activity surface, with the upper and lower limit from the costs in Table 20 as references.

Hypothesis Test

In Table 19, one can see what the differences in the average cost per square meter activity surface. The purpose of following hypothesis testing is to test if the facility types means are considerably different from each other.

The effects model for the cost per square meter activity surface is

$$\begin{matrix} cost\ per\ activity \\ surface\ area_{ij} \end{matrix} = \mu + \tau_i + \epsilon_{ij} \begin{cases} i = 1,2,3\ or\ small, normal, large \\ j = 1, \dots, n_i \end{cases}. \qquad (15)$$

In this case, n is different for the different types ($n_{small} = 104$, $n_{normal} = 207$, and $n_{large} = 46$), which means that the design is unbalanced.

The Minitab Assistant was used, choosing *Hypothesis testing* and *One-Way ANOVA*. In the diagnostic report in Figure 14, it can be seen that 12 observations (marked with red squares) are unusual compared to the other observations with the same facility type. Eleven of these are larger than the other values and one is smaller. The unusual observations were investigated to see if there had been any mistake recording the value. This did not lead to any changes. One of the sports halls categorized as unusual is built under the ground, which probably can explain the high cost. Another sports hall is very simple, without standard sports hall facilities such as changing rooms and is found as the bottom outlier in Figure 14.

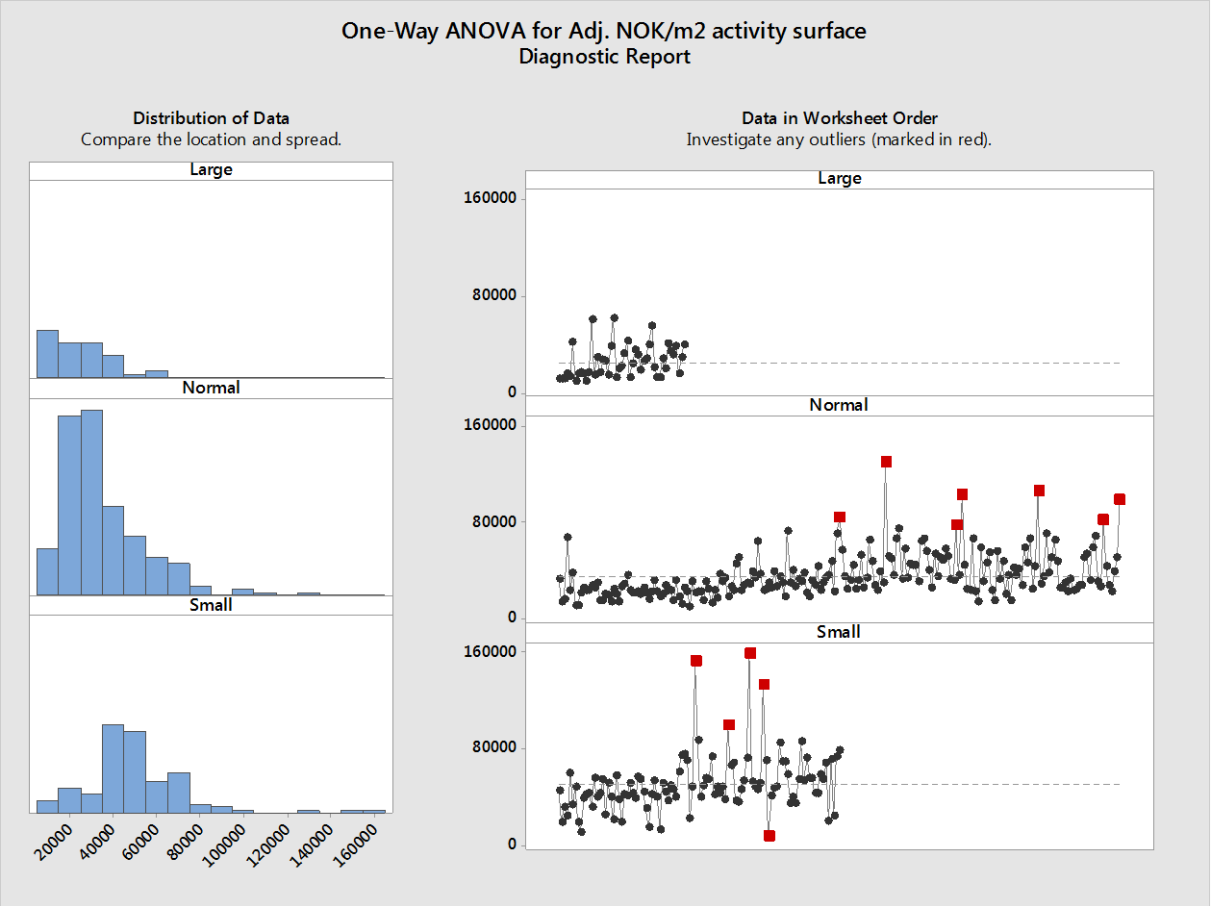

Figure 14: Diagnostic report from Minitab 17 assistant, One-Way ANOVA.

The results shown in Figure 15 indicate that the facility type means differ significantly from each other. Small sports halls have cost more per square meter activity surface than normal sports halls, and normal sports halls have costed more per square meter activity surface than large sports halls. According to the *Distribution of Data* in Figure 14, neither large nor normal sports halls' estimated costs per square meter activity surface could be considered to follow a normal distribution.

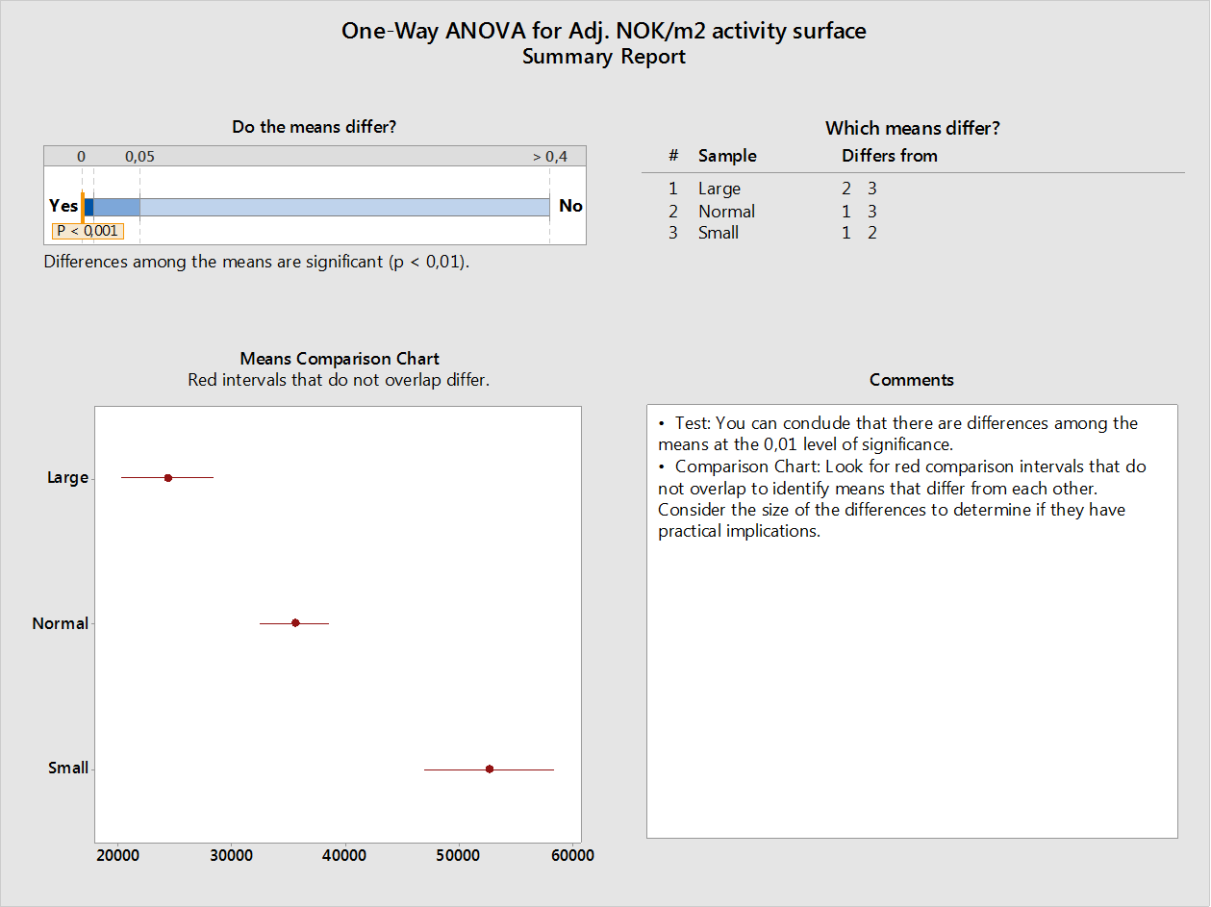

Figure 15: Summary for the One-Way ANOVA, including unusual data points.

The One-Way ANOVA was then redone, excluding the unusual observations to see what effect the unusual observations have had on the mean costs. Since there is lacking information in the information system about special circumstances that could have increased the cost, it is interesting to see if the average values change without the unusual observations. However, when redoing the analysis, other observations were considered unusual data points. These were removed and the One-Way ANOVA was preformed again. This was repeated three times, until no halls were categorized as unusual data points. The mean values for the remaining 336 sports halls are given in Table 21. Since no large sports hall was classified as an unusual observation, the average square meter activity surface cost does not differ for these. For the small and normal sports halls, on the other hand, the average square meter activity surface cost, without unusual observations, has been approximately 48 000 NOK/m2 activity surface (compared with 50 810 NOK/m^2 activity surface) for small sports halls and 33 000 NOK/m^2 activity surface (compared with 35 000 NOK/m^2 activity surface) for normal sports halls. The facility type means were still significantly different from each other. Overall, the average cost per square meter activity surface has been approximately 36 000 NOK/m^2 if one eliminates the unusual observations.

One can see that it has costed approximately 17 million NOK less to build one large sports hall with two full handball-sized activity surfaces instead of two separate (normal) sports halls[14].

Table 21: Mean values for the different facility types before and after exploring and removing the unusual data points.

Facility type	Mean value	Mean value after outlier elimination
Small sports hall	50 810 NOK/m^2	47 729 NOK/m^2
Normal sports hall	35 439 NOK/m^2	32 695 NOK/m^2
Large sports hall	24 975 NOK/m^2	24 975 NOK/m^2
Sports hall, overall	**38 568 NOK/m^2**	**35 799 NOK/m^2**

7.3.2 Estimated costs for the different facility types

The estimated costs for the entire sports halls are presented in this section. The average cost, independent of type, has been approximately 36 million NOK. In Figure 16, one sees the spread in estimated costs (inflation-adjusted) for the three different facility types. The average and median costs per facility type are given in Table 22. The mean values are larger than the median values, indicating that some sports halls have much larger estimated costs than the other halls within each type. Compared to the costs from Holte and Norconsult in Table 20, the estimated mean costs from the data set have been lower.

Hypothesis Test
In Table 22, one can see what the differences in the average costs have been. The purpose of the following hypothesis testing is to examine if the differences between the facility types means have been considerably big.

The effects model for the cost is of the same type as in the previous test:

$$cost_{ij} = \mu + \tau_i + \epsilon_{ij} \begin{cases} i = 1,2,3 \; or \; small, normal, large \\ j = 1, \dots, n_i \end{cases} \quad (16)$$

Minitab 17 Assistant was used to perform a One-Way ANOVA on the costs depending on the different facility types. As in the previous test, unusual data points were observed in the material (three in large sports halls[15], six in normal sports halls, and five in small sports halls). Without taking this into consideration, there have been significant differences in mean costs for small, normal, and large sports halls.

[14] The values are calculated as $2 \cdot 1\,125\ m^2 \cdot 24\,975\ NOK/m^2 = 56\,193\,750\ NOK$ for a large sports hall and $2 \cdot 1\,125\ m^2 \cdot 32\,695\ NOK/m^2 = 73\,563\,750\ NOK$ for two normal sports halls.
[15] Two outliers have nearly the same value, with makes it hard to see that there are three outliers for *large sports hall* in Figure 16.

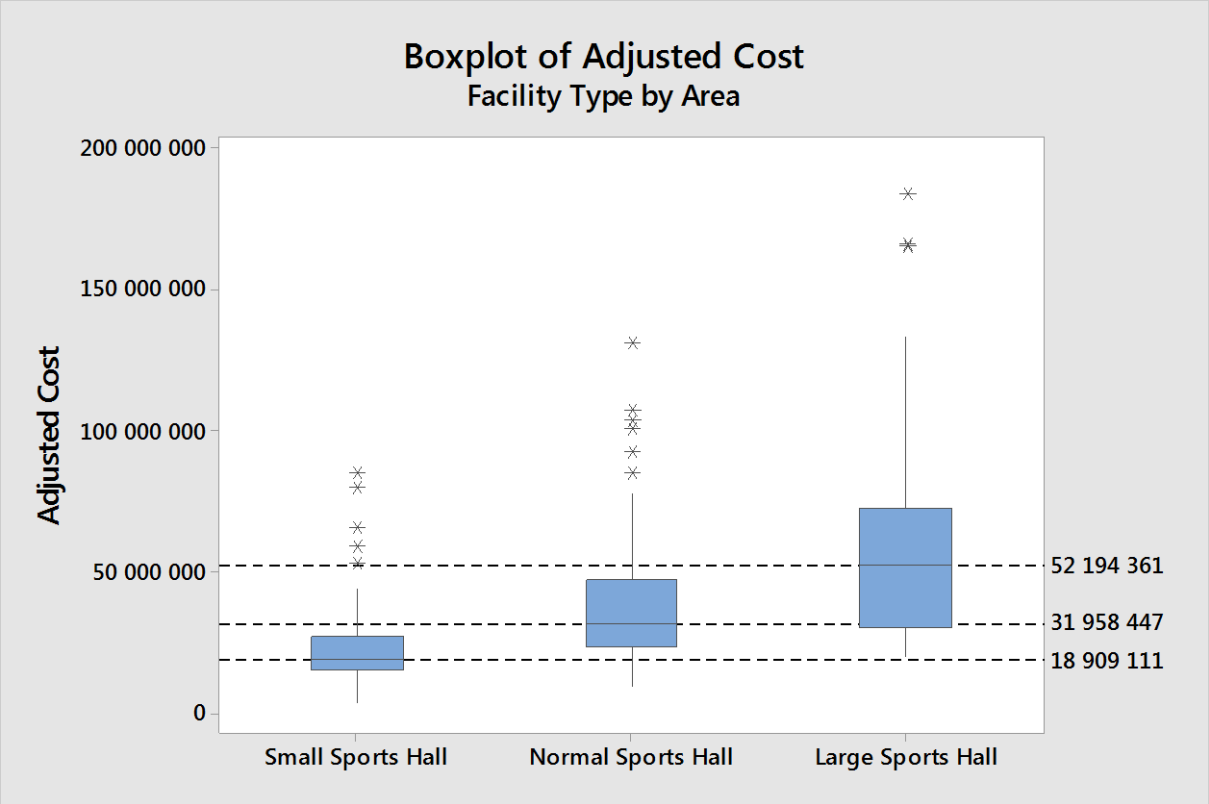

Figure 16: Inflation-adjusted estimated cost by facility type, using the area intervals.

Removing the unusual data points and redoing the analysis until no sports halls were classified as unusual data points, did not lead to non-significant differences in mean for estimated costs. The means (and medians) are given in Table 22, together with the values including unusual observations. According to these figures, in average it would have costed less to build one normal sports hall instead of two small sports halls, and one large sports hall instead of two normal sports halls. Looking at Figure 16, one sees that there are overlaps in costs for all three facility types, meaning that in several cases, a small sports hall has costed as much as a normal (or sometimes even a large) sports hall, and that some normal sports halls have costed as much as a large sports hall.

Table 22: Inflation-adjusted median and mean estimated cost before removal of unusual observations, and after removal of unusual observations.

	Median cost	Median cost, unusual observations removed	Mean cost	Mean cost, unusual observations removed
Small sports hall	18 909 111 NOK	18 494 797 NOK	22 445 463 NOK	19 194 538 NOK
Normal sports hall	31 958 447 NOK	31 441 854 NOK	36 983 736 NOK	34 588 138 NOK
Large sports hall	52 194 361 NOK	46 732 764 NOK	60 569 516 NOK	50 908 884 NOK
Sports hall, overall	28 541 982 NOK	27 362 965 NOK	35 787 561 NOK	32 354 206 NOK

7.4 Regression models of the costs

Linear regression models were used to analyze estimated costs (inflation-adjusted), to see which factors that have influenced the cost. The costs versus the area of the activity surface are given in the scatterplot in Figure 17. The red line corresponds to the model

$$cost = \alpha + \beta \cdot area. \tag{17}$$

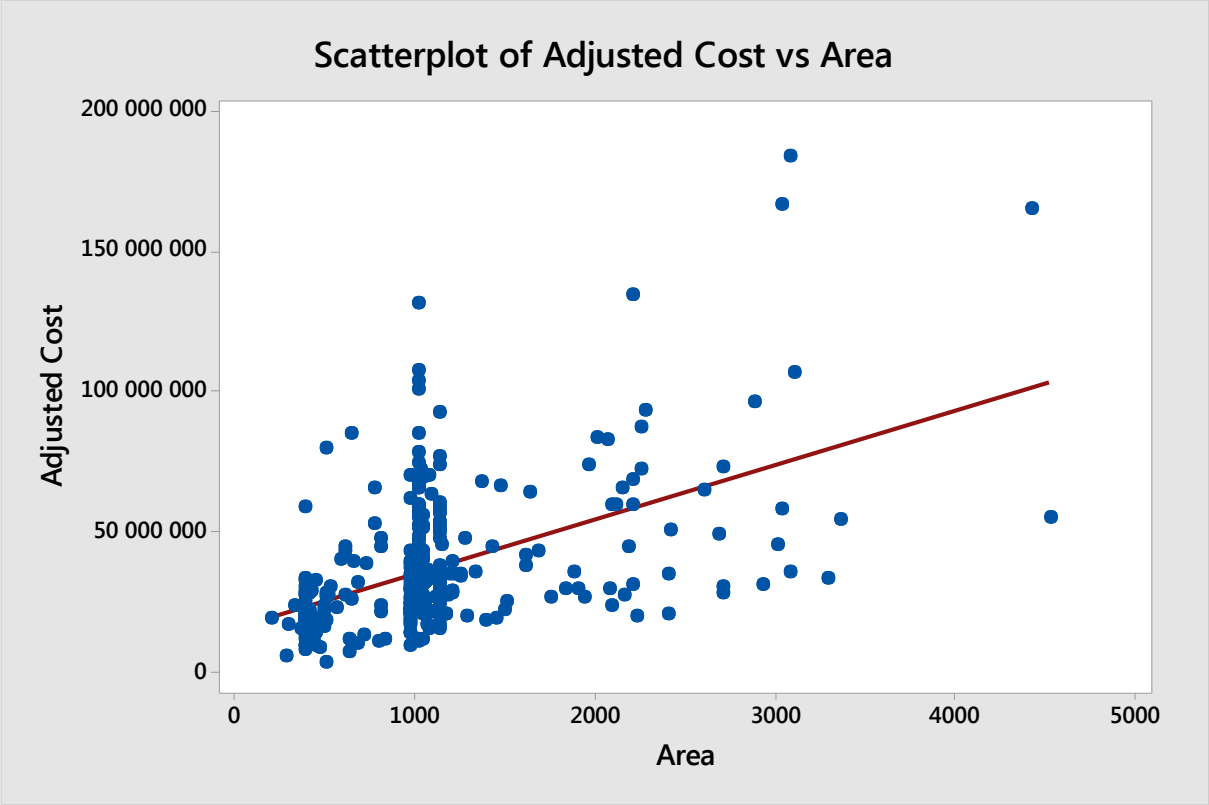

Figure 17: Scatterplot of the inflation-adjusted costs versus activity surface area.

The coefficients α and β are estimated with Minitab, and the first suggested model (called model 0) is

$$cost = 15\,339\,569 + 19\,341 \cdot area. \tag{18}$$

This simplistic model says that the estimated cost for building a sports hall is a fixed cost of approximately 15 million NOK plus a variable cost of approx. 19 000 NOK/m^2 activity surface. The standard error of the coefficient to area is 1 682. Both the value for the constant α and for the coefficient β are significant.

Using model 0 to describe standard sized sports hall, the costs are:

- For a small sports hall with 384 m^2 activity surface: approx. 23 million NOK
- For a normal sports hall with 1 125 m^2 activity surface: approx. 37 million NOK
- For a large sports hall with 2 250 m^2 (3 375 m^2) activity surface: approx. 59 million NOK (81 million NOK)

It can be seen in Figure 17 that the relationship between the *estimated cost* and the *area* (marked as a red line in the figure) is probably not enough to explain the variation in costs. The coefficient of determination, R^2, is 27.1 % (the adjusted coefficient of determination, R^2_{adj}, is 26.9 %). This indicates that a regression model just including the area as a predictor variable only can explain 27.1 % of the variation in costs. Looking at the spread in costs for sports halls with activity surface area between 1 000 m^2 and 1 200 m^2, the cost range is 10 million NOK to 131 million NOK. The other available attributes for the sports halls might explain more of the cost variation, other what can be explained by the area differences. Nonetheless, it is no guarantee that the available attributes for the sports halls are enough to explain the variation in costs completely.

Area and *construction year* are quantitative, all of the other attributes are qualitative/categorical. To handle the categorical variables, the model must include indicator variables.

The *municipalities* are too many to use (there are 194 different municipalities in the material; 58 municipalities have more than one sports hall in the material, and only 11 have five or more sports halls). Therefore, the *municipality groups* from Statistics Norway (Langørgen, Løkken, & Aaberge, 2013) were intended to be used instead of municipalities. If one looks at the number of sports halls per municipality group in Table 16, one can see that 14 out of 15 groups have five or more sports halls in the material. Still, the 15 categories for municipality group are also too many. However, the municipality grouping is based on the three factors *number of inhabitants*, *tied costs per inhabitant*, and *free disposable income per inhabitant*: these factors are used instead of the municipality groups.

The *construction years* were coded with *0* for 1996, *1* for 1997, …, and *19* for 2015. Using the construction years as continuous variables yielded a lower R^2 than using the years as categorical variables, but using continuous variables catches a linear trend (if present) and the overall trend is considered more interesting than the effects from specific years.

A problem could be correlation between variables (attributes), that some of the attributes explain the same variation. For example, facilities in Oslo have Oslo as both municipality and county, and Oslo is the only municipality included in municipality group 15. Another example is *facility type*, which is a categorization based on the activity surface *area*, and these two attributes cover the same variation. It must be decided which of the attributes that describe the variation the best (which of the correlating variables to choose and how to modify attributes so that the correlation decreases). In Table 23, the coefficient of determination R^2 and adjusted coefficient of determination R^2_{adj} for each attribute are given, when only using that attribute in a regression model.

Table 23: Attributes and their stand-alone coefficients of determination and adjusted coefficients of determination.

Attribute		R^2	R^2_{adj}
Area	Size	27.1 %	26.9 %
Facility type	Size	22.1 %	21.7 %
Construction year (categorical)	Time	16.7 %	12.1 %
Construction year (continuous)	Time	11.2 %	10.9 %
Application period	Time	14.3 %	9.5 %
Municipality group	Municipal information	13.1 %	9.5 %
Number of inhabitants (categorized)	Municipal information	9.5 %	9.0 %
County	Geographical	13.3 %	8.7 %
County-region	Geographical	6.4 %	5.3 %
Tied costs per inhabitant (categorized)	Municipal information	5.0 %	4.5 %
Free disposable income per inhabitant (categorized)	Municipal information	1.9 %	1.4 %
Municipality	Geographical	53.6 %	0.0 %

The first suggested model includes almost all the available attributes, choosing only one of the attributes that describes the same property. The chosen attributes are:

1. *Area* (activity surface area has a higher R^2 than *facility type* and contains more information, since it is not grouped).
2. *Construction year*, coded 0 for 1996, 1 for 1997 and so on, (since the costs already are adjusted for inflation, the overall trend is more interesting than each year).
    - Called *years after 1996* in the models.
3. *County-regions* (fewer categories within this group than in *county*), with Oslo extracted to its own group.
    - Called *region* in the models, with potential values East, Mid-Norway, North, Oslo, South, and West.
    - Coding: Oslo as reference level
4. Number of inhabitants in municipality (categorized)
    - Called *population* in the models, with levels Large, Medium, Small.
    - Coding: Large as reference level
5. Tied costs per inhabitant
    - Called *tied costs* in the models, with levels Large, Medium, Small.
    - Coding: Large as reference level
6. Free disposable income per inhabitant
    - Called *free income* in the models, with levels Large, Medium, Small.
    - Coding: Large as reference level

In the following sections, some regression models are suggested and compared. To find the best model, the least significant contributing variable in the model was removed before testing a new model (i.e. the variable where the p-value for the coefficient does not give a reason to reject the null hypothesis that the coefficient is zero). This procedure continued until all variables were significant.

7.4.1 Model 1a: Full model

Model 1a is, with simplified expressions for the indicator variables:

$$cost = \alpha + \beta_1 \cdot area + \beta_2 \cdot years\ after\ 1996 + \beta_3 \cdot D_{region} +$$
$$+\beta_4 \cdot D_{population} + \beta_5 \cdot D_{tied\ costs} + \beta_6 \cdot D_{free\ income} + \epsilon. \quad (19)$$

The coefficients were estimated with Minitab, and the ANOVA for the model and the coefficients are presented in Appendix D – Model 1a. The R^2 and R^2_{adj} of Model 1a is 48.2 % and 46.2 %, respectively. There are 14 observations with remarkably high residuals that are potential outliers. The histogram in the residual plot in Figure 18 implies that the residuals are somewhat normally distributed. In the normal probability plot in the same figure, one can see that many residuals do not follow the normal line: There is a tendency of the normal probability plot to bend down on the right side, implying that the right tail of the error distribution is somewhat thicker than what is expected for a normal distribution. Looking at the fitted value versus the residuals, one can see that the residual size increases with increased fitted value – the variance does not seem to be constant. The assumption of normally distributed errors seems to be unfulfilled. In section 7.5, the observations with large residuals are examined and new regression models are fitted to the reduced data.

From the ANOVA, one sees that five regression variables are significant at significance level of 0.05. *Tied costs* is least significant (with a p-value of 0.74). Looking at the coefficients (the β's), 8 out of 13 are significant at level 0.05, i.e. the null-hypothesis that these coefficients are equal to zero is rejected. *Tied costs* have the least significant coefficients. When looking at the VIF's for each of the coefficients, the VIF for the *area*-coefficient and the VIF for the *years after 1996*-coefficient are almost equal to one (1.03 and 1.06 respectively), which means that these two predictors are not correlated to other predictors. The rest of the coefficients are moderately correlated (their VIF's are between 1.84 and 4.30), except for *tied costs = small*, which is highly correlated with VIF equal to 7.88. The lack-of-fit has a p-value of 0.65, implying that there is no evidence that Model 1a does not fit the data. All numbers are found in Appendix D: Model 1a.

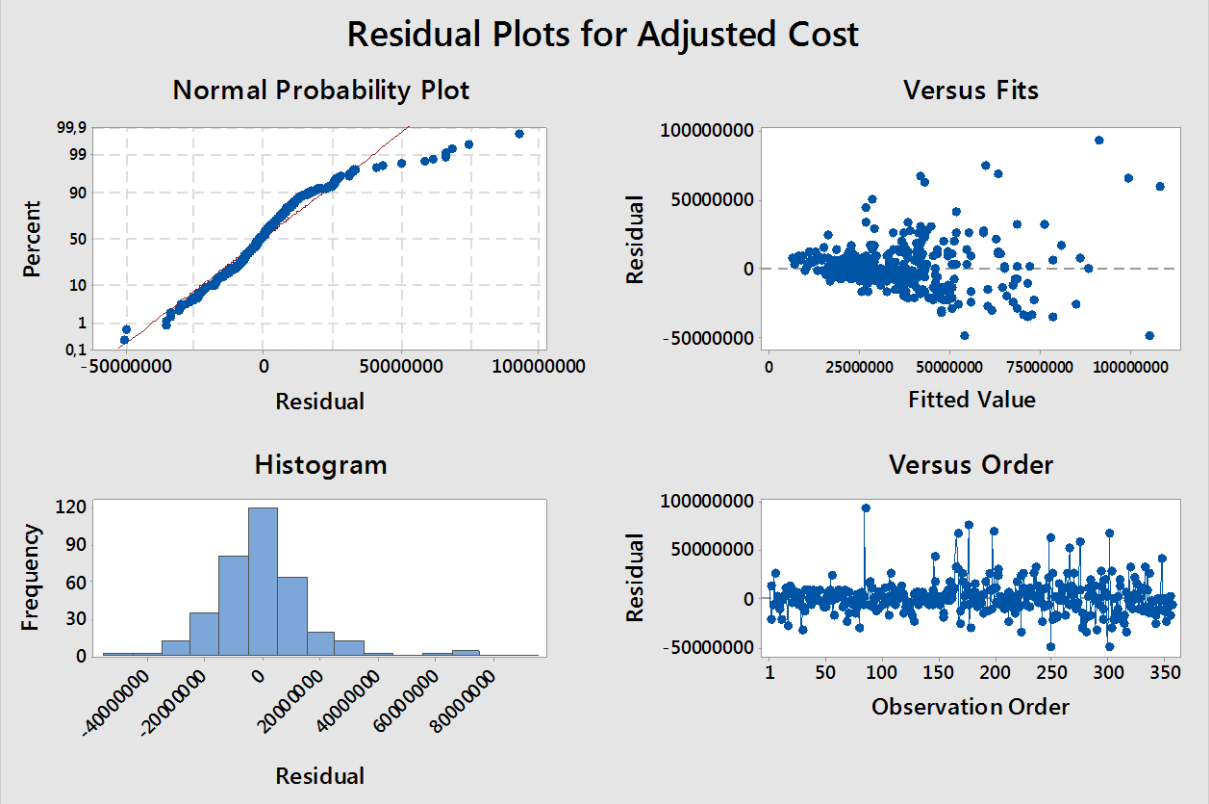

Figure 18: Residual plots for Model 1a.

7.4.2 Model 1b: Reduced model by one regressor

Removal of the factor with least significant effect and coefficients (i.e. *tied costs*) from Model 1a yields Model 1b:

$$cost = \alpha + \beta_1 \cdot area + \beta_2 \cdot years\ after\ 1996 + \beta_3 \cdot D_{region} +$$
$$+\beta_4 \cdot D_{population} + \beta_5 \cdot D_{free\ income} + \epsilon. \quad (20)$$

The R^2 and R^2_{adj} of Model 1b is 48.1 % and 46.4 %, respectively. R^2 has decreased slightly by reducing the model with one factor, and R^2_{adj} has increased slightly. There are still 14 observations with remarkably high residuals. The residual plots in Figure 19 are very similar to the plots for Model 1a in Figure 18.

From the ANOVA, one sees that four out of five regression variables are at significance level of 0.05 (the only non-significant factor is *free income*). For the regression coefficients, 9 out of 11 are significant at level of 0.05. *Free income* has the least significant coefficients. The VIF's for the coefficients are still indicating that there is no correlation between predictors for the *area*- and *years after 1996*-coefficients (1.03 and 1.06 respectively). All the other coefficients have VIF's between 1.31 and 4.28, indicating moderate correlation. The lack-of-fit has a p-value of 0.48, implying that there is no evidence that Model 1a does not fit the data. All numbers are found in Appendix D: Model 1b.

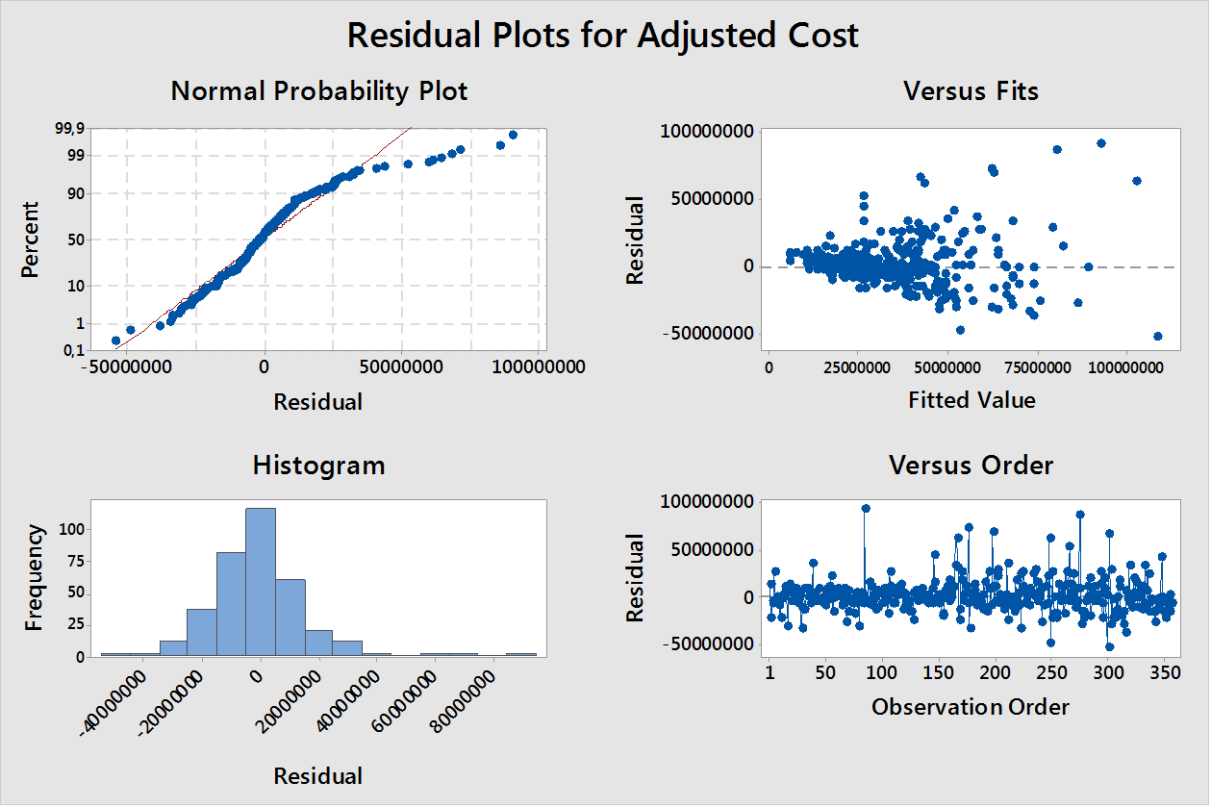

Figure 19: Residual plots for Model 1b.

7.4.3 Model 1c: Reduced model by two regressors

Removal of the factor with least significant effect in Model 1b (i.e. *free income*) yields Model 1c:

$$cost = \alpha + \beta_1 area + \beta_2 years\ after\ 1996 + \beta_3 D_{region} + \beta_4 D_{population} + \epsilon. \quad (21)$$

The R^2 and R^2_{adj} of Model 1c is 48.0 % and 46.6 %, respectively. R^2 has decreased slightly and R^2_{adj} has increased slightly. There are now 16 observations with remarkably high residuals. The residual plots in Figure 20 are very similar to the plots for Model 1a and for Model 1b in Figure 18 and Figure 19, respectively. From the ANOVA, one sees that all regression variables are at significance level of 0.05 (and even at 0.001). All nine regression coefficients are significant, with largest p-value of 0.007 (*population = small*). The VIF's are almost equal to one for the *area* coefficient and for the *years after 1996*-coefficient (1.02 and 1.05 respectively), implying no correlation. For the other coefficients, the VIF's are between 1.22 and 4.26, implying moderate correlation. The lack-of-fit has a p-value of 0.20. All numbers are found in Appendix D: Model 1c.

Model 1c (with values) is:

$$cost = 23\,840\,899 + 18\,930 \cdot area + 1\,331\,520 \cdot years\ after\ 1996 +$$
$$+ \begin{cases} -19\,174\,931\ if\ region = East \\ -14\,183\,826\ if\ region = Mid\ Norway \\ -22\,816\,597\ if\ region = North \\ 0\ if\ region = Oslo \\ -20\,157\,857\ if\ region = South \\ -23\,364\,834\ if\ region = West \end{cases} +$$
$$+ \begin{cases} 0\ if\ population = large \\ -7\,704\,846\ if\ population = medium \\ -7\,233\,110\ if\ population = small \end{cases} + \epsilon \quad (22)$$

According to the model, a sports hall in Oslo (i.e. *region = Oslo* and *population = large*), built in 2015 (*years after 1996 = 19*) and with an activity surface area of 1 012 m^2 in average has costed:

$$cost_{1012,19,Oslo,large} = 23\,840\,899 + 18\,930 \cdot 1\,012 + 1\,331\,520 \cdot 19 + 0 + 0 =$$
$$= 68\,296\,939\ NOK. \quad (23)$$

According to the model, the average cost for "the same" sports hall, but built in Trondheim (or another municipality in the region Mid-Norway with a population-size at minimum 20 000 inhabitants) has been:

$$cost_{1012,19,Mid\ Norway,large} = 23\,840\,899 + 18\,930 \cdot 1\,012 +$$
$$+1\,331\,520 \cdot 19 - 14\,183\,826 + 0 = 54\,113\,113\ NOK. \quad (24)$$

That means that there is a difference of approximately 14 million NOK, which also could be seen in (22), at the coefficient for *region = Mid-Norway*.

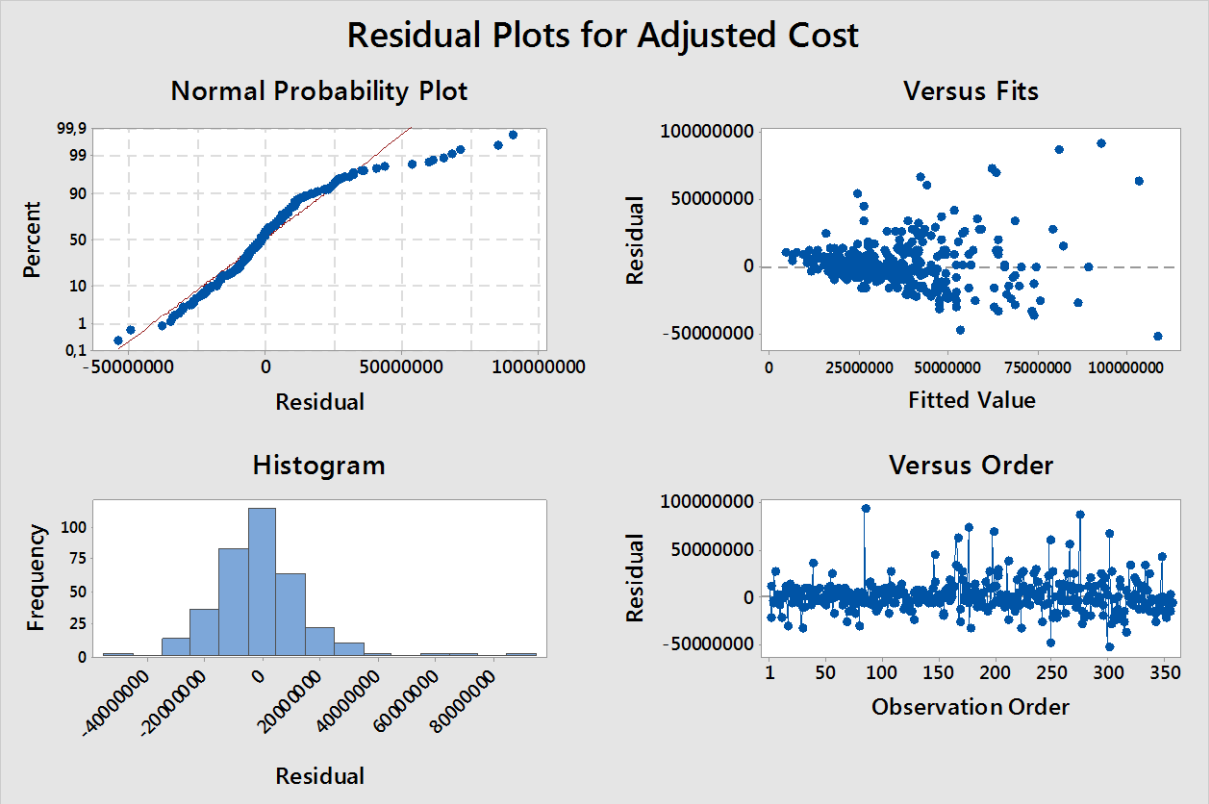

Figure 20: Residual plots for Model 1c.

7.5 Regression models of the costs with removed observations

One should always be careful not to reject or discard outliers unless there are non-statistical grounds to do so (Montgomery, 2013). However, it is interesting to see how the variations in costs for sports halls can be explained when excluding unusual sports halls. As mentioned in previous analysis, some of the sports halls have had special reasons for being unusually expensive/inexpensive – for example built below ground or without changing rooms. The 14 observations with remarkably high residuals from Model 1a, given in Table 24, were examined in the information system and/or online to see if there was anything unusual about them. Twelve of these facilities, where reasons to its low/high cost (and large residual) could be found, were deleted from the data before the new regression models were estimated.

Table 24: The 14 sports halls with largest residuals in Model 1a.

Facility number	Adjusted cost	Fitted value when using Model 1a	Residual	Removed	Comment
0104012401	103 457 650	42 566 846	60 890 804	Yes	Combined with swimming facility (cost approx. from total)
0215011101	69 549 200	26 531 688	43 017 512	No	Missing information
0301026304	37 989 000	72 482 068	-34 493 068	No	Nothing special found
0301063902	3 566 073	53 651 725	-50 085 652	Yes	Small without normal facilities as for example changing rooms
0301108201	183 604 320	91 056 446	92 547 874	Yes	Combined with school
0301121201	131 010 526	63 009 394	68 001 132	Yes	Built under ground
0403016301	91 900 000	51 565 348	40 334 652	Yes	Constructed for top sports
0514004401	77 965 101	28 015 707	49 949 393	Yes	Combined with other facilities
0709024901	164 761 678	99 366 862	65 394 815	Yes	Constructed for tops sports
1201002508	54 460 076	105 085 479	-50 625 403	Yes	Hall for tennis
1201083601	107 138 845	41 641 206	65 497 639	Yes	Combined with school and swimming facility
1246011017	165 944 734	107 722 483	58 222 251	Yes	Constructed for tops sports
1445007108	35 417 800	71 174 262	-35 756 462	Yes	No changing rooms
1719022101	133 713 911	59 620 471	74 093 440	Yes	Combined with for example swimming facility

7.5.1 Model 2a: Model 1a with removed observations

Model 2a is the same as Model 1a (but fitted to the reduced data set):

$$cost = \alpha + \beta_1 \cdot area + \beta_2 \cdot years\ after\ 1996 + \beta_3 \cdot D_{region} + \beta_4 \cdot D_{population} + \\ + \beta_5 \cdot D_{tied\ costs} + \beta_6 \cdot D_{free\ income} + \epsilon \quad (25)$$

The coefficients were estimated with Minitab, and the ANOVA for the model and the coefficients are found in Appendix D: Model 2a. The R^2 and R^2_{adj} of Model 2a is 51.1 % and 49.2 %, respectively. There are now 23 observations with remarkably high residuals. The histogram in the residual plot in Figure 21 implies that the residuals are somewhat normally distributed, and in the normal probability plot in the same figure, one can see that many residuals follow the normal line. Looking at the fitted value versus the residuals, one can see that the residual size increases with increased fitted value, but less clearly compared with Model 1a. The residual variance seems to increase with larger fitted value.

From the ANOVA, one sees that most regression variables are significant at significance level of 0.05. *Tied costs* is least significant (with a p-value of 0.72). Looking at the coefficients (the β's), 8 out of 13 are significant at level of 0.05. Both *free income* and *tied costs* have non-significant coefficients (0.23 - 0.90). The VIF's are 1.04 for the *area*-coefficient and 1.06 for the *years after 1996*-coefficient, meaning that these two do not correlate with other predictors. The rest of the VIF's for the coefficients are between 1.9 and 4.67 (implying moderate correlation with other predictors), except for the VIF for *tied costs = small*, which is 7.99 (implying high correlation). The lack-of-fit has a p-value of 0.95, implying that there is no evidence that Model 2a does not fit the data. All numbers are found in Appendix D: Model 2a.

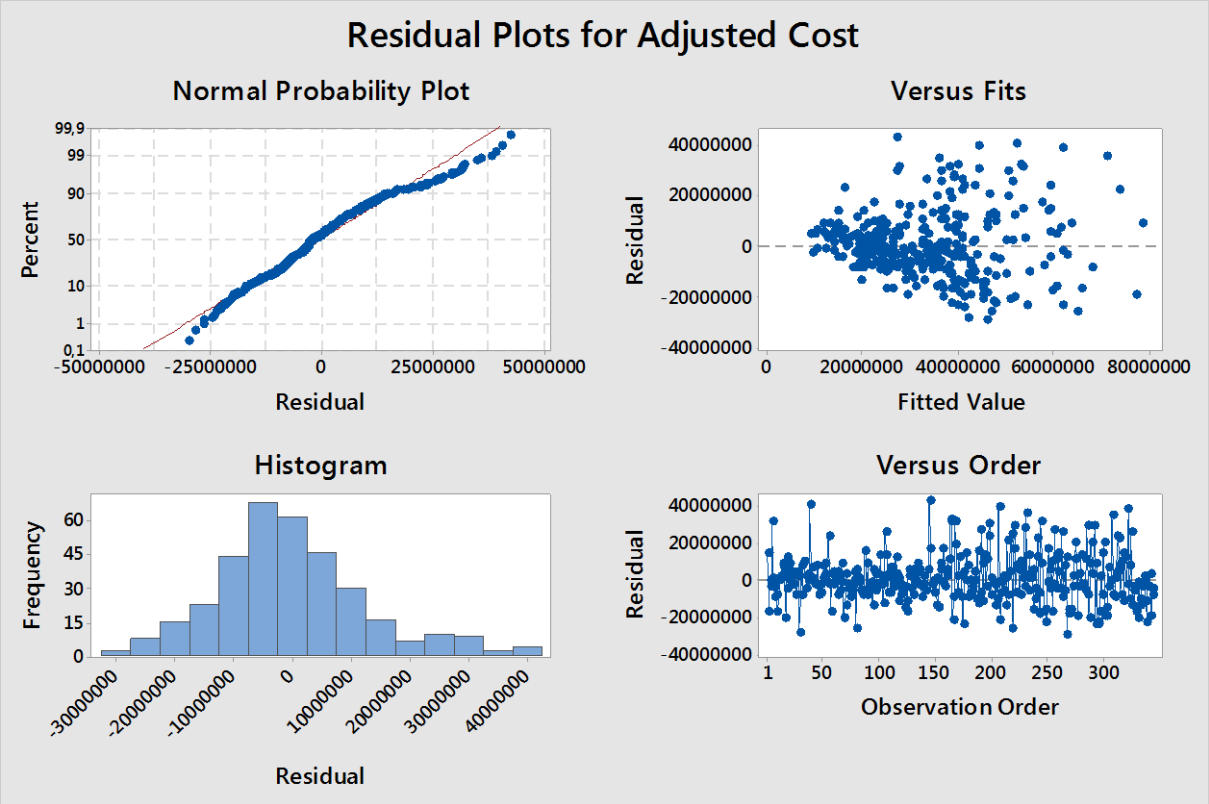

Figure 21: Residual plots for Model 2a.

7.5.2 Model 2b: Model 1b with removed observations

Model 2b is the same as Model 1b, but with the same data set as used in Model 2a.

$$cost = \alpha + \beta_1 \cdot area + \beta_2 \cdot years\ after\ 1996 + \beta_3 \cdot D_{region} +$$

$$\beta_4 \cdot D_{population} + \beta_5 \cdot D_{free\ income} + \epsilon. \qquad (26)$$

The estimated coefficients are given in Appendix D: Model 2b. The R^2 and R^2_{adj} of Model 2b is 51.0 % and 49.4 %, respectively. R^2 has decreased slightly compared to Model 2a, and R^2_{adj} has increased slightly. There are 21 observations with remarkably high residuals. The residual plots in Figure 22 are very similar to the plots for Model 2a in Figure 21.

From the ANOVA, one sees that four out of five regression variables are significant at significance level of 0.05 (the only non-significant factor is *free income*). For the regression coefficients, 9 out of 11 are significant at the 0.05 level. *Free income* has the least significant coefficients. The VIF's for the coefficients are 1.03 for *area* and 1.06 for *years after 1996*, implying no correlation with other predictors. The VIF's for the other coefficients are between 1.33 and 4.66, implying moderate correlations. The lack-of-fit has a p-value of 0.90, indicating that there is no evidence that Model 2b does not fit the data. All numbers are found in Appendix D: Model 2b.

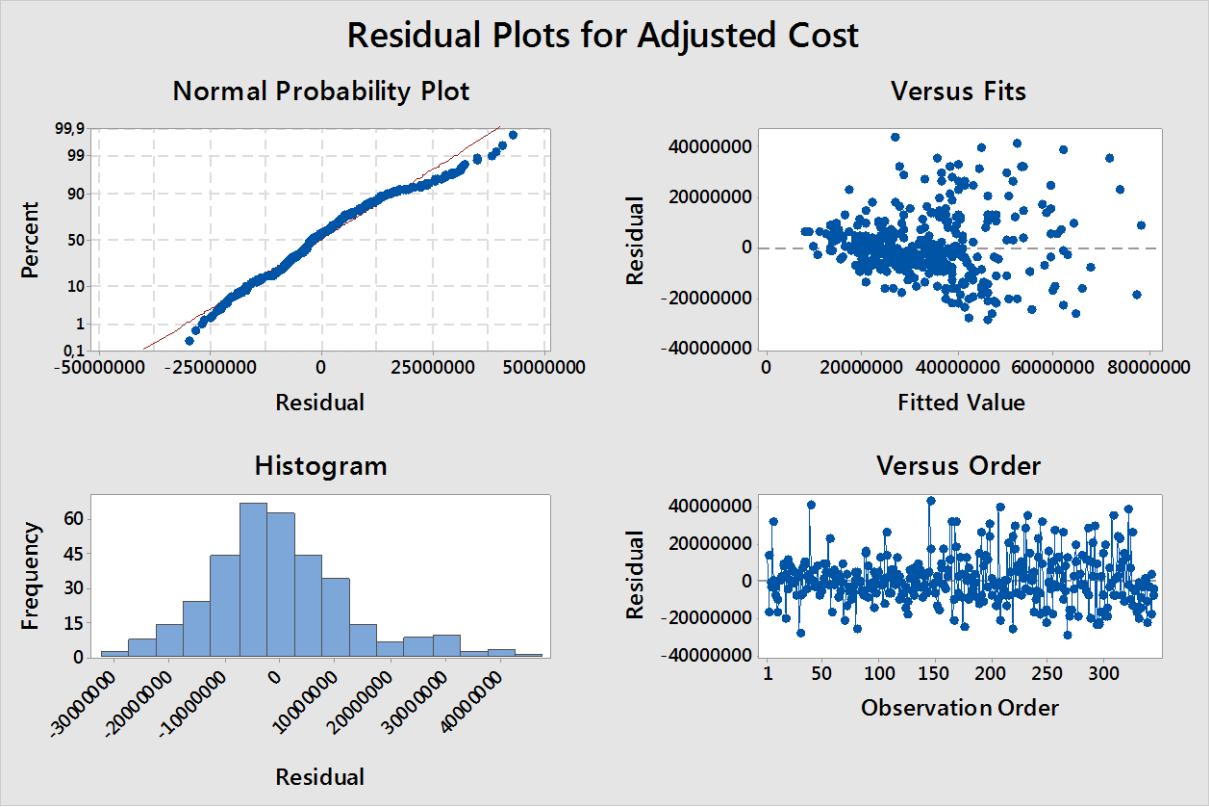

Figure 22: Residual plots for Model 2b.

7.5.3 Model 2c: Model 1c with removed observations

Model 2c is just like Model 1c, but using the reduced data:

$$cost = \alpha + \beta_1 \cdot area + \beta_2 \cdot years\ after\ 1996 + \beta_3 \cdot D_{region} + \\ + \beta_4 \cdot D_{population} + \epsilon \qquad (27)$$

The R^2 and R^2_{adj} of Model 2c is 50.6 % and 49.3 %, respectively. Both R^2 and R^2_{adj} have decreased slightly compared to Model 1c. From the ANOVA, one sees that all regression variables are at a significance level of 0.05 (and even less). All nine regression coefficients are significant, with the largest p-value at 0.006 (*region = Mid-Norway*). The VIF's for the coefficients are 1.03 for *area* and 1.06 for *years after 1996*, implying no correlation with other predictors. The VIF's for the other coefficients are between 1.22 and 4.64, implying moderate

correlations. The lack-of-fit has a p-value of 0.79 indicating that there is no evidence that Model 2b does not fit the data. There are 20 observations with remarkably high residuals. The residual plots in Figure 23 are very similar to the plots for Model 2a and for Model 2b in Figure 21 and Figure 22 respectively. In Figure 24, one can see that the model underestimates the costs for sports halls with large costs, and overestimates the costs for sports halls with small costs. All numbers are found in Appendix D: Model 2c.

Model 2c (with values) is:

$$cost = 22\,538\,567 + 15\,212 \cdot area + 1\,262\,509 \cdot years\ after\ 1996 + \\ + \begin{cases} -15\,219\,132\ if\ region = East \\ -10\,113\,336\ if\ region = Mid\ Norway \\ -17\,545\,323\ if\ region = North \\ 0\ if\ region = Oslo \\ -15\,412\,297\ if\ region = South \\ -18\,807\,955\ if\ region = West \end{cases} + \\ + \begin{cases} 0\ if\ population = large \\ -6\,891\,896\ if\ population = medium \\ -7\,019\,379\ if\ population = small \end{cases} + \epsilon. \quad (28)$$

According to Model 2c, the cost for a sports hall with an activity surface of 1 012 m^2 in Oslo would be

$$cost_{1012,19,Oslo,large} = 22\,538\,567 + 15\,212 \cdot 1\,012 + 1\,262\,509 \cdot 19 + 0 + 0 = \\ = 61\,920\,782\ NOK, \quad (29)$$

which is approximately 6 million less than according to Model 1c. The same sports hall but in Trondheim (or any other Mid-Norway municipality with a population classified as large) would cost approximately 10 million less, 51 807 446 NOK, compared to 54 113 113 NOK in Model 1c.

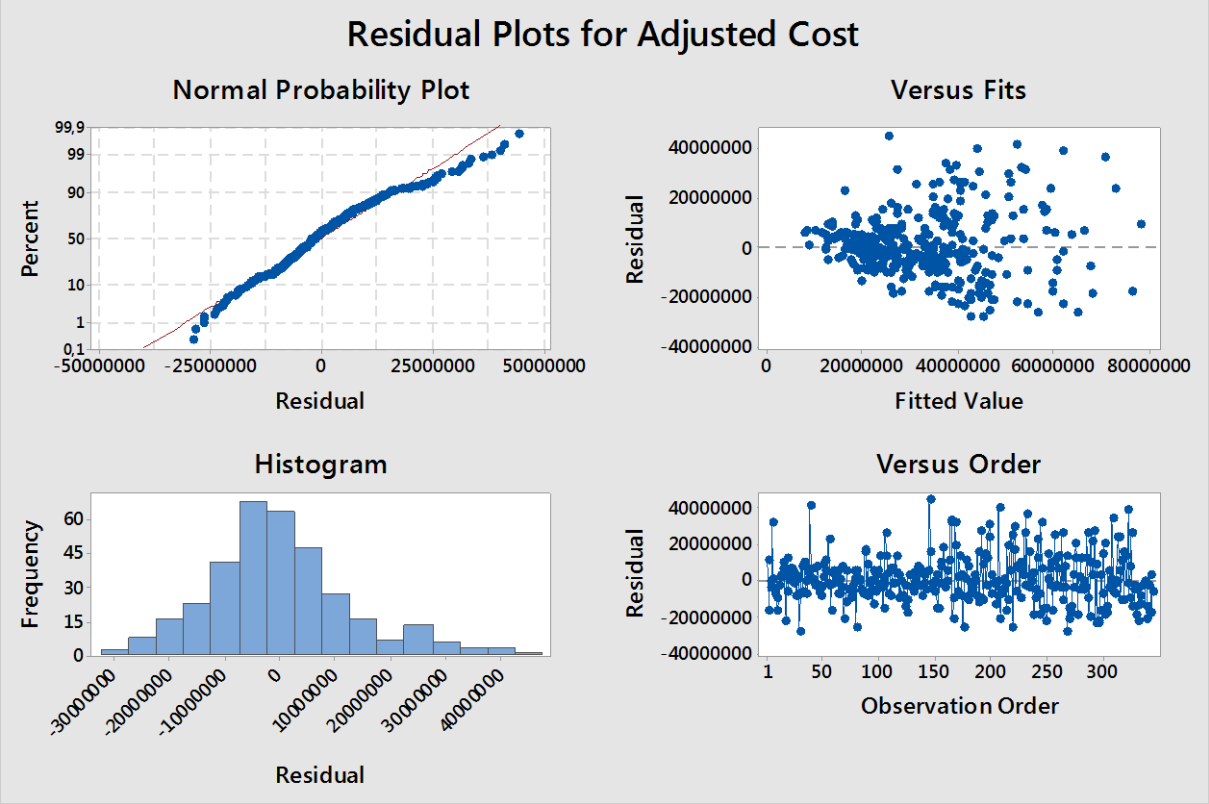

Figure 23: Residual plots for Model 2c.

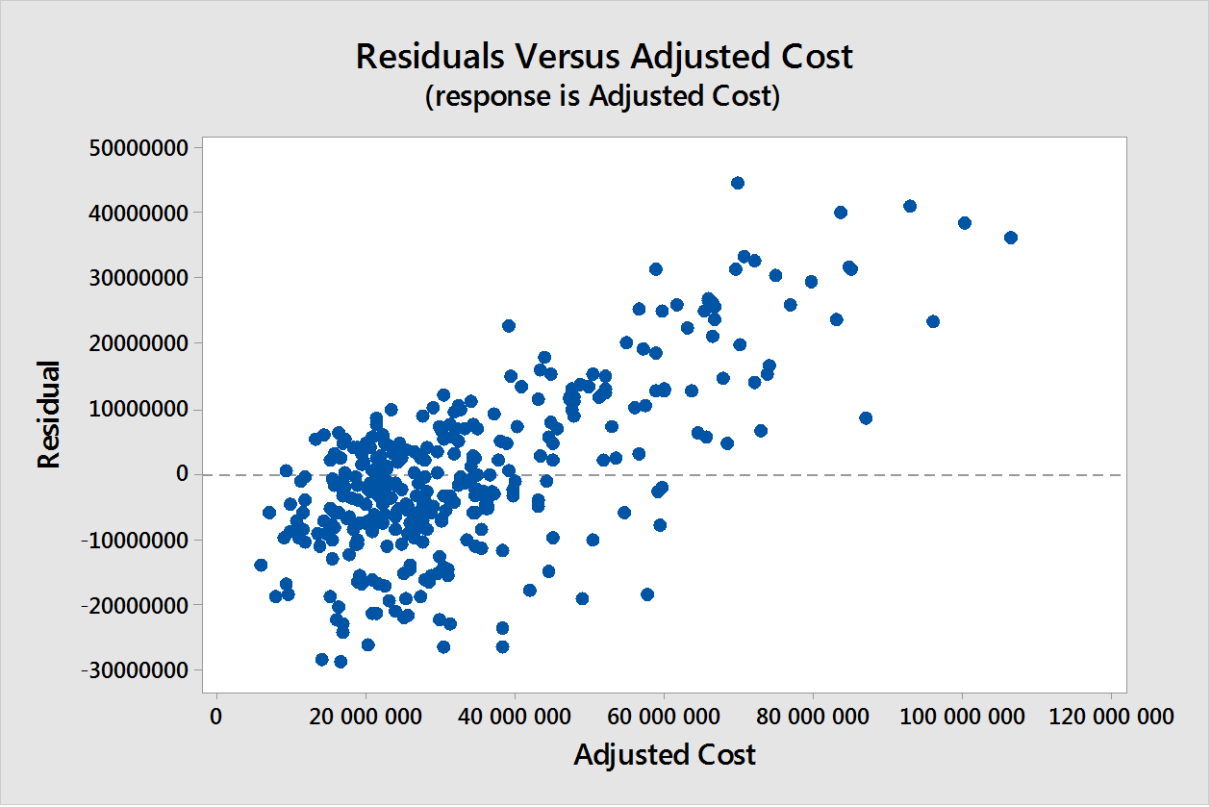

Figure 24: Residuals versus adjusted costs for Model 2c.

In Table 25, the coefficients in Model 1c and Model 2c are compared. The factors *region = Oslo* and *population = large* are used as default in both Model 1c and Model 2c, and hence the effects are in relation to Oslo or a large municipal population-size. There are large differences between the coefficients in Model 1c and Model 2c: up to 29 % (for the effect of Mid-Norway). In numbers, the differences in the *categorical factors* is up to a bit more than 5.3 million NOK, and in the numerical factors, the differences are at minimum 1.4 million NOK for the *area*[16], at maximum 11 million NOK for the *area*[17], and at maximum 1.3 million NOK for the *years after 1996*[18].

Table 25: Comparison of coefficients in Model 1c and Model 2c.

Factor	Effect in Model 1c	Effect in Model 2c	Difference	Relative difference[19]
constant	23 840 899 NOK	22 538 567 NOK	1 302 332 NOK	5 %
area	18 930 NOK	15 212 NOK	3 718 NOK	20 %
years after 1996	1 331 520 NOK	1 262 509 NOK	69 011 NOK	5 %
region = East	-19 174 931 NOK	-15 219 132 NOK	-3 955 799 NOK	21 %
region = Mid-Norway	-14 183 826 NOK	-10 113 336 NOK	-4 070 490 NOK	29 %
region = North	-22 816 597 NOK	-17 545 323 NOK	-5 271 274 NOK	23 %
region = South	-20 157 857 NOK	-15 412 297 NOK	-4 745 560 NOK	24 %
region = West	-23 364 834 NOK	-18 807 955 NOK	-4 556 879 NOK	20 %
population = medium	-7 704 846 NOK	-6 891 896 NOK	-812 950 NOK	11 %
population = small	-7 233 110 NOK	-7 019 379 NOK	-213 731 NOK	3 %

7.6 Summary of results: Factors that have had an impact on the cost

It has not been possible to produce a completely satisfying model to describe the costs of sports halls, using the parameters found in the Sports Facility Register, the applications for gaming funds, and location factors as for example region and municipal economy level. The coefficients of determination for the regression models are approximately 50 %, meaning that the factors can only explain 50 % of the variation in costs between sports halls. The large residuals for some of the halls are also an indication that the regression models are missing one or more important factors/explanatory variables. Nevertheless, low values for the coefficient of determination are not always bad (Frost, 2013), and the *significant coefficients* provides important information about differences between sports halls. In addition, the lack-of-fit for the models were not under the significance level of 0.05.

[16] Computed for a facility with an activity surface area of 384 m^2: $384\ m^2 \cdot 3\ 718\ NOK/m^2 = 1\ 427\ 712\ NOK$
[17] Computed for a facility with an activity surface area of 3 000 m^2: $3\ 000\ m^2 \cdot 3\ 718\ NOK/m^2 = 11\ 154\ 000\ NOK$
[18] Computed for a facility built in 2015 (19 years after 1996): $19 \cdot 69\ 011\ NOK/year = 1\ 311\ 209\ NOK$
[19] The relative difference is calculated as (Effect in Model 1c – Effect in Model 2c)/Effect in Model 1c and rewritten in percentage.

In general, the total cost for a sports hall increases with facility type small, normal, and large, but there have been overlaps, as can be seen in Figure 25. However, the relationship is the opposite when looking at costs per square meter activity surface; the cost increases with facility type, but overlaps are found here as well, as can be seen in Figure 26.

The region where the sports hall was built has had an effect on the cost. Sports halls in Oslo have been more expensive than sports halls in other regions:

- With Model 1c: In average, a sports hall has costed between 14 million NOK and 23 million NOK less in other regions. The difference has been smallest between Oslo and Mid-Norway (Møre og Romsdal, Sør-Trøndelag, and Nord-Trøndelag), and largest between Oslo and West (Rogaland, Hordaland, and Sogn og Fjordane), and Oslo and North (Nordland, Troms, and Finnmark).
- With Model 2c: In average, a sports hall has costed between 10 million NOK and 19 million NOK less in other regions. The difference has been smallest between Oslo and Mid-Norway, and largest between Oslo and West.

The municipal population-size has also had an effect, but a smaller one. For both Model 1c and Model 2c, a municipality with a small or medium sized population (i.e. a population-size smaller than 20 000 inhabitants) has had, in average, between 7 million NOK and 8 million NOK less expensive sports hall than larger municipalities.

In average, the cost of a sports hall has increased by one million NOK per year from 1996 to 2015 (inflation-adjusted): In the value of the Norwegian krone in 2015, it would have costed approximately 19 million less to build a sports hall in 1996 than in 2015.

If one assumes that the cost just depended on the activity surface area, the results from Model 0 suggests an increase with 19 341 NOK per increase in square meter activity surface. In Model 1c and in Model 2c, the increase in cost per increase in square meter activity surface is 18 930 NOK/m^2 and 15 212 NOK/m^2, respectively.

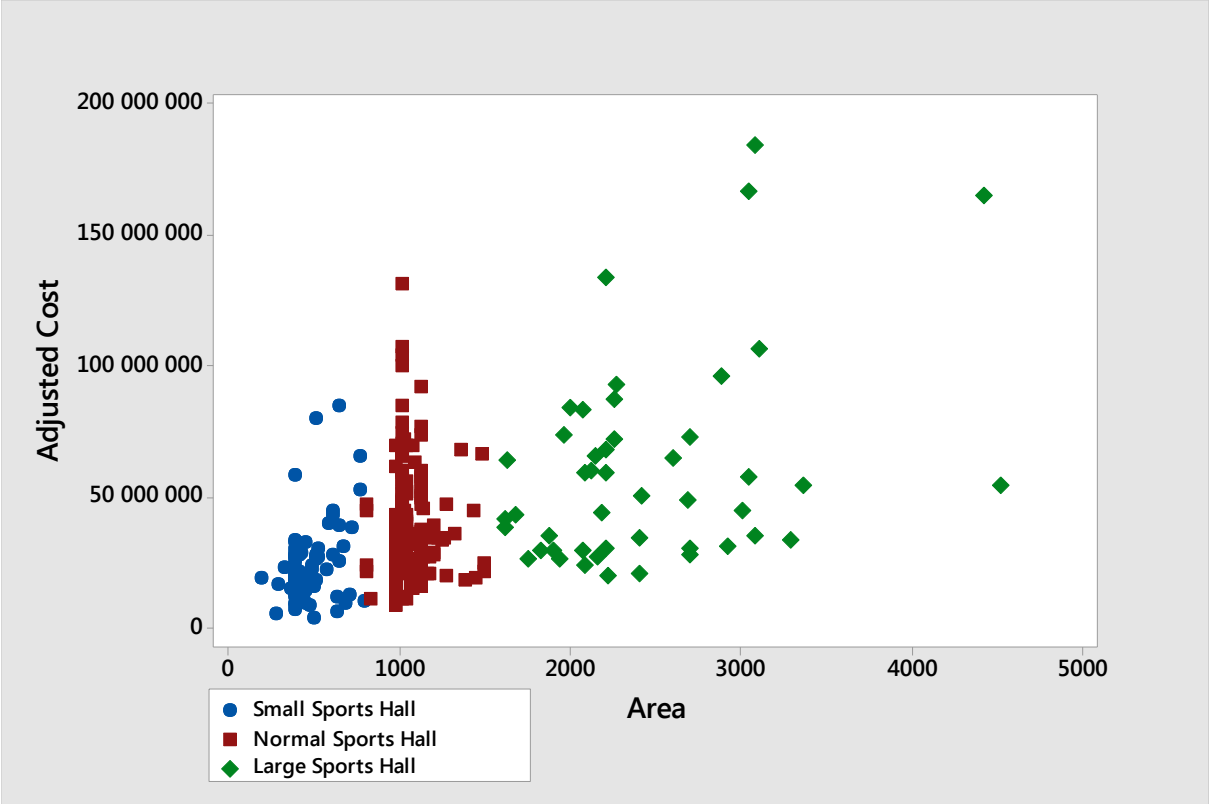

Figure 25: Scatter plot of adjusted costs versus area.

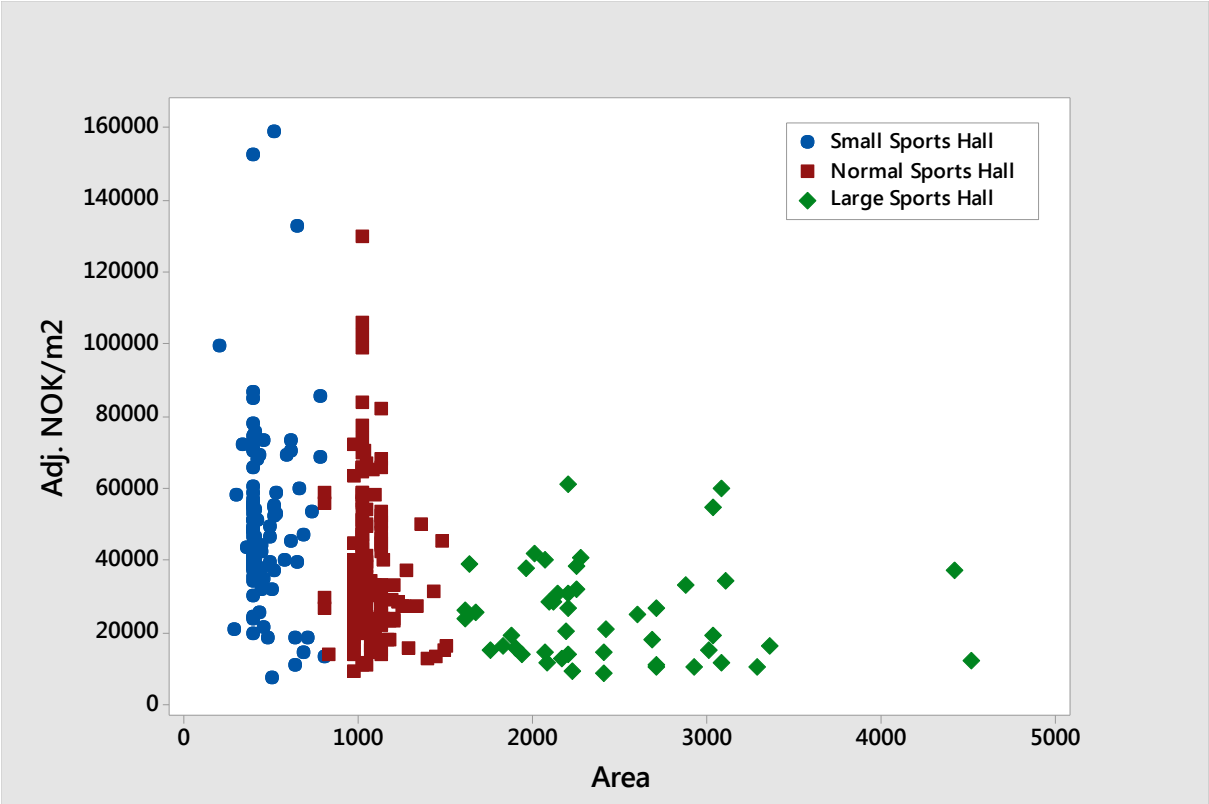

Figure 26: Scatter plot of adjusted cost per activity surface area versus area.

8. Discussion

8.1 Data preprocessing and errors in data

In the preprocessing of the application data, all applications marked *renewed* or *repeated* were deleted. This removal strategy turned out to be unwise: it was discovered that the estimated cost could change from one year to another, and hence the latest application would have been the most interesting one, having the most recent updated estimated cost. Unfortunately, this discovery was made late in the preprocessing, and had to be neglected.

The inflation-adjustment of the costs could have been done before the outlier investigations, to avoid investigation of low cost sports halls which costs were correct, and to find sports halls from earlier years with relatively unusually high costs.

Even though the data was preprocessed, errors were found during the entire analysis part, mainly due to incorrect categorization of facilities as sports hall. In addition, it seems that it is not/has not been controlled (for example by the administration at KUD) that the data in the information system corresponds to the data in the attached documents and the information on the registered sports facility.

Traces from the updates of *kkd-idrettsanlegg.no/growbusiness* were found in various parts of the information system, for example new categories and choices. It would have been convenient if all the existing records had been updated with the new categories and choices, to make the entire application and facility data set complete and consistent. In addition, some applications contain several attached documents, in which additional information on the facility or the application can be found: other applications have no attached documents and no additional or explaining information can be found.

If one just exports the sports hall applications from 1996 to 2015 and do not preprocess the data, the averaged estimated cost is approximately 21 million NOK. If one exports applications from 2015 only, the average estimated cost is approximately 28 million NOK. If one exports applications from 2015, marked as *new facility*, the average cost is approximately 39 million NOK. Compared to the overall average cost for a sports hall (approximately 36 million NOK), found in Table 22, the difference is between 3 million NOK and 15 million NOK.

8.2 Number of sports facilities

The numbers on new applications in Table 3 regard so-called *ordinary facilities for sports and physical activity*, while the numbers in Figure 1, despite its name include these facilities and facilities within the categories *local activity facility, facility for seaside outdoor recreation, facility for outdoor recreation in the mountains,* and *cultural facility.* Therefore, it is not correct to compare these to each other directly. Looking at the numbers on sports halls, on the other hand, one can see that the number of built sports halls in 2014 (31) and in 2015 (11) do not match the number of new applications regarding sports halls in 2014 (52) and in 2015 (78). From the total application numbers for *sports halls* in Table 3, one gets the impression that the number of built sports halls has increased steadily from 2011 to 2015. However, if one looks at Figure 5 and the number of built sports halls in the same period, one sees that there has been a decrease instead.

The title in the reports from NIF and KUD (i.e. *Hva bygges?* which means *What is built?)* indicates that the figures regard built facilities – not applications for potential facilities, as it is. In addition, the given figures do not provide the proportion between projects for new facilities and projects for renovation, nor how many of the projects that have been realized, which makes the figures even more imprecise – and unsuitable as statistics for *What is built?*. The numbers on built facilities collected from the Sports Facility Register, on the other hand, are more reliable, as long as the register is kept updated. The most preferable would be a combination of the two, which in some sense is given for sports halls in this thesis. It is remarkable that it is necessary to

1. Export application data
2. Fill in *new facility/renovation of facility, application period* and *facility class* manually, and
3. Merge the application data and the Sports Facility Register

to be able to connect application data and facility properties to each other, since it is all in the same database in the information system at kkd-idrettsanlegg.no/growbusiness.

8.3 Sports hall costs

8.3.1 The use of municipality groups and regions

The municipality groups (and values for population-size, tied costs per inhabitant and free disposable income per inhabitant) used in this thesis are valid from 2013, meaning that the divisions in groups/categories are only fully reliable for sports halls built 2013 or later, since many municipalities might have been categorized differently in 1996 - 2012. This could be a potential reason behind that tied costs and free income were not significant in the regression models.

Another disadvantage is the use of categories instead of values, since data divided in classes provide less information than actual values. In addition, the final regression models use one region (i.e. *Oslo*) and one population-size (i.e. *large*) as the default: The region effect factor in the models describes the effect in relation to *Oslo* and the population-size effect factor in the model describes the effect in relation to *large*.

8.3.2 The use of activity surface as cost factor

The cost will naturally depend on more than just the activity surface area, such as other units in the hall, for example number of changing rooms, storage rooms, social meeting places and cafés, as well as the total usable area of the hall, the utility floor space. However, the activity surface area is specified for most of the sports halls in the Sports Facility Register, as the only indicator of what is included in the sports hall (except for sometimes in the name of the hall, for example *Sørvågen nye flerbrukshall og sosialt rom (samfunnssal)*, meaning *Sørvågen new sports hall and social meeting place (community hall)*. Some facilities have separate units in the register for the hall, the social meeting place and the extra changing rooms; others have all these included in the sports hall unit. Other properties of the sports hall than the activity surface area are necessary to include in the analysis describe the costs, but the activity surface area is

the most important part of a sports hall and is the only available quality indicator for the sports hall (as the register is constructed today).

8.3.3 Price indexes

The *consumer price index* was used to inflation-adjust the costs in relation to general cost increases in Norway. There are other price indexes that could have been used, for example the *construction cost index for residential buildings* from Statistics Norway (2016c). The reason not to use any construction cost index is that these indexes are either measures/predictors of construction costs: hence, using any of these indexes would have made it unnecessary to look into variation in costs depending on year.

8.3.4 Cost differences

The large number of outliers, i.e. sports halls with large residuals, shows that the factors found in the registered application data (or the used municipal/county information) are not enough to explain the variations in costs. As seen in Table 24, some of the residuals are in the same size order as either the fitted value or the estimated cost. Special circumstances were found both in the preprocessing and in the outlier investigation, for example that the cost was estimated from a total cost for a new school or a multiple sports center, based on area ratio. To find this kind of information, one must seek through the attached documents in the information system, and this is not appropriate for a large data analysis.

8.4 Problems working with the sports facility information system

Working with the applications and facilities in the information system on the web-based platform at *kkd-idrettsanlegg.no/growbusiness* has its challenges, which are described below:

- The system is incompatible with new web browsers.
- The system must be opened in Internet Explorer, preferably version 6, 7 or 8[20].
    - If using 10 or 11, one must edit the settings in the browser: add *compatibility mode* and add *.kkd-idrettsanlegg.no to *trusted sites*.
- The site must be added as an exception in the security settings for Java.
- One has to download client files to be able to use the reports.

Sometimes, this was not enough, and to make the system work the window had to be right clicked and *inspect element* chosen to display the report-page. The report-page is shown in Figure 27.

It has been challenging for the author of this thesis, a master student in Computational Science, to understand and make the system work. Therefore, it becomes understandable that the sport consultants in the municipalities (and counties) might have problems as well. This can be the explanation of errors in data and the lack of updates of the sports facility information.

[20] When this thesis was written, the latest version of Internet Explorer available was 11.

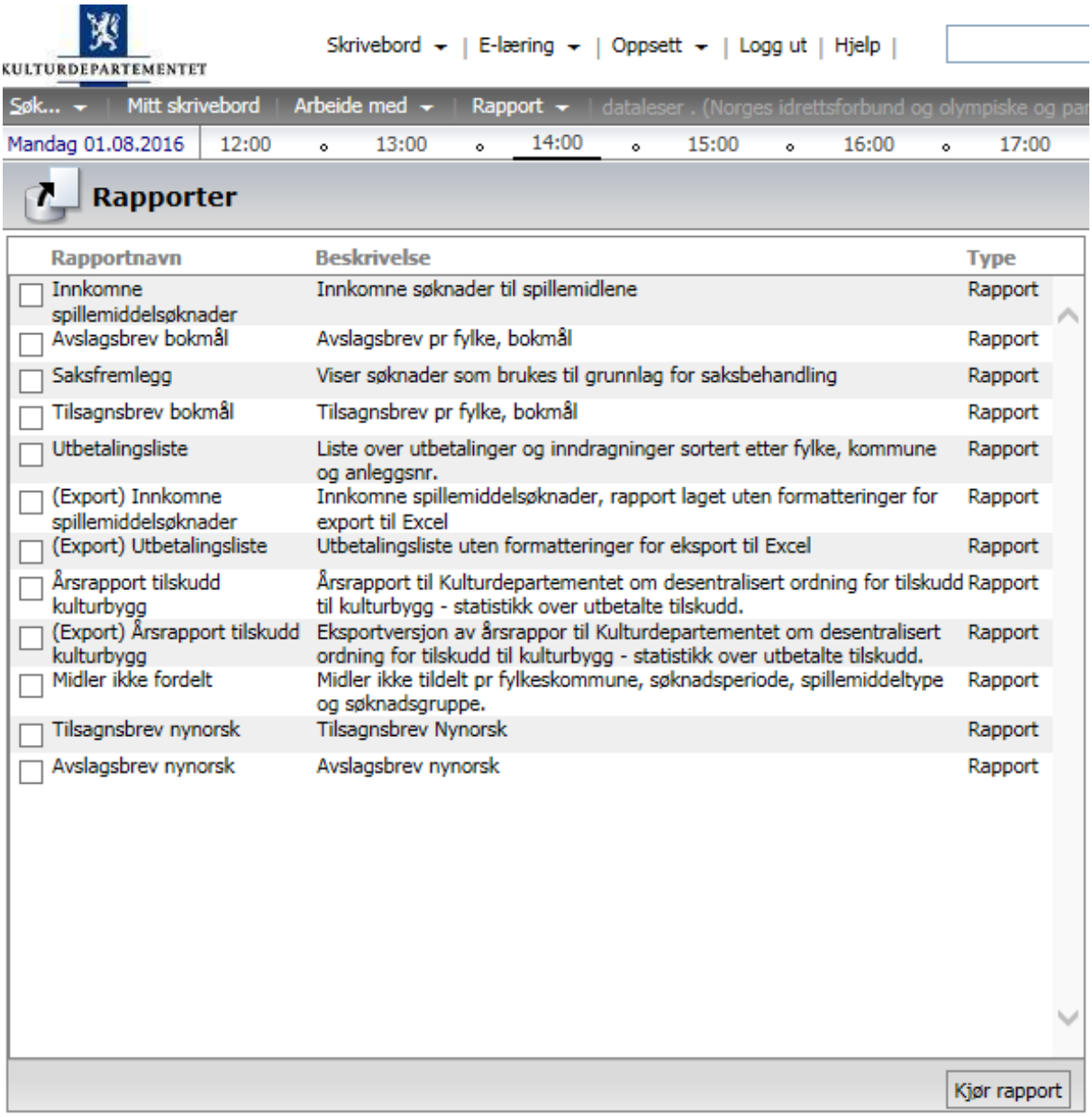

Figure 27: Print screen of the report-view in the information system.

8.5 Improvements of the Sports Facility Register and the information system

There is a great potential of the Sports Facility Register and the information system. The data can be used for comparison of costs between facility groups and types, and within facility groups and types. The register can also be used by for example the municipalities, counties, and sports federations to make strategical decisions on what facilities to build, and where, and to make predictions on what renovations will be necessary in the future. However, as poorly cared for as the Sports Facility Register and the information system is today, the data becomes unreliable unless preprocessed. Considering all the work it takes to make the data somewhat clean, it becomes doubtable if it is worth the effort.

To make the register and the application data reliable and useable, the following must be fixed:

1. The facility data must be kept updated and correct
2. The categorization of facilities in groups and types must be standardized
3. The facility registration must be standardized: it must be decided if different parts of the facility should be registered as separate units (with several facility numbers) or as one unit including all the parts (sharing facility number)
4. The types and groups must be updated:
    a. For example, what is the difference between activity facility: table tennis facility and activity room: table tennis hall? Is it necessary to have both?
    b. When new groups or types are introduced, existing facilities should be updated and re-categorized if the new group/type is more suitable.
5. The people working with the register in the municipalities and counties must be kept updated on changes and how to work with the register.

To make the register and the application data even more useable, one could for example add the attribute *final cost* in addition to the estimated cost in the application. Further, the available attributes for the sports halls in the register did not seem to be enough to explain the cost variations (partly discussed in 8.3.2 The use of activity surface as cost factor). Some factors that obviously have had an impact on the cost, but are not easily accessible or not accessible at all, are:

- The number and the size of changing rooms, storage rooms, social areas, offices, meeting rooms, etc.
- The total area of utility floor space

8.6 Hypothesis testing on census data

To preform hypothesis tests on mean values from a census can seem unnecessary, since hypothesis tests assume a randomness caused by the random data sample. In a census, all units (here: sports halls) are included in the sample, and there is no randomness. Nevertheless, in the section 7.2 Descriptive statistics on the preprocessed data, it was observed that the preprocessed sports hall application data contained 357 facilities with construction year 1996 to 2015, but in the Sports Facility Register, the number of sports halls constructed between 1996 and 2015 was 480 (486 including six facilities with imputed construction year). Hence, in some sense, the sports hall application data could be seen as a sample, where the sports hall applications not included in the sample had either missing estimated cost or missing information on new facility/renovation. Although, it is very questionable that the sample can be assumed completely random.

8.7 Operational costs

In total, only 78 (18 %) of the municipalities answered to the survey about operational costs for sports facilities. Of the answering municipalities, 43 (10 %) sent some kind of operational data. The rest of the answering municipalities gave one or more of the following reasons to why they did not send data:

1. The municipality does not own any sports facilities.

2. The municipality does not operate any sports facilities; the operational responsibility is assigned to sport teams.
3. The operational costs of sports facilities are included in the operational costs for a school complex and cannot be estimated for the sports facilities only.
4. The municipality does not have figures on sports facility operational costs and/or the operational costs cannot be derived.
5. The figures would be too time consuming to find, and the municipality cannot prioritize it.
6. There are no other figures on sports facility operational costs than those in KOSTRA[21]/the municipality referred to the figures in KOSTRA.

The first two reasons are (obviously) understandable for not sending data. However, some municipalities seem to be incorrect in their answer: facilities were found in the Sports Facility Register, where the municipality was stated to be the owner and/or operator. This leads to the question: what is the definition of a sports facility? Among the found facilities are for example a football turf, a swimming pool and a pool hall, as well as outdoor recreation facilities. Another reason could be that the found facilities are wrongly described in the Sports Facility Register, that the municipalities do not operate the facilities even though that is what is stated in the register.

The other reasons can be discussed. From the third and fourth reason, one gets the impression that the municipalities have no control of their sports facility operational costs. It is a bit alarming that many municipalities do not know how they spend their money. In addition, having an overview of energy use of the municipal sports facilities would make it possible to identify if the sports facilities are energy effective; if not, the municipality would be able to reduce its operational costs by improving the facility. This should be an incentive for the municipalities to store its operational costs for sports facilities, and to store them separately from other buildings. The fifth reason is related to the third and fourth. It is implied that there are figures, but not easily available. This leads to the same discussion as above. The sixth reason, referring to KOSTRA for figures, was of little help. The figures in KOSTRA are not satisfying, since these include both expenses *and* income from operation of municipal sports facilities. Hence, it is not possible to use these numbers as operational costs.

The reasons why 349 municipalities did not answer at all is not known. Potential reasons could be, in addition to the reasons stated from the answering municipalities: lack of interest, the municipalities' e-mail servers classified the e-mails as spam or that the e-mail did not reach the right person. One could speculate that the reason is lacking knowledge within the municipality of how the facilities are operated, and to whom to address the survey. Of course, the latter problem could have been avoided or at least reduced if the survey where addressed to the right person from the start, and not as now, to the municipal mail center.

One can also criticize the survey approach in this work: it was somewhat naive to think that the respondents of the survey possessed the same access to operational data as we had received

[21] In *KOSTRA* one finds key figures on municipal activities, for instance municipal expenses for sports facilities. Details can be found at Statistic Norway, https://www.ssb.no/en/offentlig-sektor/kostra.

from Trondheim municipality, and to think that all the municipalities record the costs in the same format as Trondheim. It would have been better to send a test survey to some of the municipalities, and rather reformulate the question and perhaps only ask for a certain kind of sports facility.

9. Conclusions

In this thesis, the Sports Facility Register has been used to give an overview of the number of built sports facilities in Norway between 1996 and 2015, and applications for gaming funds have been used to give an overview of sports hall costs during the same period. The application data was preprocessed and then analyzed using regression analysis and ANOVA.

During the last 20 years, almost 20 000 sports facilities have been built in Norway. Except for Sami sports facility, five or more facilities have been built within each *facility group* in the Sports Facility Register. The five facility groups with most facilities built are

1. Activity facility (8 701 facilities)
2. Outdoor recreation facility (2 454 facilities)
3. Map (1 479 maps)
4. Football facility (1 368 facilities)
5. Sports house (1 336 facilities)

Of the sports facilities for organized sports, artificial football turf is the most commonly built *facility type*, with 968 facilities. This facility type has had a remarkable increase from 2000 to 2009 (see Figure 2), but the number of yearly built artificial football turfs seems to have been decreasing (or at least leveling off) from 2009 to 2015.

The spread in sports hall costs has been large during the last 20 years. Categorized into facility types, the average square meter costs (inflation-adjusted to 2015 price level) have approximately been:

- Large sports hall: 25 000 NOK/m^2 activity surface area
- Normal sports hall: 35 000 NOK/m^2 activity surface area
- Small sports hall: 51 000 NOK/m^2 activity surface area
- Independent of type: 39 000 NOK/m^2 activity surface area

The average costs for sports halls (inflation-adjusted to 2015 price level), if only considering the sizes according to above, have approximately been:

- Large sports hall: 61 000 000 NOK
- Normal sports hall: 37 000 000 NOK
- Small sports hall: 22 000 000 NOK
- Independent of type: 36 000 000 NOK

Of the tested factors, *area*, *years after 1996*, *region*, and municipal *population* size have significantly affected the cost. Generally, sports halls built in Oslo have costed more than sports halls built in other regions of Norway (in average between 14 million NOK and 23 million NOK more), and the cost for a sports hall has in average been larger in municipalities with a population size of 20 000 inhabitants or more, than in smaller municipalities. The costs have been increasing with approximately one million each year since 1996, even though the costs have been adjusted for inflation.

Since the cost differences have been large between Oslo and other regions, it might be an idea to change the gaming fund distribution, and increase the sum funds to sports halls in Oslo.

However, the data is probably not good enough to change the criteria, and the credibility of the data must be increased before making important decisions.

The application data that was collected from the information system associated with the Sports Facility Register was very challenging to work with, from extraction to analysis. The exporting options in the system are limited and the data is very *dirty* (missing values, inconsistent, wrongly recorded/updated etc.). The performed data preprocessing has made the data more reliable, but it is hard to say how strong the conclusions from the results are.

The municipalities were asked to send operational data from their sports facilities, but only 10 % did. The received data came in many different formats and further analysis was left out from this thesis.

9.1 Suggestion on further studies

This thesis has given a brief overview of the trends in sports facility building, and the trends can be further analyzed to see if they are matching political decisions and aims for the same period of time. The primary focus has been sports hall costs, but sports hall is only one of 25 facility groups found in the Sports Facility Register. The methods used in this work could be reused to examine the costs of facilities from another facility group, or be generalized so that several facility groups could be examined and compared to each other at the same time.

The sports hall analysis can also be extended, for example by testing other factors effect on the cost. It would also be interesting to examine the relation between incoming gaming fund applications and paid out funds.

Similar registers of sports facilities as the Sports Facility Register in Norway exist in both Denmark, Finland, and Iceland[22], but does not in Sweden (Riksidrottsförbundet, 2012). There is a project going on in Sweden that might lead to the creation of a register (Glimvert, 2015), and when/if this is done, it will be possible to make comparisons between sports facilities in the different Nordic countries.

One could also try to redo the operational cost-survey, preferably by choosing one sports facility to focus on. Then it would be possible to examine the relationship between building, renovation, and operational costs.

[22] The Icelandic register has not been updated recently (Stefánsson, 2015).

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Appendix A: E-mail to the municipalities

The e-mail sent to the municipalities is presented below, as well as its attached files (in Norwegian).

E-mail

Hei!

Som en del av min masteroppgave og et prosjekt ved Senter for idrettsanlegg og teknologi (SIAT) ved NTNU ønsker jeg å få data på driftskostnader koblet til ulike idrettsanlegg i kommunen.

Vedlagt er en mer detaljert beskrivelse og eksempel hva for type data jeg er interessert i.

Med vennlig hilsen

Camilla Öhman

Attached file: Example of operational data

Måned	Nr. på ref.bilag	Bevilgnings-sted	Betegnelse bevilgnings-sted	Bevilgnings-art	Betegnelse - bevilgningsart	område	Anleggsnr	Betegnelse område	Disposisjons-program	Betegnelse på disposisjons-program	Beløp i LSO-valuta som skal kontrolleres
12	1300011973	615380	Idrettsbygg	101070	Fordel lønn, enhet	222000	2220019016	Diverse	97380000	Navn på idretts	171 600,00
11	1300011973	615380	Utendørs idretts	101070	Fordel lønn, enhet	381000	2220019017	Diverse	97380000	Navn på idretts	-171 600,00
10	1300011306	615380	Svømmehall	101070	Fordel lønn, enhet	38150F	2220019018	Parkeringsplass	97380000	Navn på idretts	143,88
10	1300011306	615380	Friluftsanlegg	101070	Fordel lønn, enhet	38150J	2220019019	Garderober	97380000	Navn på idretts	1 703,09
9	1300011306	615380		101070	Fordel lønn, enhet	38153C	2220019020	Idrettshaller	97380000	Navn på idretts	2 590,64
8	1900198268	615380	Lysløype	118000	Strøm	38153C	2220019021	Lys	97380000	Navn på idretts	7 589,14
7	1300011527	615380		118000	Strøm	38153C	2220019022	Idrettshaller	97380000	Navn på idretts	7 508,31
6	1900198020	615380		118100	Fjernvarme/fjernkjøl	38153C	2220019023	Ishaller	97380000	Navn på idretts	40 393,42
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3	1900215185	615380	Svømmehall	124000	Serviceavtaler mv	38153C	2220019026	Idrettshaller	97380000	Navn på idretts	7 985,00
3	1900198020	615380	Friluftsanlegg	142910	Mva komp - full sats	38153C	2220019027	Turstier	97380000	Navn på idretts	10 098,36
3	1900198268	615380		142910	Mva komp - full sats	38153C	2220019028	Garderober	97380000	Navn på idretts	1 897,29
2	1900204473	615380		142910	Mva komp - full sats	38153C	2220019029	Idrettshaller	97380000	Navn på idretts	2 628,80
2	1900215183	615380		142910	Mva komp - full sats	38153C	2220019030	Diverse	97380000	Navn på idretts	2 023,50
1	1900215185	615380		142910	Mva komp - full sats	38153C	2220019031	Idrettshaller	97380000	Navn på idretts	1 996,25
1	1900198020	615380		150040	Forsink.rente (utg)	38153C	2220019032	Idrettshaller	97380000	Navn på idretts	106,90

Attached file: Introduction letter

GODE IDRETTSANLEGG

18.11.2015

Hei,

Senter for idrettsanlegg og teknologi (SIAT) ved NTNU, Kulturdepartementet og Norges idrettsforbund samarbeider om å lage en webløsning kalt Godeidrettsanlegg.no for å heve kompetansen innenfor områdene planlegging, prosjektering, bygging og drift av idrettsanlegg. Som en del av dette undersøker vi på SIAT kostnader koblet til idrettsanlegg, hva gjelder både bygging og drift.

Kommunene drifter en stor andel av idrettsanleggene i Norge og vi ønsker derfor vi å få *data på driftskostnader på kommunene sine idrettsanlegg for 2014*, for å lage en statistisk oversikt over driftskostnadene ved ulike idrettsanlegg. Data tas gjerne imot i en Excel fil, og eksempel på regnskap finnes vedlagt sammen med dette brevet i e-posten.

Resultater fra denne undersøkelse kommer til å presenteres i korthet på webløsningen Godeidrettsanlegg.no som lanseres i 2016, samt mer fullstendig i en masteroppgave fra Uppsala universitet i Sverige. Gi beskjed dersom du ønsker mer informasjon om disse.

Vennligst svar innen 18. desember.

Ved spørsmål om undersøkelsen, ta kontakt med Camilla Öhman, camilla.ohman.5838@student.uu.se og ved spørsmål om godeidrettsanlegg.no, ta kontakt med Gudrun Reikvam, gudrun.reikvam@ntnu.no.

Med vennlig hilsen

Camilla Öhman
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samt Masterstudent, Uppsala universitet
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Gudrun Reikvam
Forsker, SIAT
gudrun.reikvam@ntnu.no
Mobil: 98673471

GODE idrettsanlegg

NTNU
SIAT – Senter for idrettsanlegg og teknologi

Appendix B: Facility groups and types

Facility Group		Facility Type	
Activity facility	Aktivitetsanlegg	4-cross cycling track	4-cross sykkelbane
		Beach handball court	Sandhåndballbane
		Beach volleyball court	Sandvolleyballbane
		BMX facility	BMX-anlegg
		Different small facilities	Ulike småanlegg
		Frisbee facility	Frisbeeanlegg
		Marked-up ball pitch	Ballbane
		Miniature golf	Minigolf
		Mini pitch, enclosed	Ballbinge
		Mini pitch, open	Balløkke
		Obstacle course	Hinderløype
		Outdoor climbing facility	Utendørs klatreanlegg
		Parkour	Parkour
		Petanque court	Petanquebane
		Roller-skating rink	Rulleskøytebane
		Skateboard facility	Skateboardanlegg
		Ski play	Skileikanlegg
		Sled facility	Akeanlegg
		Table tennis facility	Bordtennisanlegg
Activity room	Aktivitetssal	Aerobic	Aerobic
		Community hall (room for sports)	Samfunnshus (idrettsdelen)
		Dancing facility	Anlegg for dans
		Fencing hall	Fektehall
		Fitness center	Trimrom/helsestudio
		Gym (gymnasium)	Gymnastikksal
		Material arts facility	Kampsportanlegg
		Spinning room	Sykkelsal
		Table tennis hall	Bordtennishall
		Wrestling hall	Brytehall
Air sports facility	Luftsportanlegg	Air sports/hang gliding	Luftsport/Hanggliding
		Air sports/parachute	Luftsport/Fallskjerm
		Hangar	Hangar
		Sailplane	Seilfly
		Undefined	Luftsport, ikke definert
Archer facility	Bueskytteranlegg	Archery shooting range (indoors)	Bueskytterhall
		Archery shooting range (outdoors)	Bueskytterbane
Athletics facility	Friidrettsanlegg	Athletics stadium	Friidrettsstadion

		Gravel track	Friidrett grusbane
		Indoors stadium	Friidrettshall
		Subsidiary facility	Delanlegg friidrett
		Synthetic track	Friidrett kunststoffbane
		Timer/secretariat etc.	Tidtaker/sekretariat m.m.
		Undefined	Friidrett ubestemt
Bowling facility	Bowlinganlegg	Bowling hall	Bowlinghall
Culture House	Kulturbygg	Art gallery	Kulturbygg - Galleri
		Cinema	Kulturbygg - Kino
		Concert hall	Kulturbygg - Konsertsal
		General culture house	Kulturbygg - Allment kulturhus
		Library	Kulturbygg - Bibliotek
		Local culture house	Lokalt kulturbygg
		Museum	Kulturbygg - Museum
		Other rooms	Kulturbygg - Andre lokaler
		Owned by organisation	Organisasjonseid hus
		Regional culture house	Regionalt kulturbygg
		Theatre	Kulturbygg - Teater
Equestrian Facility	Hestesportanlegg	Dressage arena	Dressurbane
		Manege	Ridebane
		Race course gallop	Galoppbane
		Race course trotting	Travbane
		Riding hall	Ridehall
		Stable	Stall
		Trail	Ridesti
		Undefined	Rideanlegg ikke def
Football facility	Fotballanlegg	Artificial turf	Fotball kunstgressbane
		Grass pitch	Fotball gressbane
		Gravel pitch	Fotball grusbane
		Large hall 100 x 60 m	Fotball Storhall 100 x 60 m
		Small hall 40 x 20 m	Fotball Minihall 40 x 20 m
		Training hall 70 x 50 m	Fotball Treningshall 70 x 50 m
		Undefined	Fotball ubestemt
Golf Facility	Golfanlegg	Driving range	Driving-Range
		Golf course 18 holes	Golfbane 18 hull
		Golf course 6 holes	Golfbane 6 hull
		Golf course 9 holes	Golfbane 9 hull
		Pitch-put	Pitch-put
		Short course	Korthullsbane

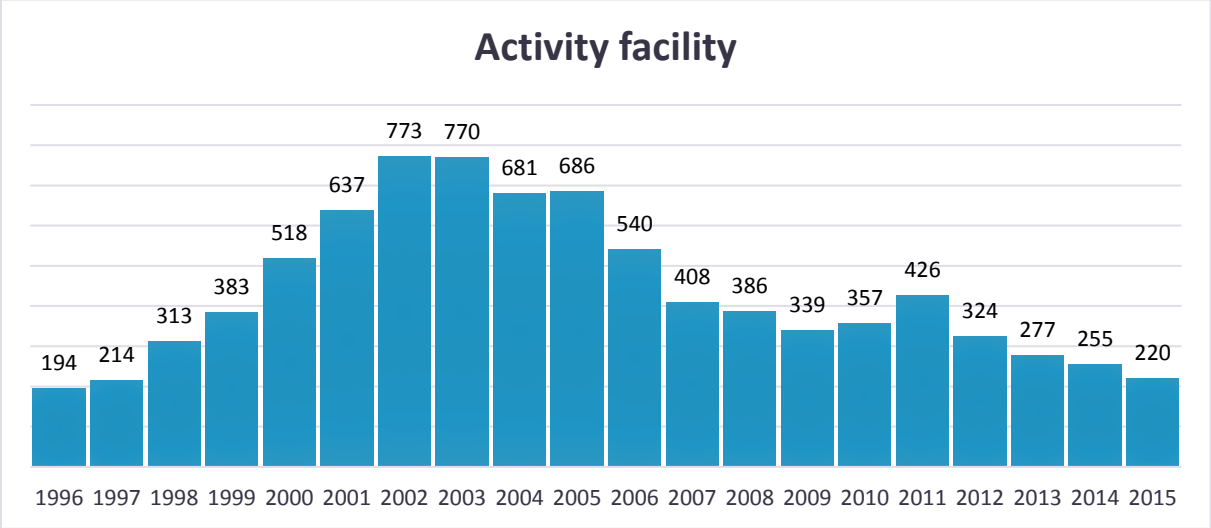
		Sports house	Idrettshus
Gymnastics facility	Turnanlegg	Basic hall gymnastics	Basishall turn
		Gymnasics hall	Turnhall
Ice facility	Isanlegg	Bandy court, artificial ice	Bandybane, kunstis
		Bandy court, natural ice	Bandybane, naturis
		Curling hall	Curlinghall
		Ice hall	Ishall
		Ice surface, artificial	Isflate, kunstis
		Ice hockey, artificial ice	Ishockey, kunstis
		Ice hockey, natural ice	Ishockey, naturis
		Speed skating hall	Hurtigløpshall
		Speed skating track, artificial ice	Hurtigløpsbane, kunstis
		Speed skating track, natural ice	Hurtigløpsbane, naturis
Map	Kart	Hiking map	Turkart
		Neighborhood/School map	Nærmiljøkart
		Orienteering map	Orienteringskart
		Other maps	Andre kart
		Ski orienteering map	Skiorienteringskart
Motorsports facility	Motorsportanlegg	Car cross track	Motorsport bilcrossbane
		Cross cart track	Motorsport crosscartbane
		Go cart	Motorsport Go-cart
		Motocross track	Motorsport motocrossløype
		Rallycross track	Motorsport Rallycrossbane
		Remote-controlled car track	Motorsport bane for radiostyrt bil
		Road racing track	Motorsport Road racing
		Snow scooter track	Motorsport Snøscooterbane
		Speedway	Motorsport Speedway
		Track racing	Motorcross baneracing
		Trial	Motorsport Trial
		Undefined	Motorsport, ikke def
Other facilities	Diverse anlegg	Baseball court	Baseballanlegg
		Billiards hall	Biljardhall
		Casting facility	Castinganlegg
		Cricket pitch	Cricketbane
		Fitness, unspecified	Helsesport ikke definert

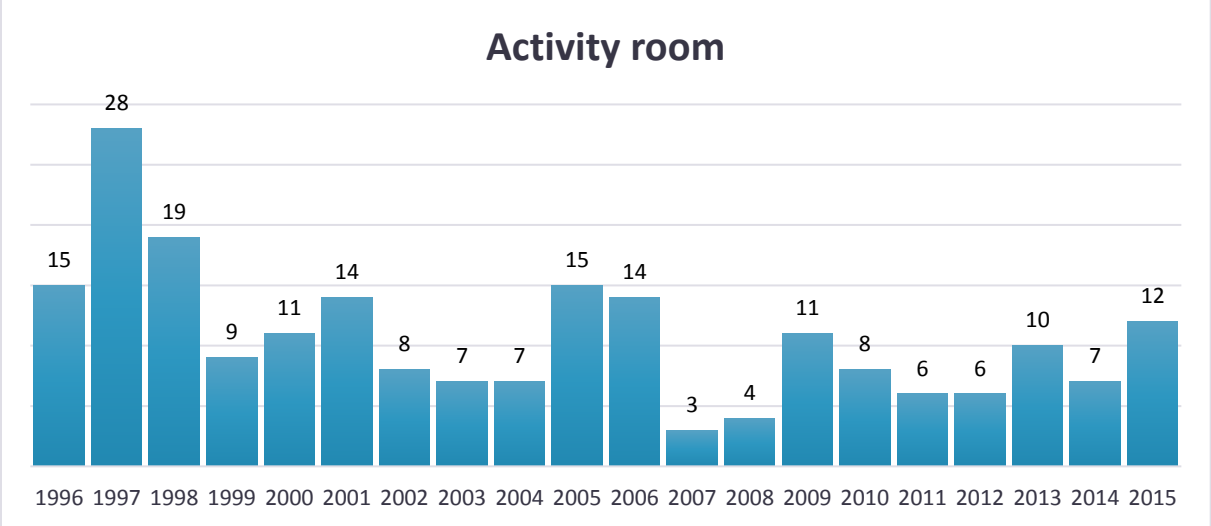
		Indoors climbing facility	Klatreanlegg (innendørs)
		Obstacle course (military)	Hinderbane (militær)
		Plastic tent	Plasthall
		Sanitary facility	Sanitæranlegg
		School facility	Skoleanlegg
		Sports ground	Idrettspark
		Undefined	Udefinert
		Velodrome	Velodrom
Outdoor recreation	Friluftsliv	Bathing place	Badeplass
		Cabin	Overnattingshytte
		Day trip huts	Dagsturhytter
		Harbor for small boats	Småbåthavn
		Large trail	Turvei
		Outdoor recreation area	Friluftsområde
		Outdoor recreation undefined	Friluftsliv ikke definert
		Security cabin	Sikringshytte
		Technical trail	Turløype
		Trail	Tursti
Sami sport facility	Samiske anlegg	Lassoing	Lassokasting
		Reindeer racing	Reinkappkjøring
Shooting facility	Skyteanlegg	Biathlon facility	Skiskytteranlegg
		Clay pigeon shooting range	Lerduebane
		Field shooting	Feltskyting
		Gun shooting range (indoors)	Pistolbane (inne)
		Gun shooting range (outdoors)	Pistolbane (ute)
		Running target range	Viltmålbane
		Shooting house	Skytterhus
		Shooting range	Skytehall
		Shooting range (indoors)	Skytebane (inne)
		Shooting range (outdoors)	Skytebane (ute)
		Shooting range (shared)	Skytebane (felles)
		Shooting range 100 m	Skytebane 100m
		Shooting range 200 m	Skytebane 200m
		Shooting range 300 m	Skytebane 300m
Skiing facility	Skianlegg	Alpine facility	Alpinanlegg
		Cross country arena	Langrennstadion
		Cross country facility	Langrennsanlegg
		Dog racing	Hundekjøring
		Freestyle	Freestyle
		Roller ski track	Rulleskiløype
		Ski jumping	Hoppbakke
		Ski lift	Skitrekk

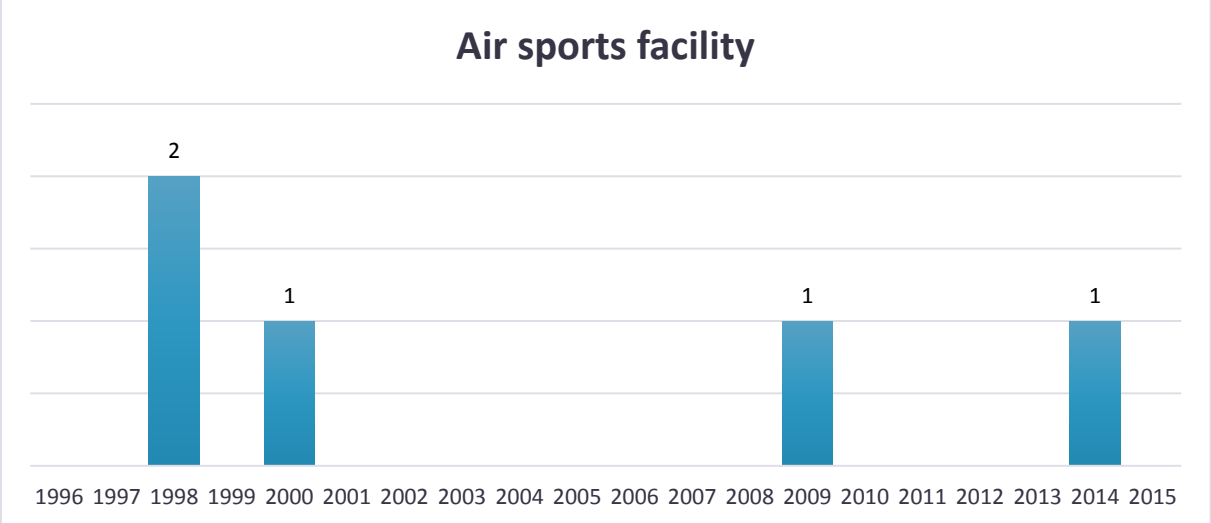
		Ski trail	Skiløype
		Snowboard	Snowboard
		Timer/secretariat etc.	Tidtaker/sekretariat m.m.
		Undefined	Skianlegg, ikke def
Sports hall	Flerbrukshall	Basketball hall	Basketballhall
		Large sports hall	Flerbrukshall, storhall
		Normal sports hall	Flerbrukshall, normalhall
		Small sports hall	Flerbrukshall, liten
		Volleyball hall	Volleyballhall
Sports house	Idrettshus	Changing room building	Garderobebygg
		Club house	Klubbhus
		Social area	Sosiale rom
		Sports house	Idrettshus
		Storage room (unspecified)	Lagerbygg (ikke spes)
		Training- and course center	Trenings-og kursenter
Squash facility	Squashanlegg	Squash court	Squashanlegg
Swimming facility	Bad og svømmeanlegg	Diving platform (indoors)	Stupeanlegg (inne)
		Diving platform (outdoors)	Stupeanlegg (ute)
		Leisure pools	Badeland/Park
		Swimming pool	Svømmebasseng
		Swimming pool (outdoors)	Svømmeanlegg (ute)
Tennis facility	Tennisanlegg	Overpressure hall	Overtrykkshall
		Tennis court	Tennisbane
		Tennis hall	Tennishall
Water sports facility	Vannsportanlegg	Boat harbor/dock	Båthavn/Brygge
		Boathouse	Båthus
		Floating dock	Flytebrygge
		Kayak facility	Kajakkanlegg
		Rowing facility	Roanlegg
		Sailing facility	Seilanlegg
		Timer/secretariat etc.	Tidtaker/sekretariat m.m.
		Water ski facility	Vannskianlegg
		Water sports facility	Vannsportsanlegg

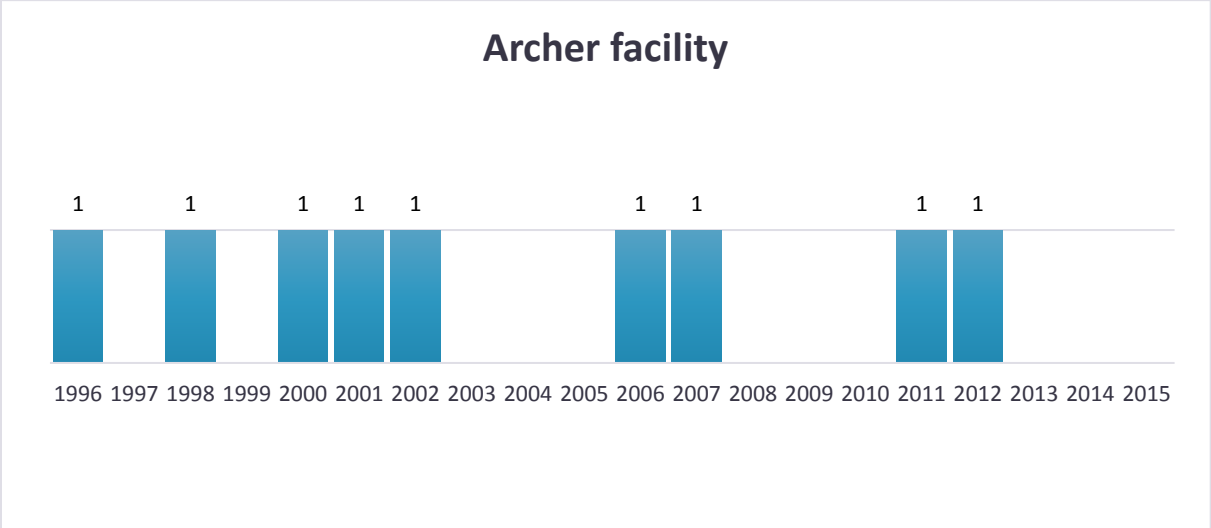
Appendix C: Overviews of built sports facilities

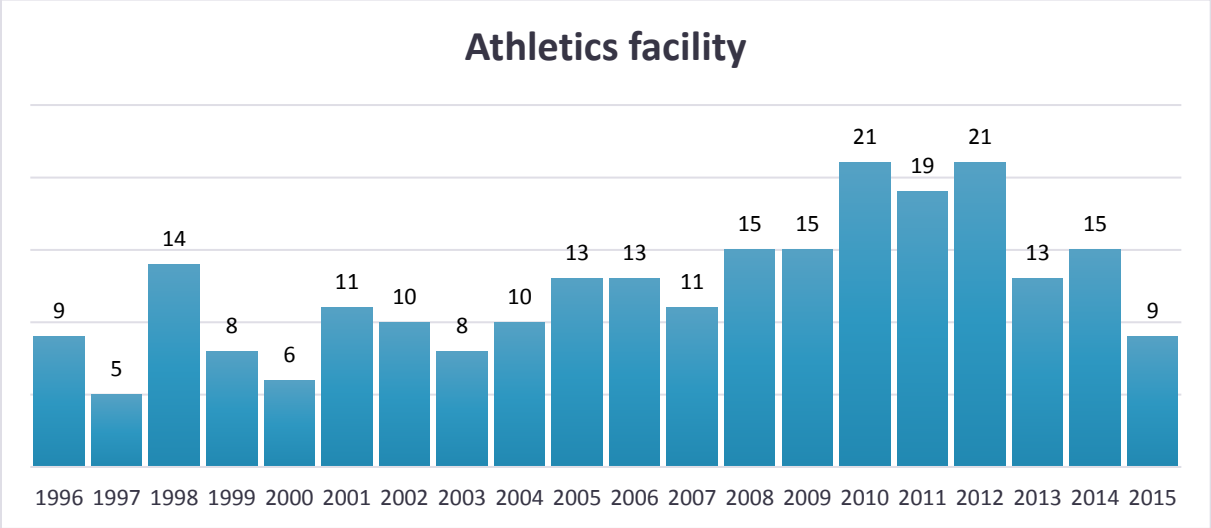
Number of built facilities 1996 - 2015








Archer facility
1 1 1 1 1 1 1 1 1
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Athletics facility
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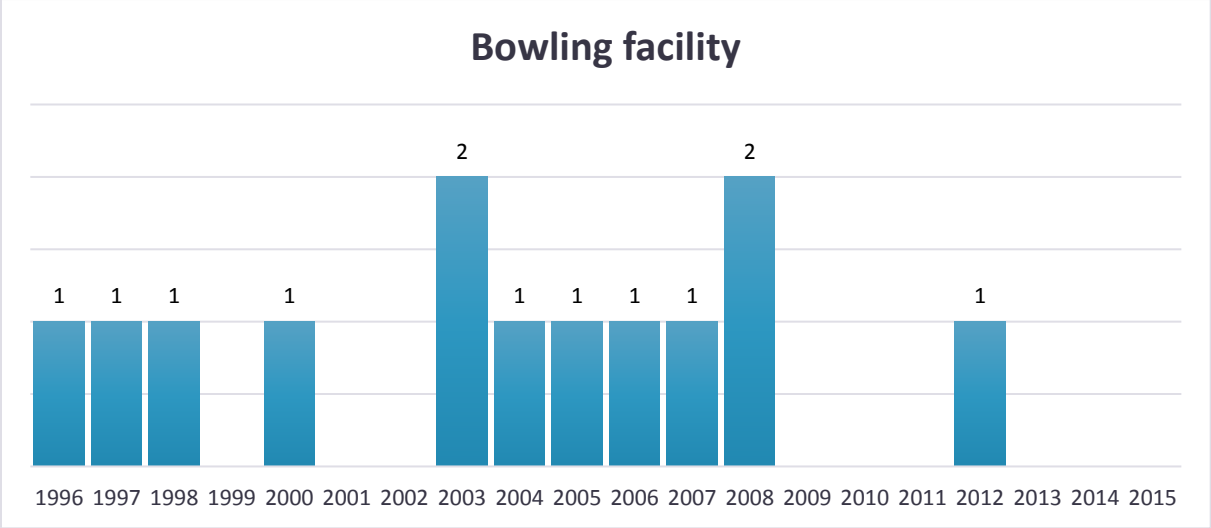
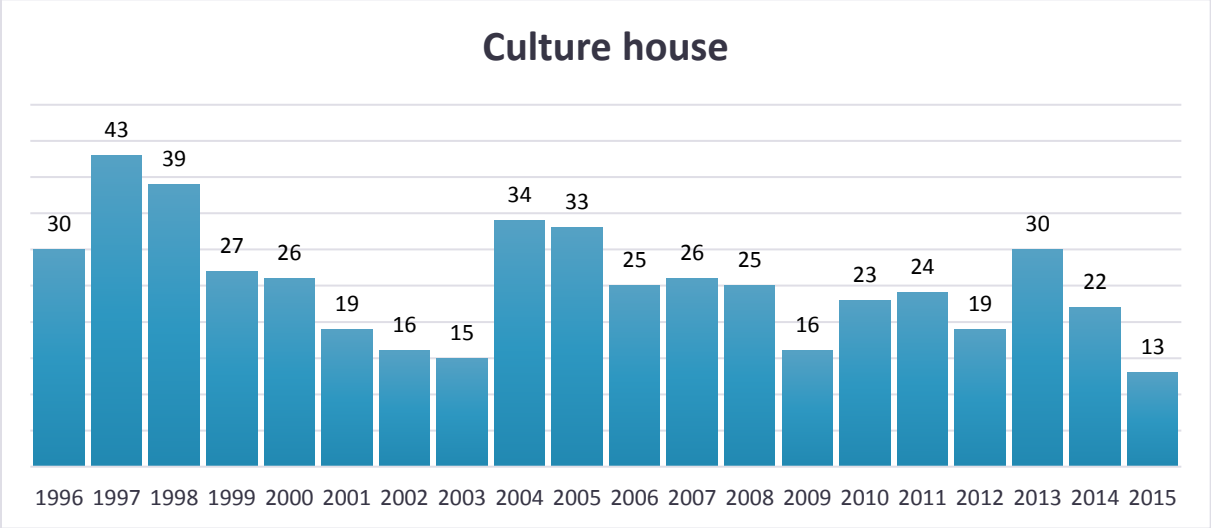
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Bowling facility
1 1 1 1 2 1 1 1 1 2 1
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Culture house
30
43
39
27
26
19
16
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33
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26
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16
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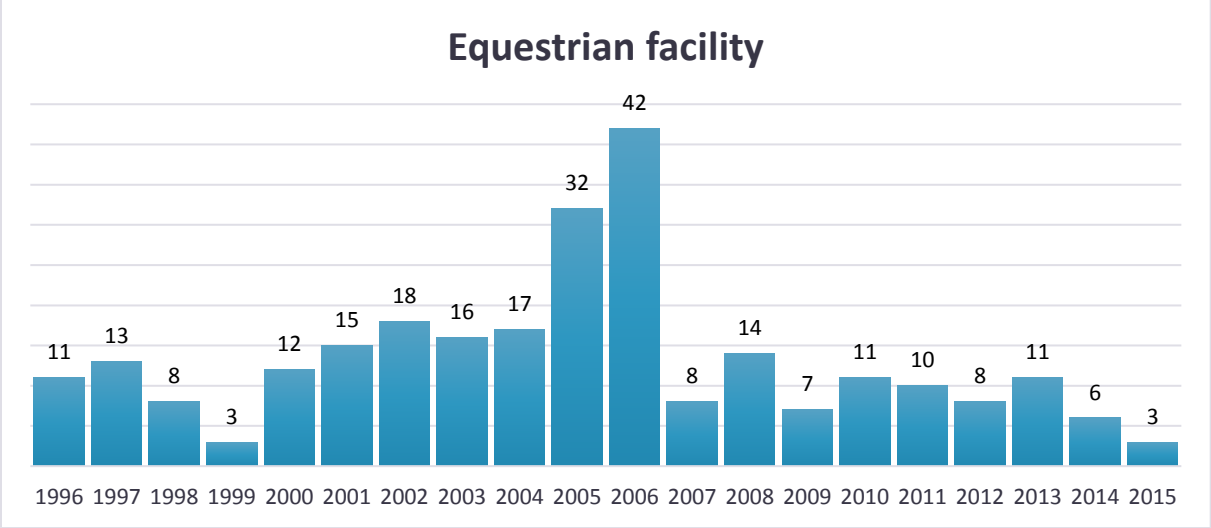
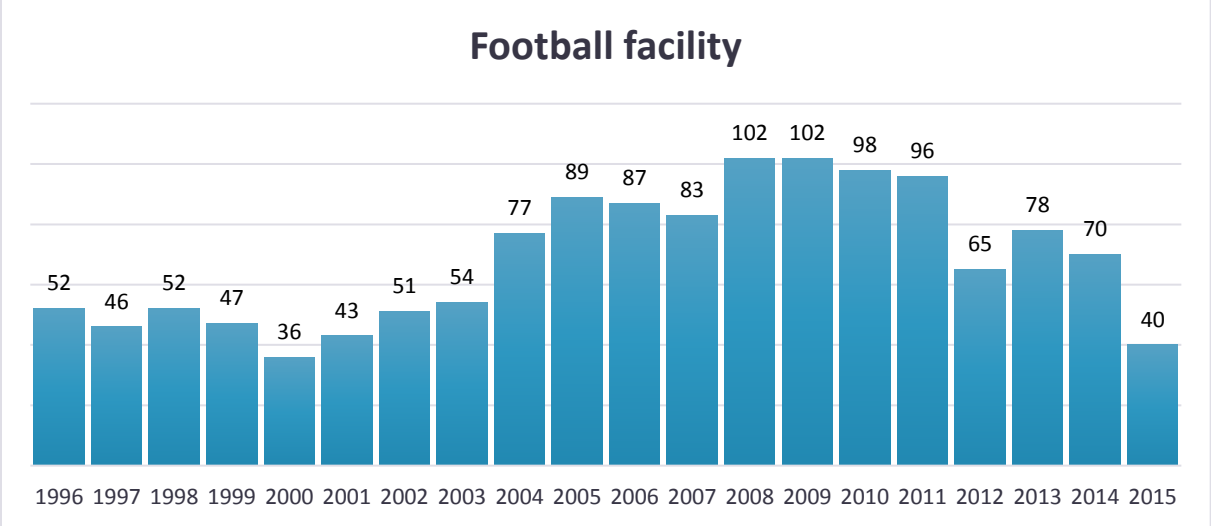
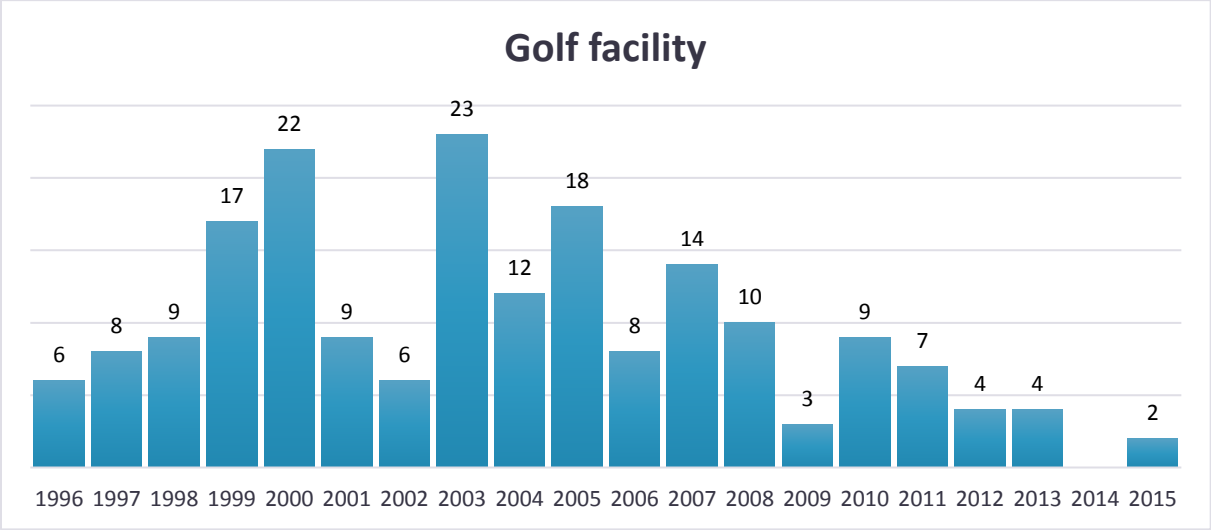
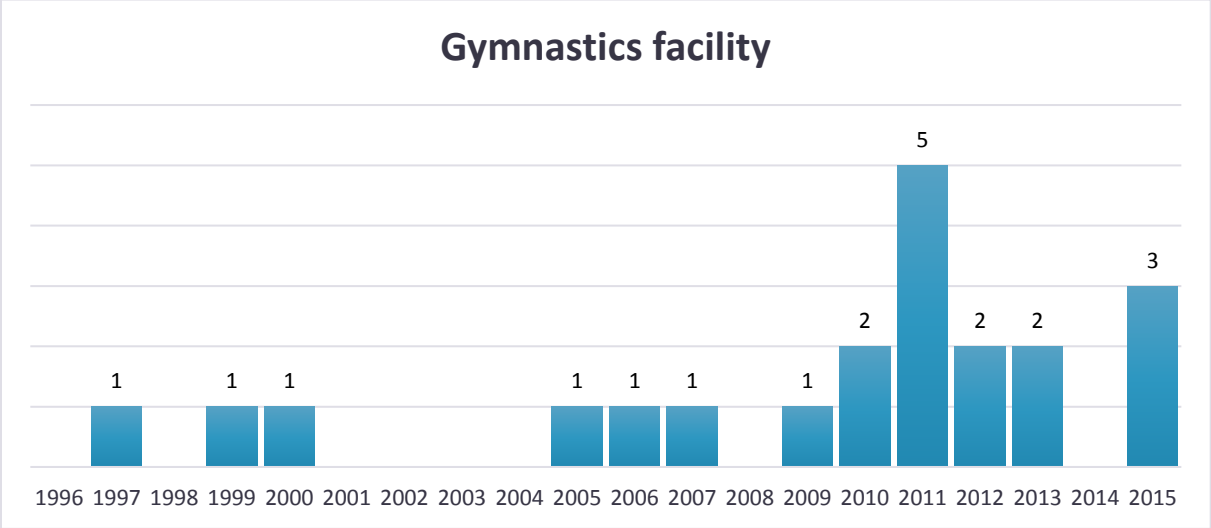
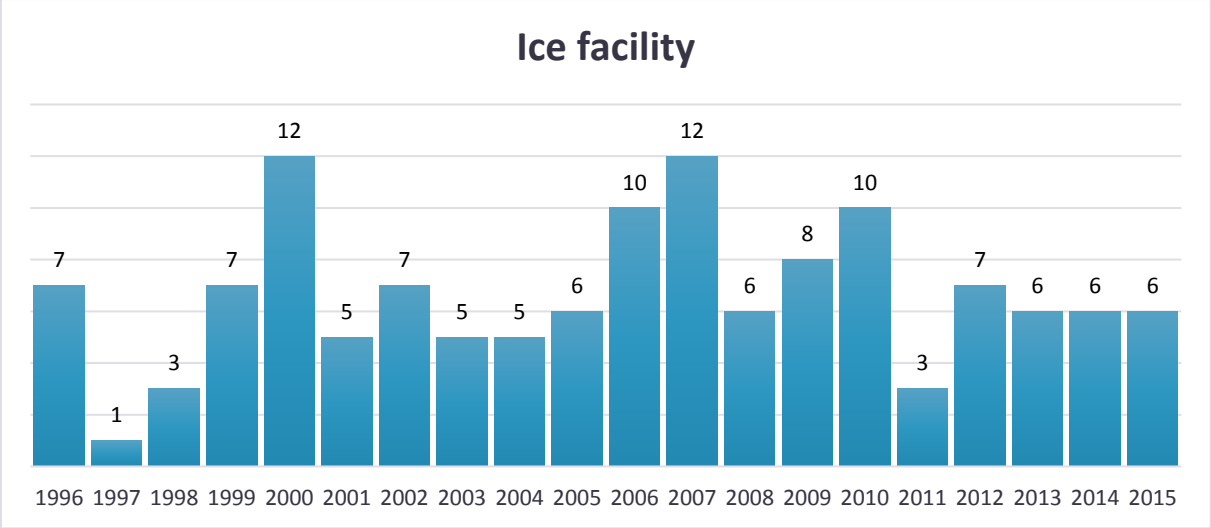
30
22
13
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Equestrian facility
11
13
8
3
12
15
18
16
17
32
42
8
14
7
11
10
8
11
6
3
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Football facility
52
46
52
47
36
43
51
54
77
89
87
83
102
102
98
96
65
78
70
40
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Golf facility
6
8
9
17
22
9
6
23
12
18
8
14
10
3
9
7
4
4
2
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Gymnastics facility
1
1
1
1
1
1
1
2
5
2
2
3
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Ice facility
7
1
3
7
12
5
7
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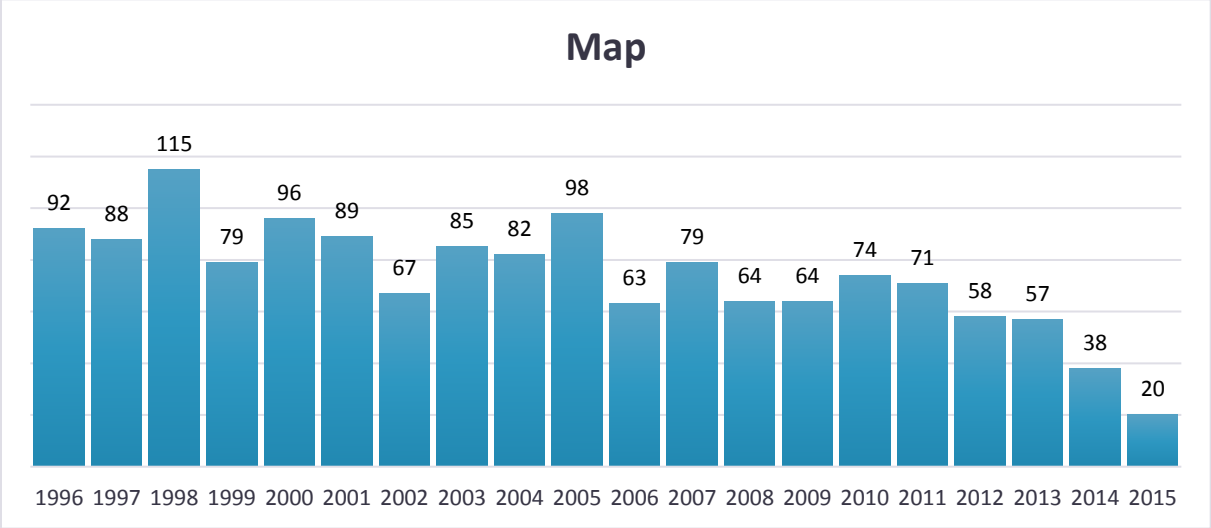
6
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Map
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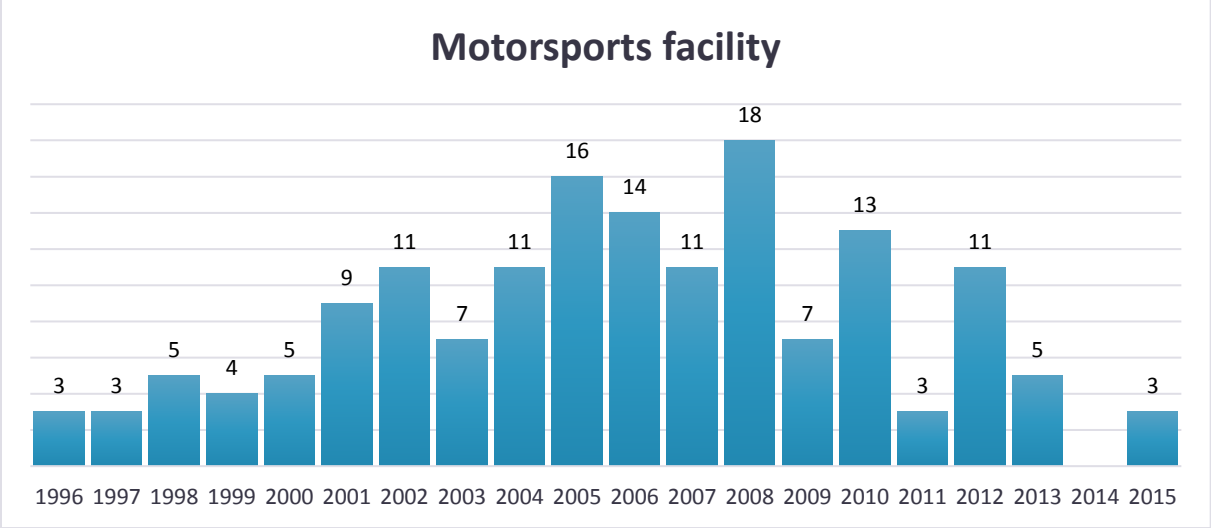
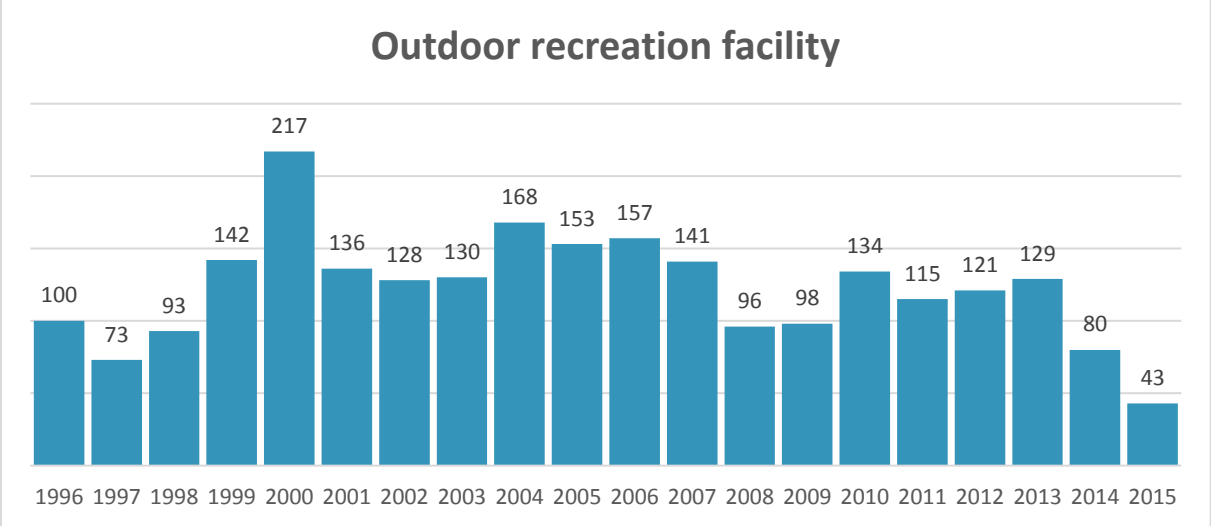
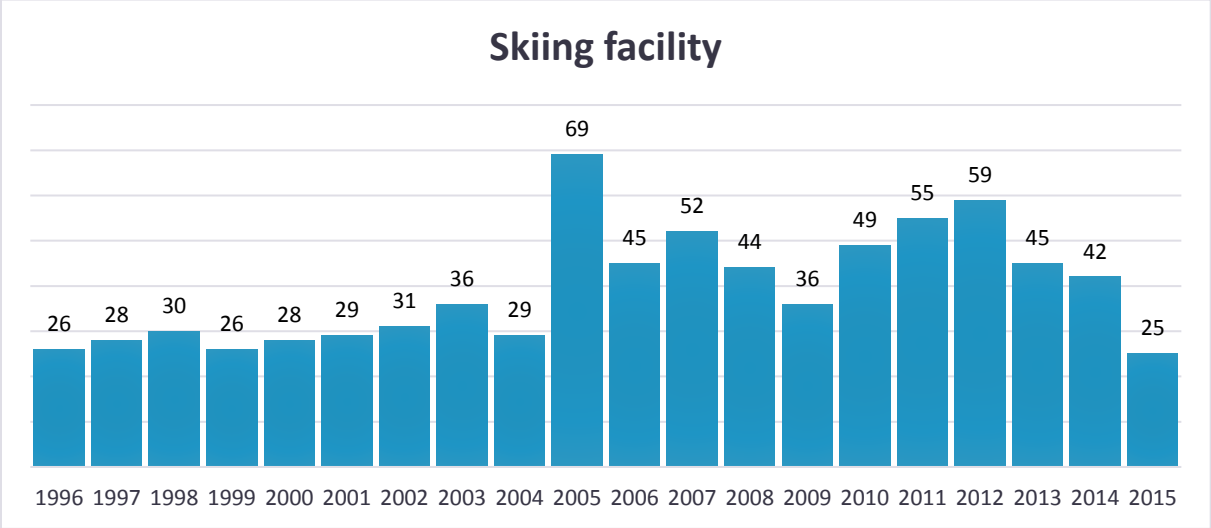
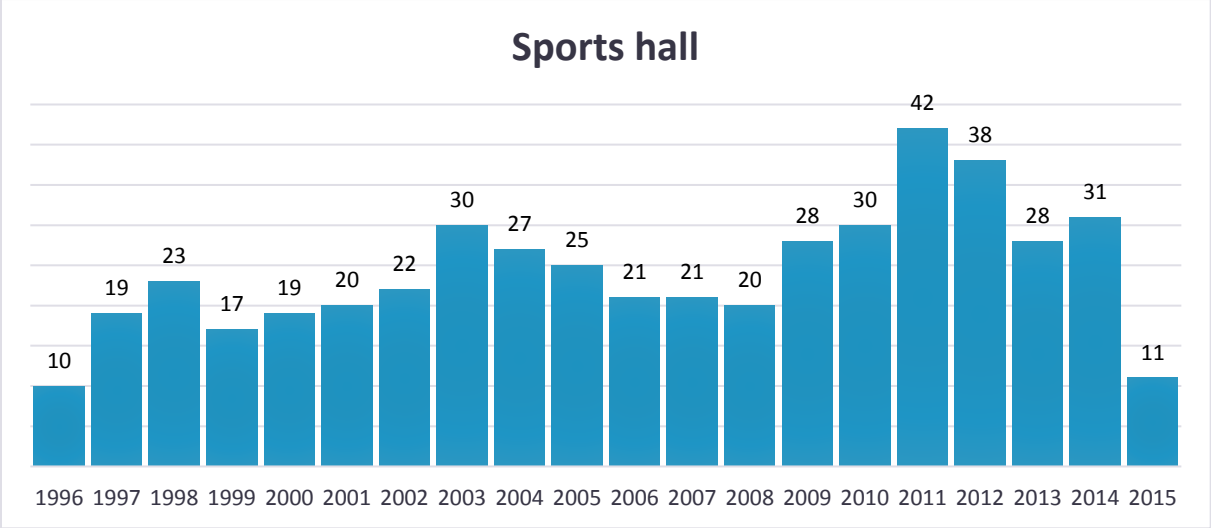
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Motorsports facility
3 3 5 4 5 9 11 7 11 16 14 11 18 7 13 3 11 5 3
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Outdoor recreation facility
100 73 93 142 217 136 128 130 168 153 157 141 96 98 134 115 121 129 80 43
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Shooting facility
39 39 39 41 52 43 42 48 38 43 33 40 27 28 40 33 18 27 23 11
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Skiing facility
26 28 30 26 28 29 31 36 29 69 45 52 44 36 49 55 59 45 42 25
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Sports hall
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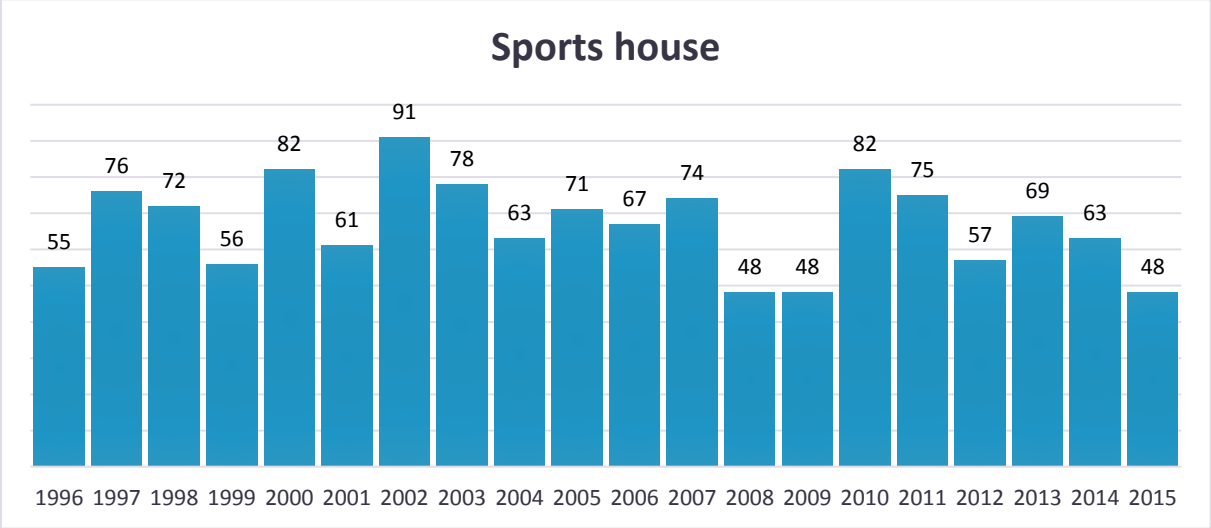
Sports house
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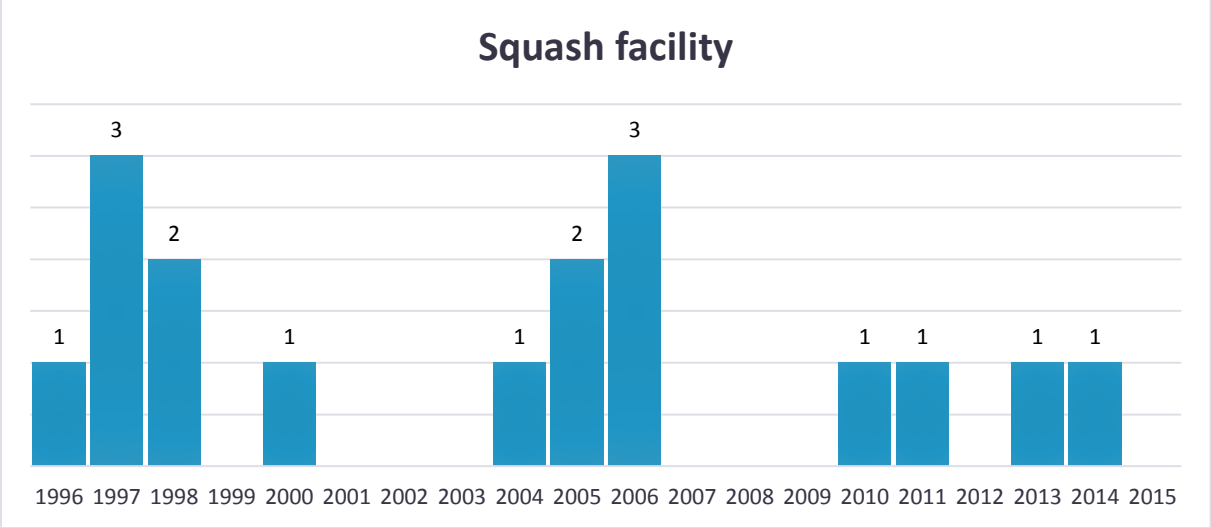
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Squash facility
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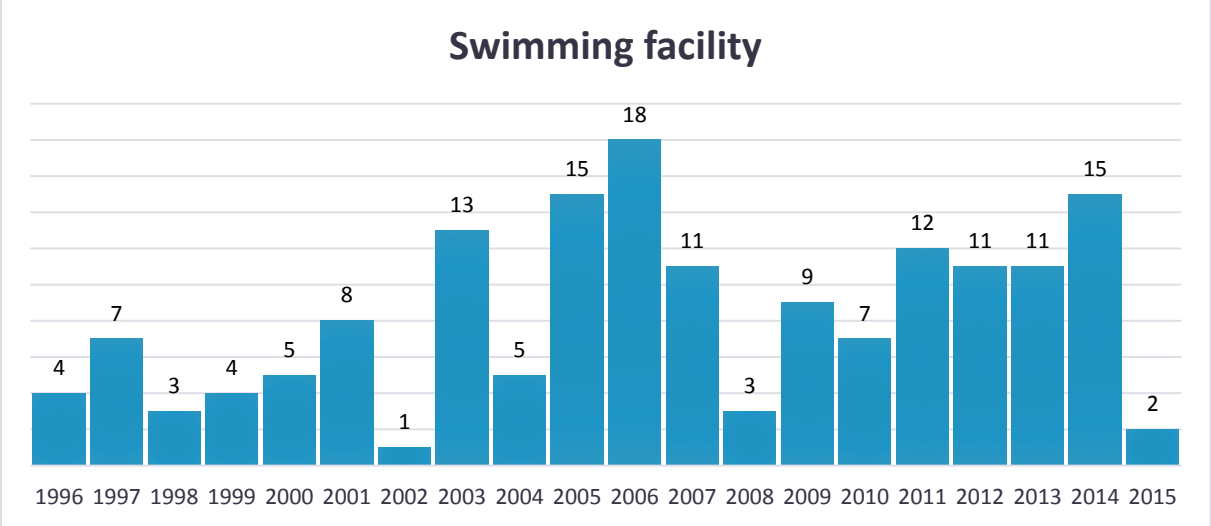
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Swimming facility
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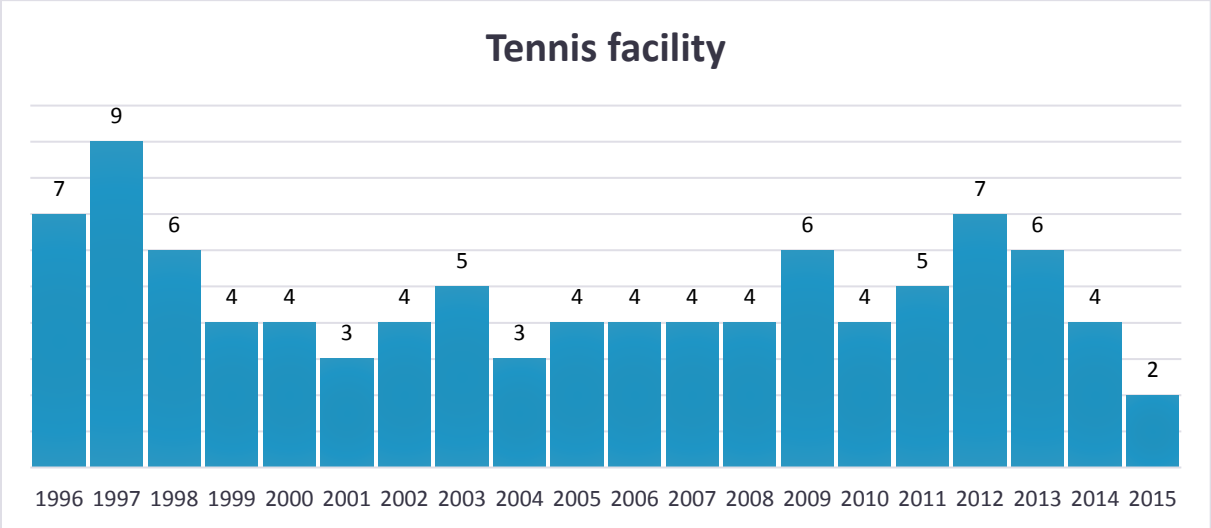
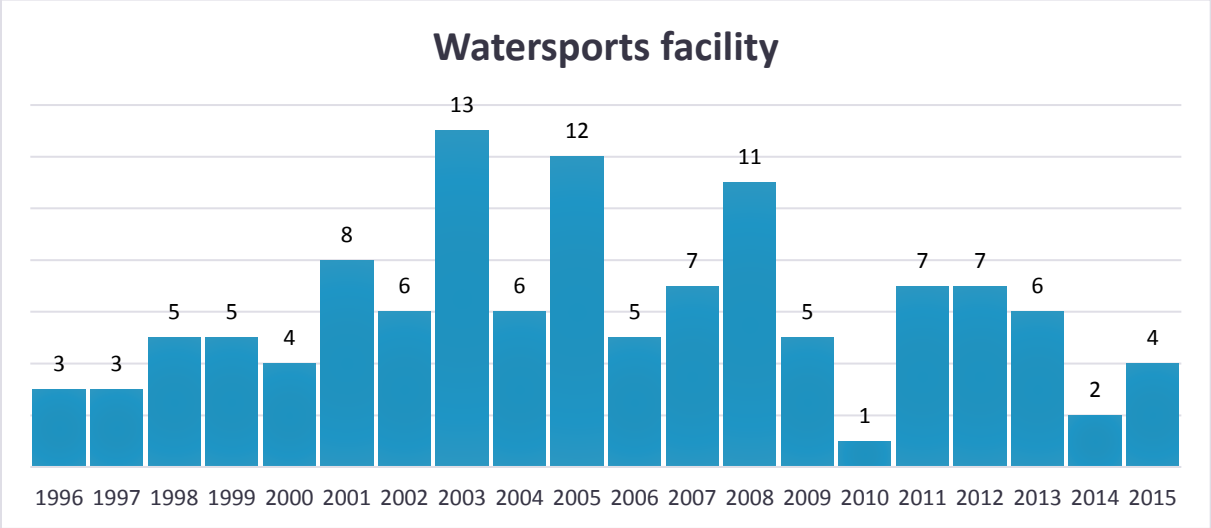
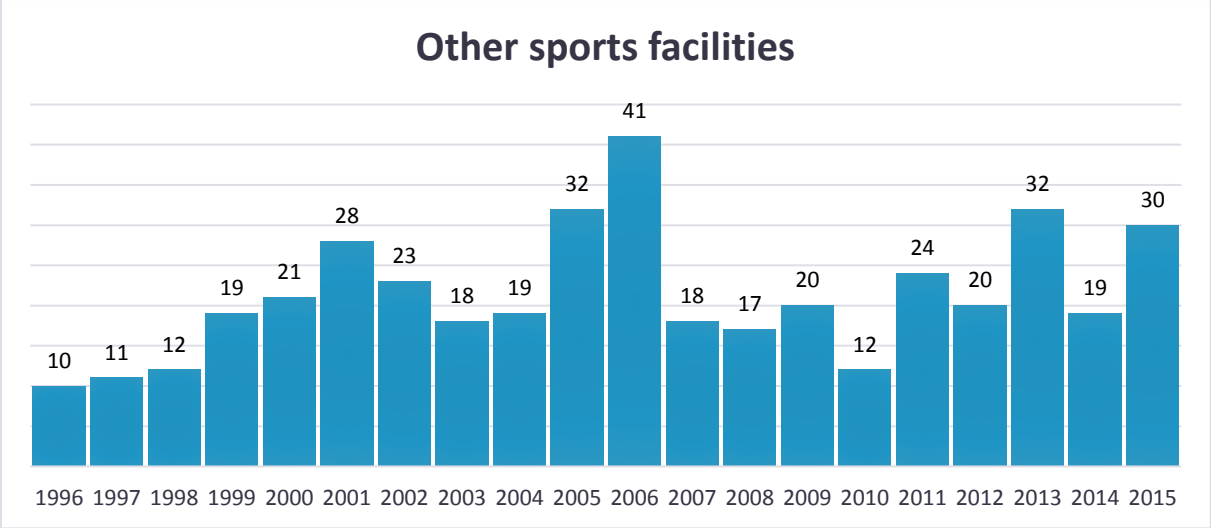
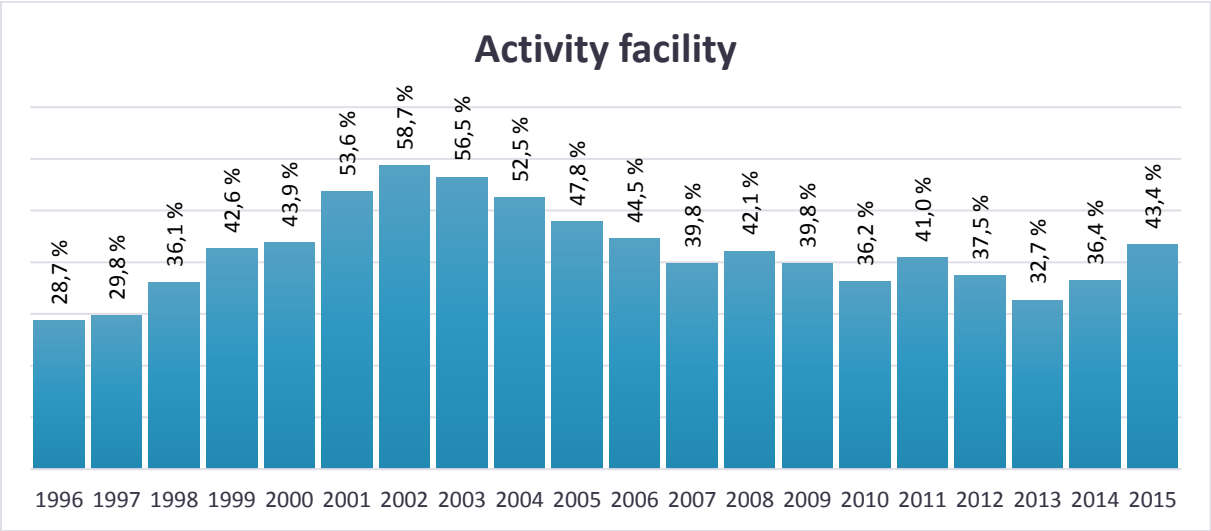
5
15
18
11
3
9
7
12
11
11
15
2
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

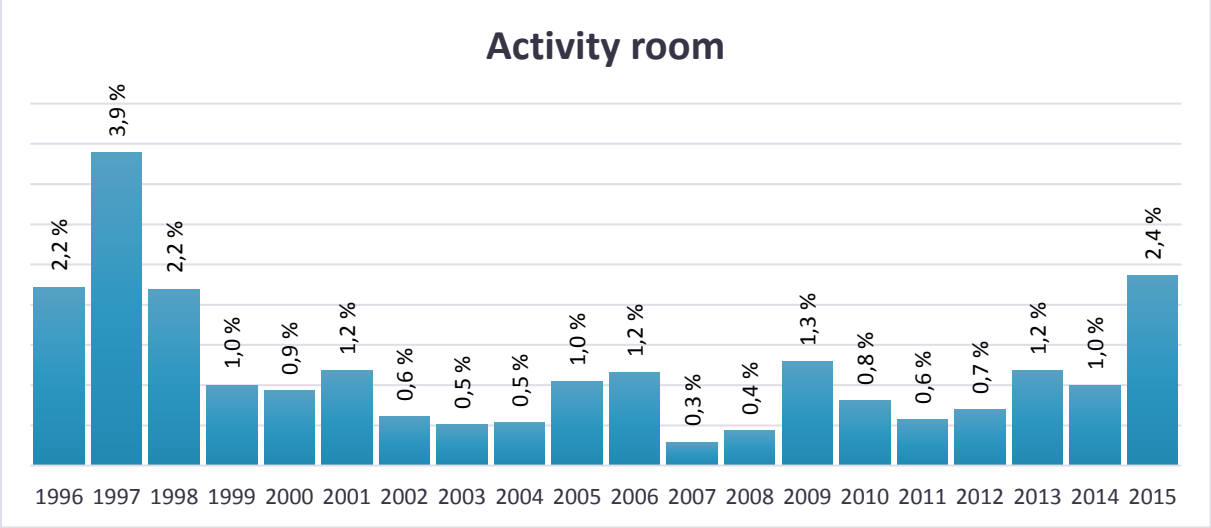

Tennis facility
7 9 6 4 4 3 4 5 3 4 4 4 4 6 4 5 7 6 4 2
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

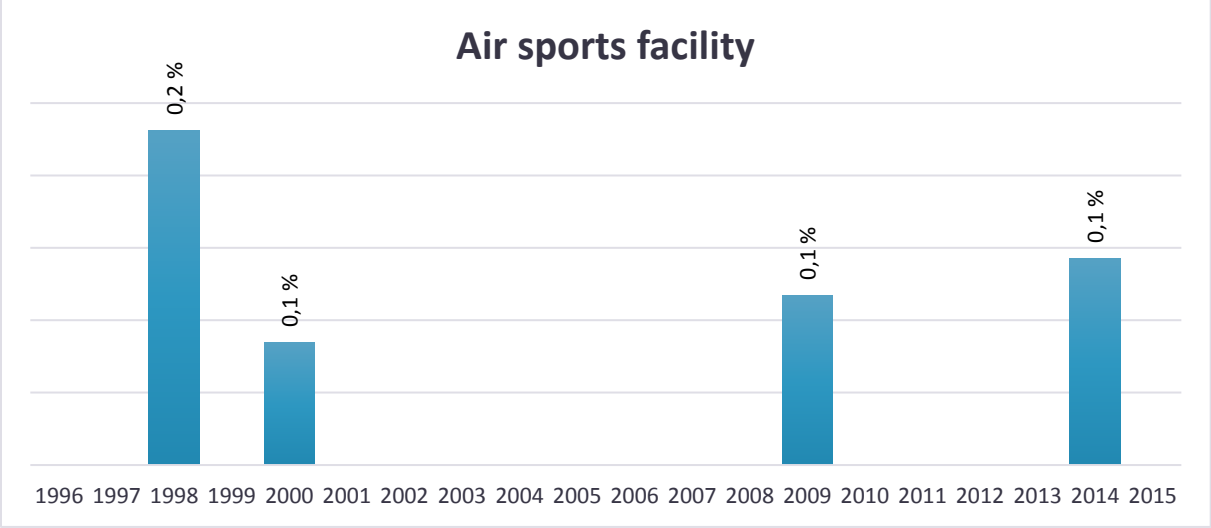

Watersports facility
3 3 5 5 4 8 6 13 6 12 5 7 11 5 1 7 7 6 2 4
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

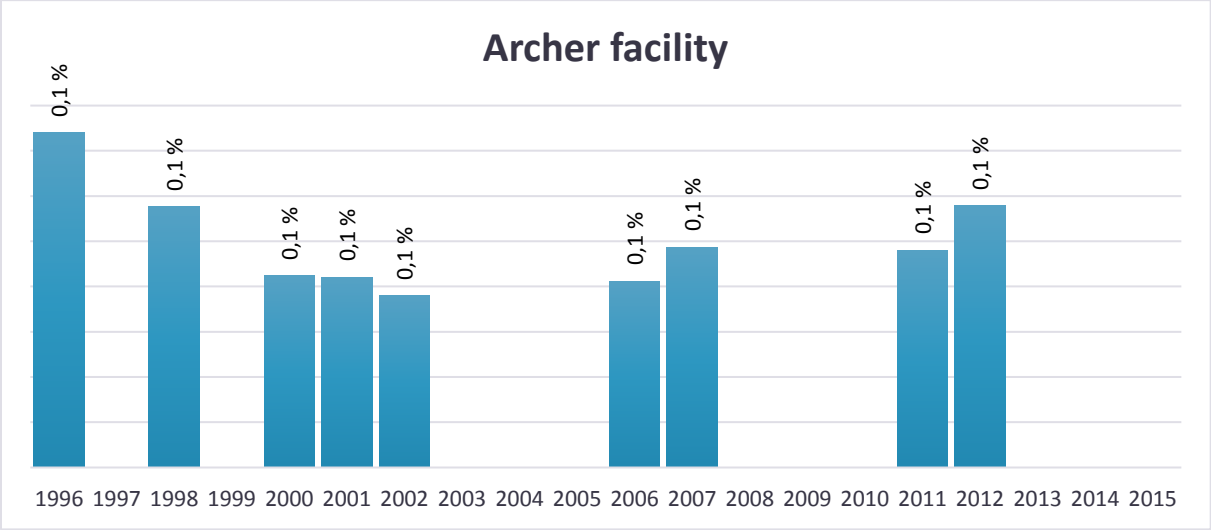

Other sports facilities
10 11 12 19 21 28 23 18 19 32 41 18 17 20 12 24 20 32 19 30
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

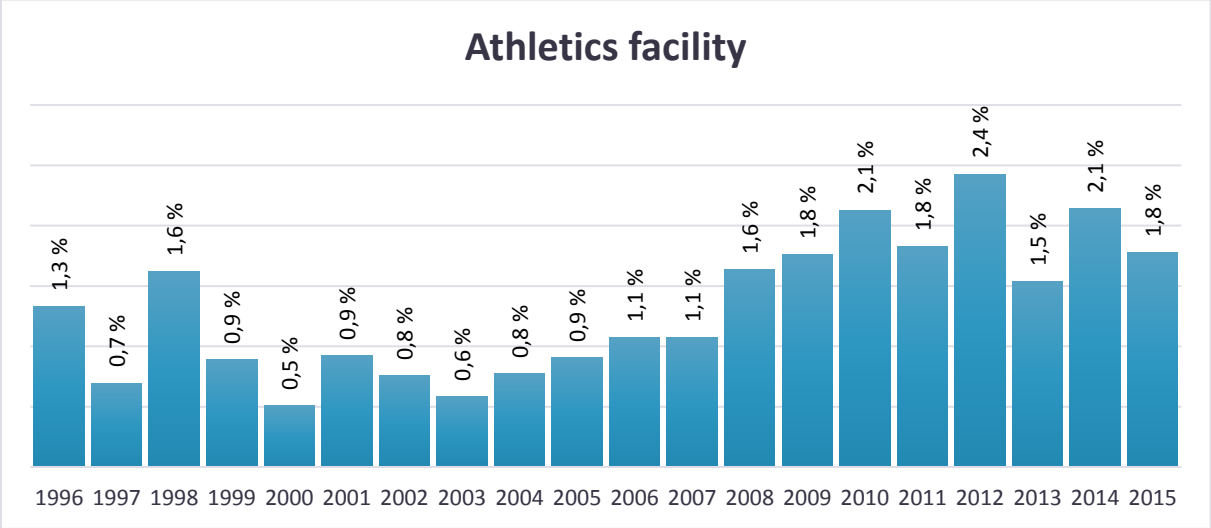
Proportion of total number of built sports facilities 1996 - 2015

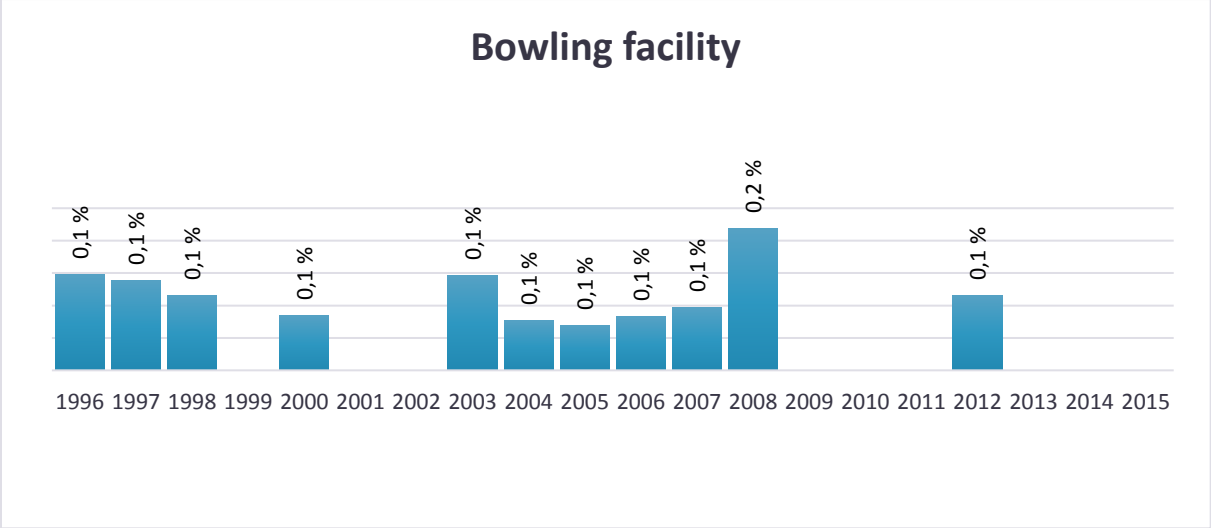


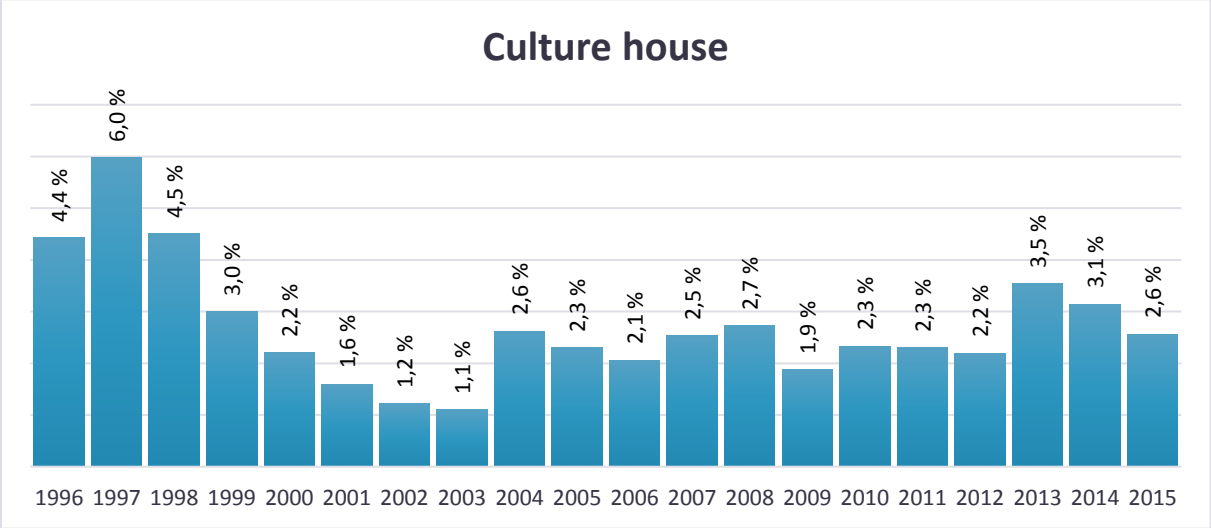


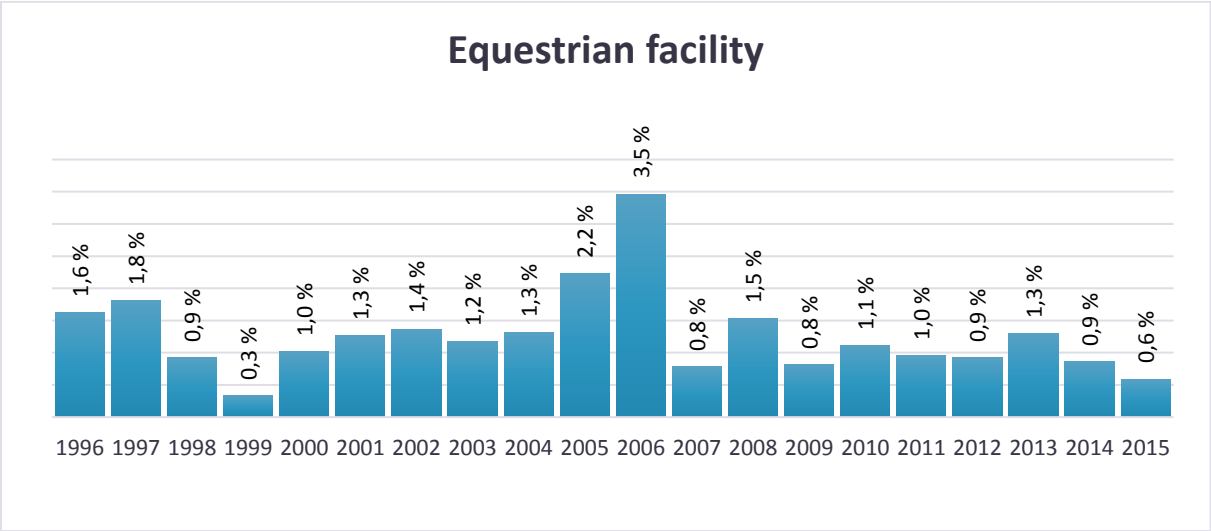


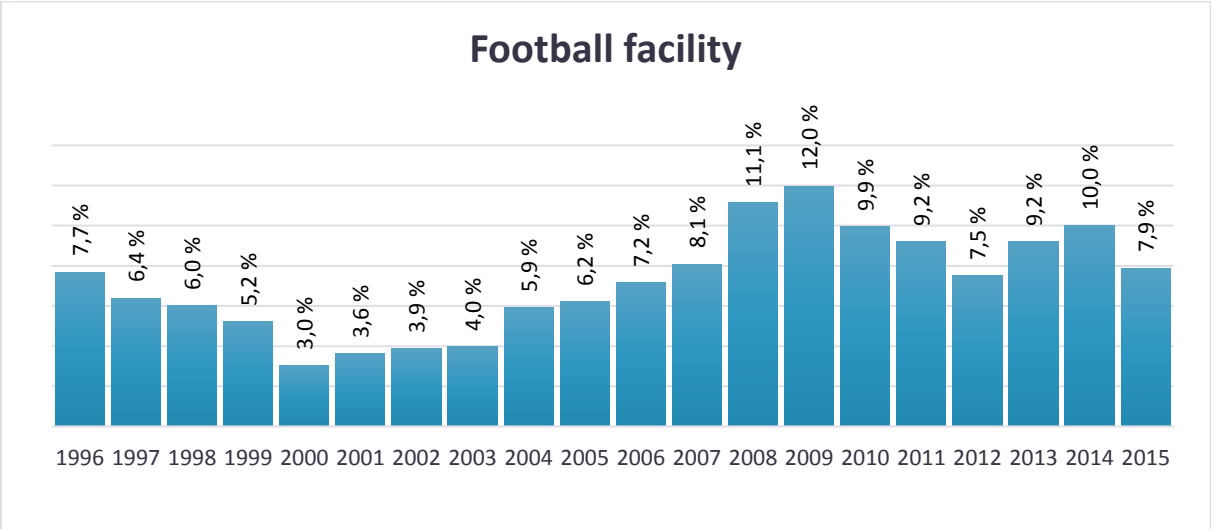

Archer facility
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

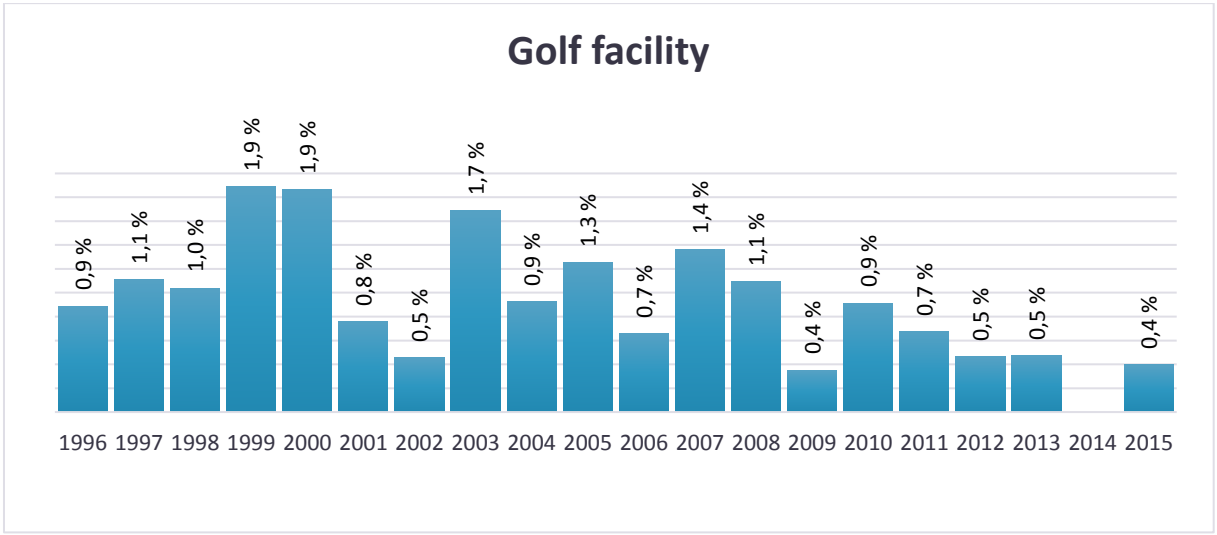

Athletics facility
1,3 %
0,7 %
1,6 %
0,9 %
0,5 %
0,9 %
0,8 %
0,6 %
0,8 %
0,9 %
1,1 %
1,1 %
1,6 %
1,8 %
2,1 %
1,8 %
2,4 %
1,5 %
2,1 %
1,8 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

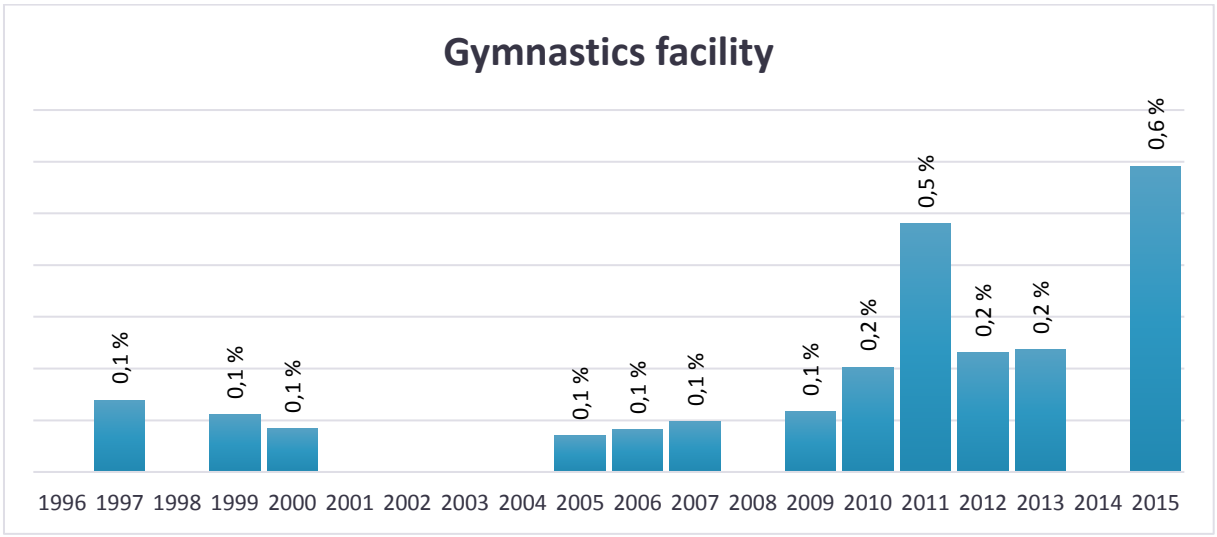

Bowling facility
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,2 %
0,1 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

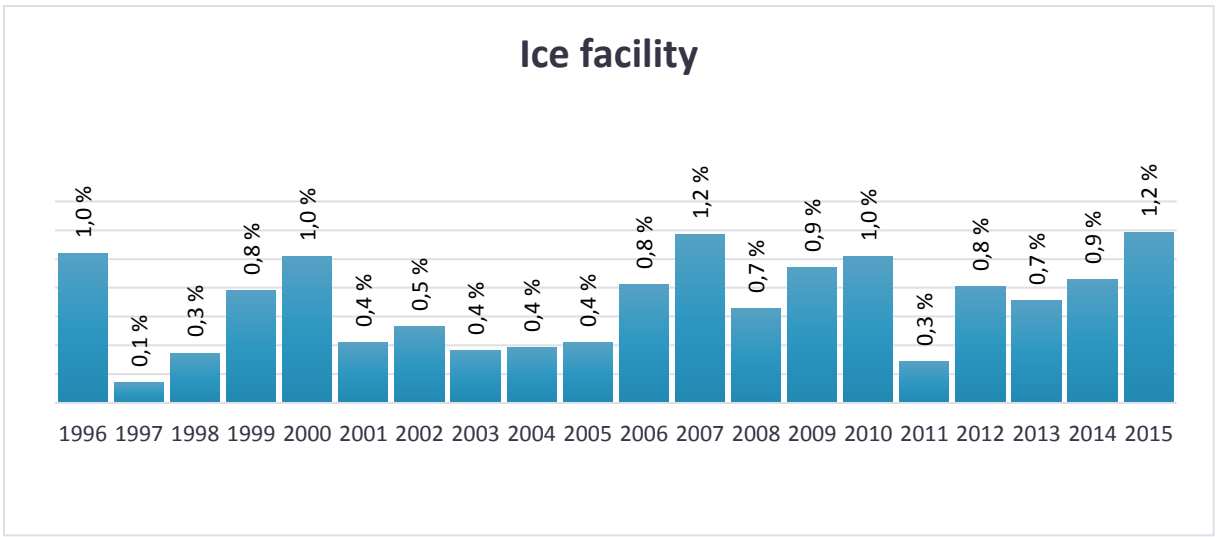

Culture house
4,4 %
6,0 %
4,5 %
3,0 %
2,2 %
1,6 %
1,2 %
1,1 %
2,6 %
2,3 %
2,1 %
2,5 %
2,7 %
1,9 %
2,3 %
2,3 %
2,2 %
3,5 %
3,1 %
2,6 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

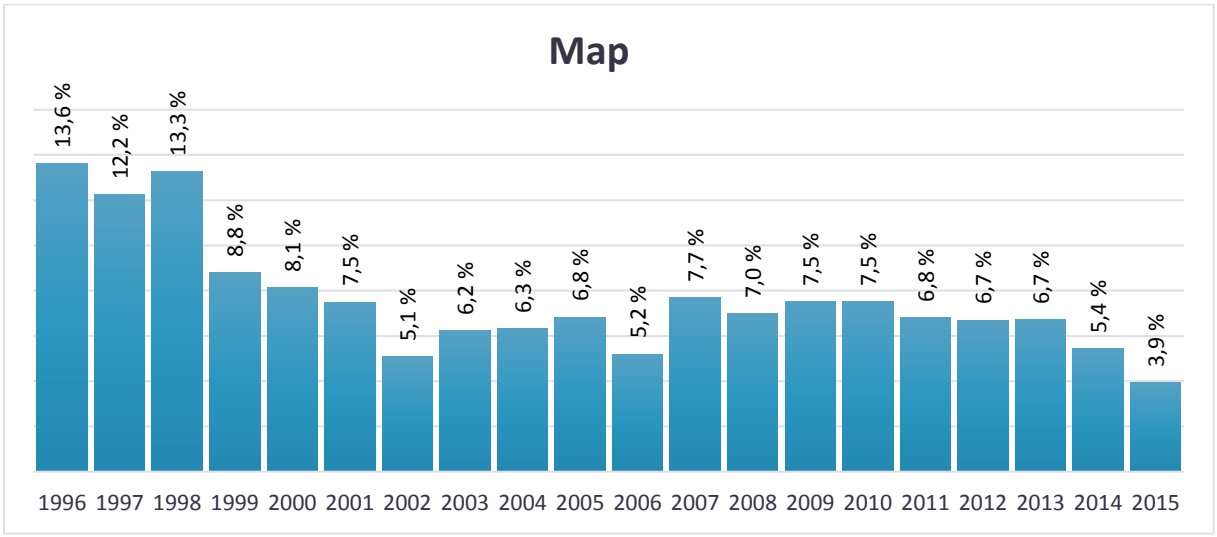

Equestrian facility
1,6 %
1,8 %
0,9 %
0,3 %
1,0 %
1,3 %
1,4 %
1,2 %
1,3 %
2,2 %
3,5 %
0,8 %
1,5 %
0,8 %
1,1 %
1,0 %
0,9 %
1,3 %
0,9 %
0,6 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

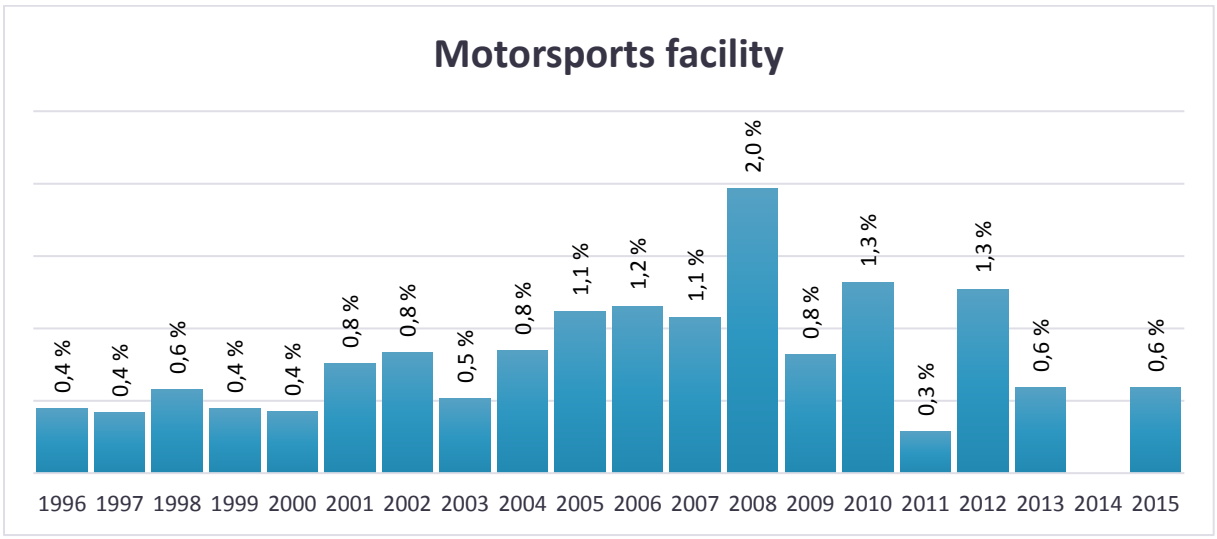

Football facility
7,7 %
6,4 %
6,0 %
5,2 %
3,0 %
3,6 %
3,9 %
4,0 %
5,9 %
6,2 %
7,2 %
8,1 %
11,1 %
12,0 %
9,9 %
9,2 %
7,5 %
9,2 %
10,0 %
7,9 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

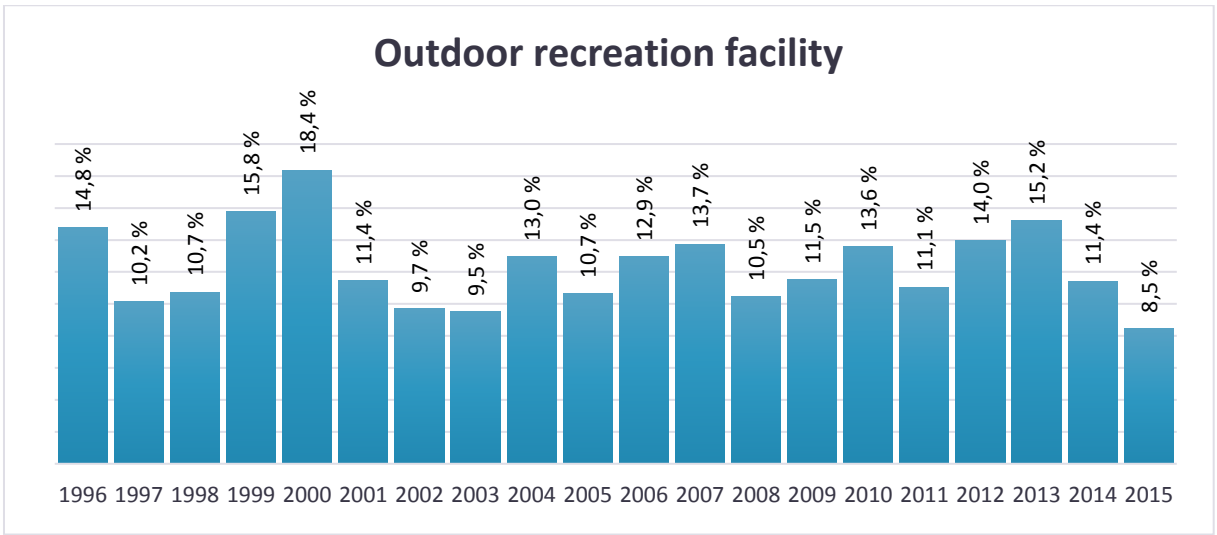

Golf facility
0,9 %
1,1 %
1,0 %
1,9 %
1,9 %
0,8 %
0,5 %
1,7 %
0,9 %
1,3 %
0,7 %
1,4 %
1,1 %
0,4 %
0,9 %
0,7 %
0,5 %
0,5 %
0,4 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Gymnastics facility
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,1 %
0,2 %
0,5 %
0,2 %
0,2 %
0,6 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

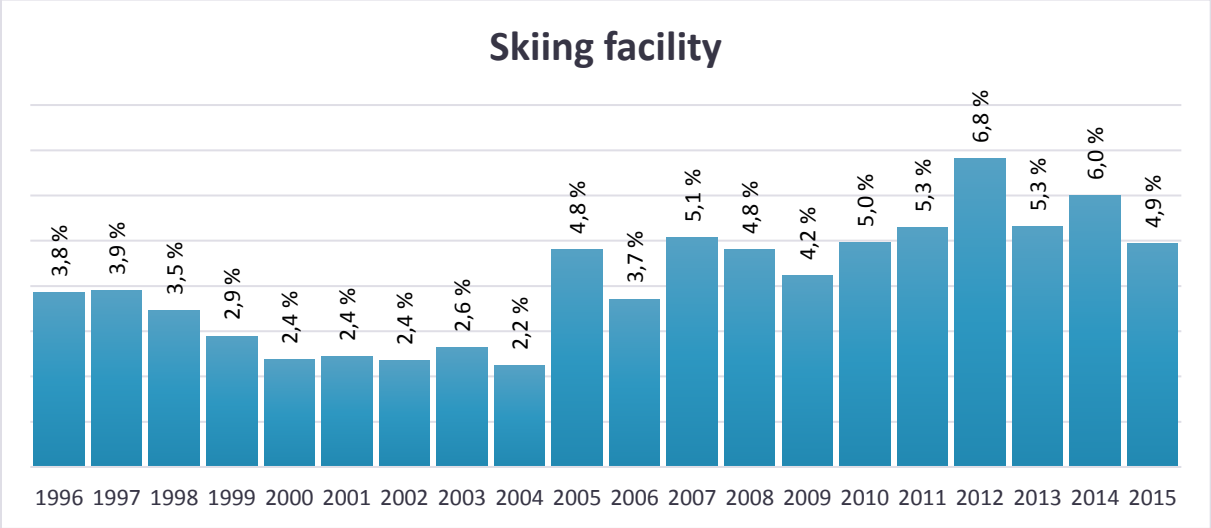

Ice facility
1,0 %
0,1 %
0,3 %
0,8 %
1,0 %
0,4 %
0,5 %
0,4 %
0,4 %
0,4 %
0,8 %
1,2 %
0,7 %
0,9 %
1,0 %
0,3 %
0,8 %
0,7 %
0,9 %
1,2 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

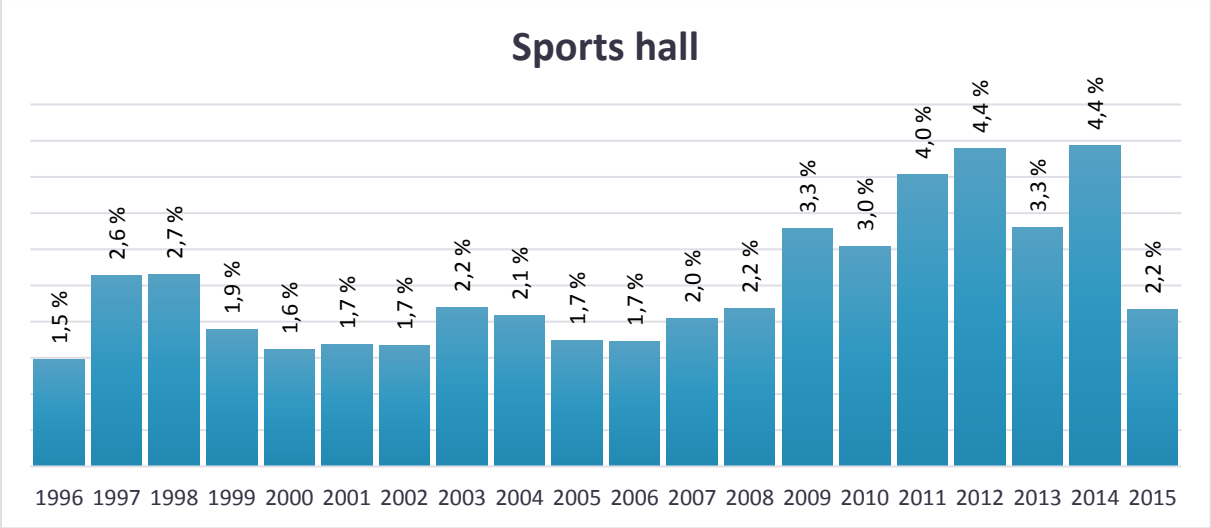

Map
13,6 %
12,2 %
13,3 %
8,8 %
8,1 %
7,5 %
5,1 %
6,2 %
6,3 %
6,8 %
5,2 %
7,7 %
7,0 %
7,5 %
7,5 %
6,8 %
6,7 %
6,7 %
5,4 %
3,9 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

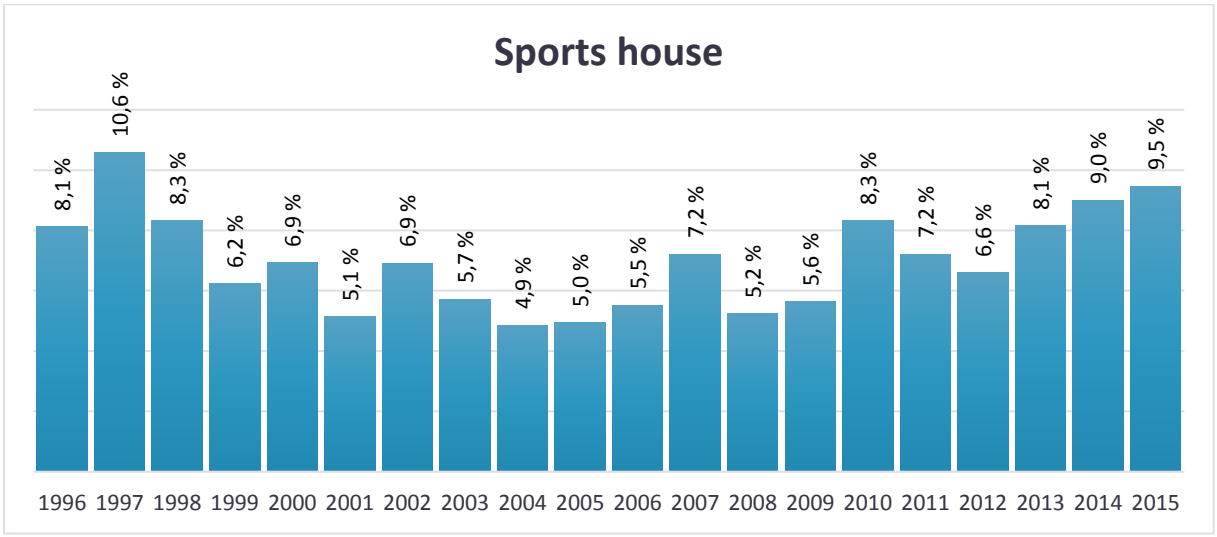

Motorsports facility
0,4 %
0,4 %
0,6 %
0,4 %
0,4 %
0,8 %
0,8 %
0,5 %
0,8 %
1,1 %
1,2 %
1,1 %
2,0 %
0,8 %
1,3 %
0,3 %
1,3 %
0,6 %
0,6 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

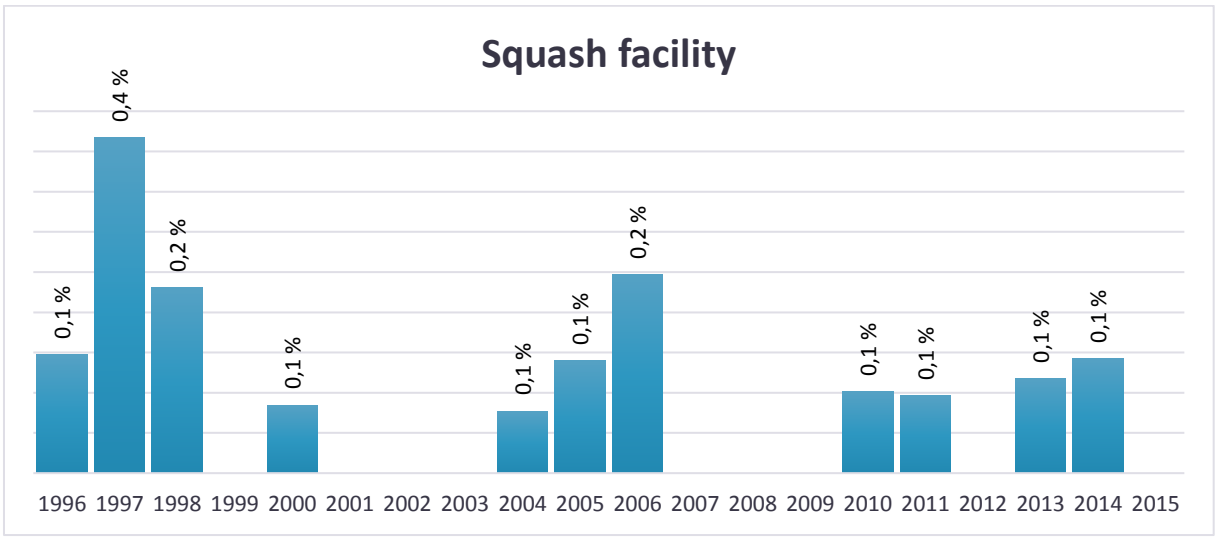

Outdoor recreation facility
14,8 %
10,2 %
10,7 %
15,8 %
18,4 %
11,4 %
9,7 %
9,5 %
13,0 %
10,7 %
12,9 %
13,7 %
10,5 %
11,5 %
13,6 %
11,1 %
14,0 %
15,2 %
11,4 %
8,5 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Shooting facility
5,8 %
5,4 %
4,5 %
4,6 %
4,4 %
3,6 %
3,2 %
3,5 %
2,9 %
3,0 %
2,7 %
3,9 %
2,9 %
3,3 %
4,1 %
3,2 %
2,1 %
3,2 %
3,3 %
2,2 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

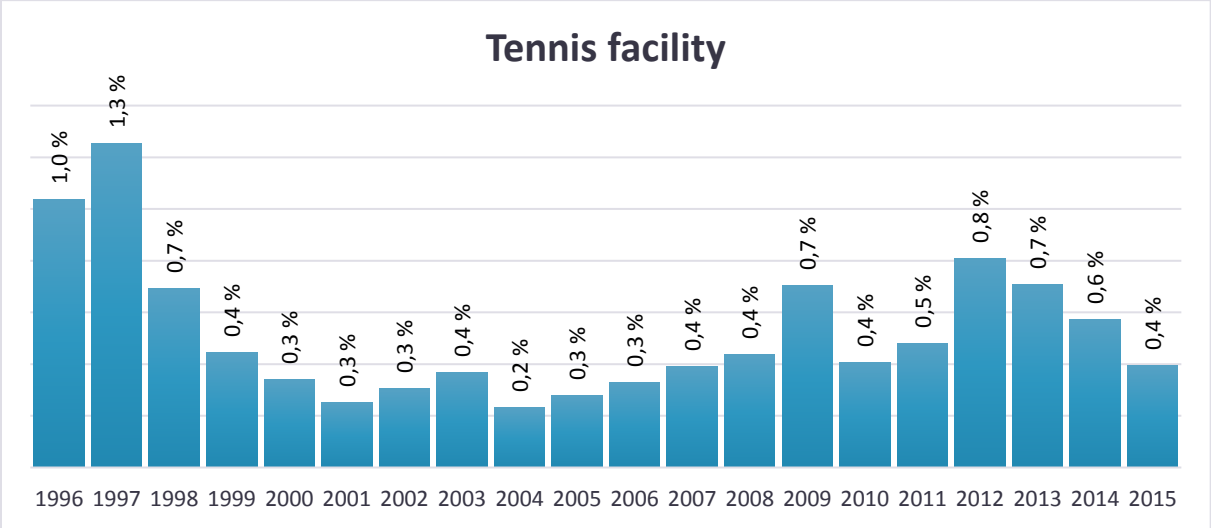

Skiing facility
3,8 %
3,9 %
3,5 %
2,9 %
2,4 %
2,4 %
2,4 %
2,6 %
2,2 %
4,8 %
3,7 %
5,1 %
4,8 %
4,2 %
5,0 %
5,3 %
6,8 %
5,3 %
6,0 %
4,9 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

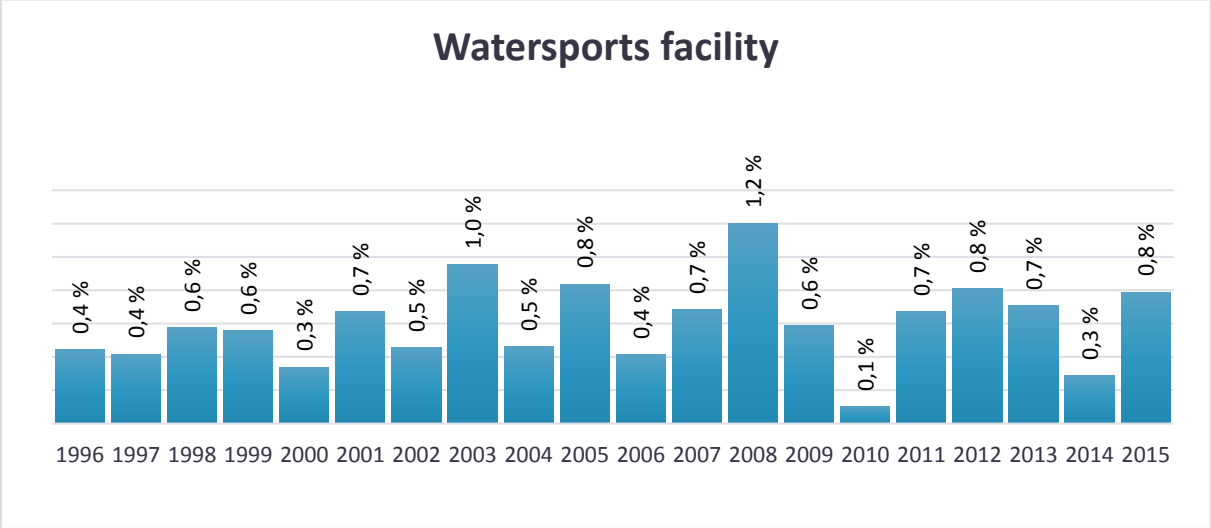

Sports hall
1,5 %
2,6 %
2,7 %
1,9 %
1,6 %
1,7 %
1,7 %
2,2 %
2,1 %
1,7 %
1,7 %
2,0 %
2,2 %
3,3 %
3,0 %
4,0 %
4,4 %
3,3 %
4,4 %
2,2 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

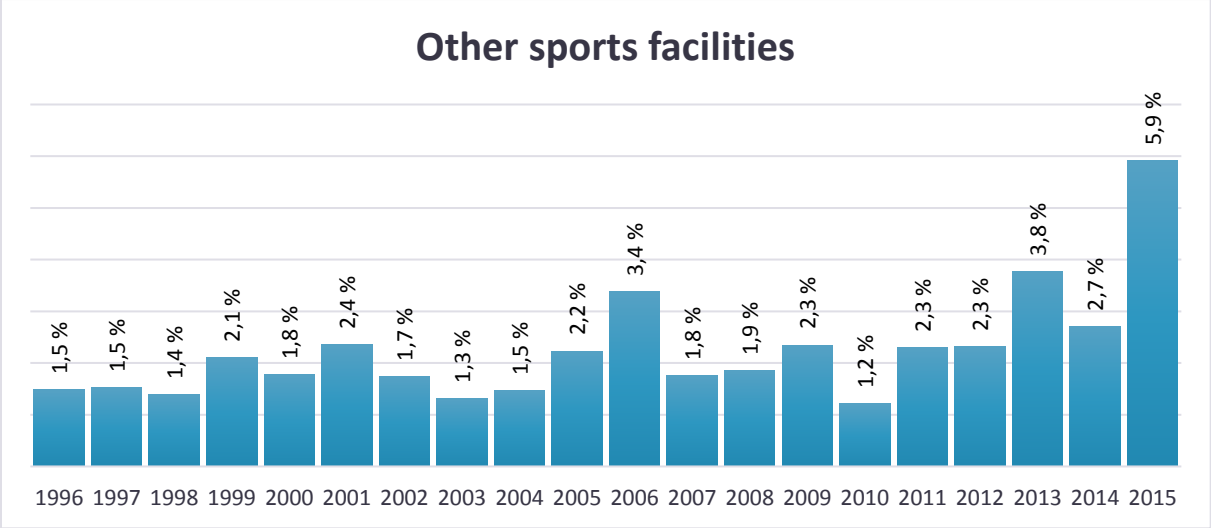

Sports house
8,1 %
10,6 %
8,3 %
6,2 %
6,9 %
5,1 %
6,9 %
5,7 %
4,9 %
5,0 %
5,5 %
7,2 %
5,2 %
5,6 %
8,3 %
7,2 %
6,6 %
8,1 %
9,0 %
9,5 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Squash facility
0,1 %
0,4 %
0,2 %
0,1 %
0,1 %
0,1 %
0,2 %
0,1 %
0,1 %
0,1 %
0,1 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Swimming facility
0,6 %
1,0 %
0,3 %
0,4 %
0,4 %
0,7 %
0,1 %
1,0 %
0,4 %
1,0 %
1,5 %
1,1 %
0,3 %
1,1 %
0,7 %
1,2 %
1,3 %
1,3 %
2,1 %
0,4 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Tennis facility
1,0 %
1,3 %
0,7 %
0,4 %
0,3 %
0,3 %
0,3 %
0,4 %
0,2 %
0,3 %
0,3 %
0,4 %
0,4 %
0,7 %
0,4 %
0,5 %
0,8 %
0,7 %
0,6 %
0,4 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Watersports facility
0,4 %
0,4 %
0,6 %
0,6 %
0,3 %
0,7 %
0,5 %
1,0 %
0,5 %
0,8 %
0,4 %
0,7 %
1,2 %
0,6 %
0,1 %
0,7 %
0,8 %
0,7 %
0,3 %
0,8 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Other sports facilities
1,5 %
1,5 %
1,4 %
2,1 %
1,8 %
2,4 %
1,7 %
1,3 %
1,5 %
2,2 %
3,4 %
1,8 %
1,9 %
2,3 %
1,2 %
2,3 %
2,3 %
3,8 %
2,7 %
5,9 %
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

Appendix D: Regression Model Details

Model 1a

Regression Analysis: Adjusted Cos versus Area; Years after; Region; ...

Method

Categorical predictor coding (1; 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS
Regression	13	1,00931E+17	48,15%	1,00931E+17	7,76391E+15
Area	1	5,89190E+16	28,11%	5,08736E+16	5,08736E+16
Years after 1996	1	2,14136E+16	10,22%	1,65281E+16	1,65281E+16
Region	5	1,58680E+16	7,57%	1,07024E+16	2,14048E+15
Population	2	4,38669E+15	2,09%	2,47641E+15	1,23821E+15
Tied costs	2	1,41097E+14	0,07%	1,94715E+14	9,73575E+13
Free income	2	2,02519E+14	0,10%	2,02519E+14	1,01260E+14
Error	343	1,08692E+17	51,85%	1,08692E+17	3,16886E+14
Lack-of-Fit	321	1,01087E+17	48,22%	1,01087E+17	3,14914E+14
Pure Error	22	7,60453E+15	3,63%	7,60453E+15	3,45661E+14
Total	356	2,09623E+17	100,00%		

Source	F-Value	P-Value
Regression	24,50	0,000
Area	160,54	0,000
Years after 1996	52,16	0,000
Region	6,75	0,000
Population	3,91	0,021
Tied costs	0,31	0,736
Free income	0,32	0,727
Error		
Lack-of-Fit	0,91	0,653
Pure Error		
Total		

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
17801290	48,15%	46,18%	1,20419E+17	42,55%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	22474551	7594499	(7536898; 37412204)	2,96	0,003
Area	18927	1494	(15989; 21865)	12,67	0,000
Years after 1996	1346967	186508	(980124; 1713811)	7,22	0,000
Region					
East	-19011850	4474359	(-27812487; -10211214)	-4,25	0,000
Mid-Norway	-14024491	4695295	(-23259687; -4789294)	-2,99	0,003
North	-23391517	5437383	(-34086330; -12696705)	-4,30	0,000
Oslo	0,000000	0,000000	(0,000000; 0,000000)	*	*
South	-19917586	4431973	(-28634852; -11200320)	-4,49	0,000
West	-23383981	4376289	(-31991724; -14776239)	-5,34	0,000
Population					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	-7719678	2785998	(-13199469; -2239887)	-2,77	0,006
Small	-6140429	4821445	(-15623749; 3342892)	-1,27	0,204
Tied costs					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	3336485	4272036	(-5066200; 11739170)	0,78	0,435
Small	3645117	5544168	(-7259730; 14549965)	0,66	0,511

```
Free income
  Large            0,000000  0,000000  ( 0,000000;  0,000000)        *        *
  Medium           -2451494   3516189  ( -9367500;   4464513)    -0,70    0,486
  Small            -3110834   3949717  (-10879550;   4657881)    -0,79    0,431

Term               VIF
Constant
Area              1,03
Years after 1996  1,06
Region
  East            3,74
  Mid-Norway      3,04
  North           2,72
  Oslo               *
  South           3,81
  West            4,30
Population
  Large              *
  Medium          1,84
  Small           4,30
Tied costs
  Large              *
  Medium          3,76
  Small           7,88
Free income
  Large              *
  Medium          3,19
  Small           2,97

Regression Equation
Adjusted Cost = 22474551 + 18927 Area + 1346967 Years after 1996
                - 19011850 Region_East - 14024491 Region_Mid-Norway
                - 23391517 Region_North + 0,0 Region_Oslo
                - 19917586 Region_South - 23383981 Region_West
                + 0,0 Population_Large - 7719678 Population_Medium
                - 6140429 Population_Small + 0,0 Tied costs_Large
                + 3336485 Tied costs_Medium + 3645117 Tied costs_Small
                + 0,0 Free income_Large - 2451494 Free income_Medium
                - 3110834 Free income_Small

Fits and Diagnostics for Unusual Observations
Obs  Adjusted Cost        Fit   SE Fit          95% CI             Resid
 85      183604320   92738810  4895148  (83110523; 102367097)   90865510
146       69549200   26033638  3310200  (19522793;  32544484)   43515562
166      164761678  102899705  5564534  (91954800; 113844610)   61861972
177      133713911   62420761  3972093  (54608033;  70233488)   71293150
198      131010526   63026723  3854825  (55444651;  70608795)   67983803
223       37989000   72998050  3910825  (65305832;  80690268)  -35009050
248      103457650   43046900  4781378  (33642386;  52451413)   60410750
249        3566073   53222581  3948563  (45456136;  60989026)  -49656509
266       77965101   27894599  4428285  (19184585;  36604612)   50070502
275      165944734   79985410  4201573  (71721318;  88249503)   85959323
300       54460076  108807999  5660199  (97674929; 119941070)  -54347923
301      107138845   42336676  2481979  (37454861;  47218492)   64802169
315       35417800   73449224  4485439  (64626796;  82271653)  -38031424
348       91900000   51541483  2675802  (46278438;  56804529)   40358517

Obs  Std Resid  Del Resid        HI  Cook's D     DFITS
 85       5,31       5,53  0,075619      0,16   1,58269  R
146       2,49       2,51  0,034578      0,02   0,47446  R
166       3,66       3,73  0,097714      0,10   1,22635  R
177       4,11       4,21  0,049789      0,06   0,96309  R
198       3,91       4,00  0,046893      0,05   0,88642  R
223      -2,02      -2,02  0,048265      0,01  -0,45602  R
248       3,52       3,58  0,072144      0,07   0,99920  R
249      -2,86      -2,89  0,049201      0,03  -0,65771  R
266       2,90       2,94  0,061883      0,04   0,75410  R
```

275	4,97	5,15	0,055708	0,10	1,25108	R
300	-3,22	-3,27	0,101102	0,08	-1,09505	R
301	3,68	3,75	0,019440	0,02	0,52736	R
315	-2,21	-2,22	0,063490	0,02	-0,57810	R
348	2,29	2,31	0,022595	0,01	0,35086	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 2,02033

Model 1b

Regression Analysis: Adjusted Cos versus Area; Years after ; Region; ...

Method

Categorical predictor coding (1; 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS
Regression	11	1,00736E+17	48,06%	1,00736E+17	9,15783E+15
Area	1	5,89190E+16	28,11%	5,12604E+16	5,12604E+16
Years after 1996	1	2,14136E+16	10,22%	1,63650E+16	1,63650E+16
Region	5	1,58680E+16	7,57%	1,06773E+16	2,13546E+15
Population	2	4,38669E+15	2,09%	4,09493E+15	2,04747E+15
Free income	2	1,48901E+14	0,07%	1,48901E+14	7,44504E+13
Error	345	1,08887E+17	51,94%	1,08887E+17	3,15613E+14
Lack-of-Fit	319	1,00961E+17	48,16%	1,00961E+17	3,16491E+14
Pure Error	26	7,92595E+15	3,78%	7,92595E+15	3,04844E+14
Total	356	2,09623E+17	100,00%		

Source	F-Value	P-Value
Regression	29,02	0,000
Area	162,42	0,000
Years after 1996	51,85	0,000
Region	6,77	0,000
Population	6,49	0,002
Free income	0,24	0,790
Error		
Lack-of-Fit	1,04	0,481
Pure Error		
Total		

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
17765509	48,06%	46,40%	1,19413E+17	43,03%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	25735148	5708150	(14507993; 36962303)	4,51	0,000
Area	18976	1489	(16047; 21904)	12,74	0,000
Years after 1996	1337323	185719	(972039; 1702606)	7,20	0,000
Region					
East	-18976920	4463076	(-27755183; -10198658)	-4,25	0,000
Mid-Norway	-14130615	4680834	(-23337179; -4924051)	-3,02	0,003
North	-23596526	5419731	(-34256399; -12936652)	-4,35	0,000
Oslo	0,000000	0,000000	(0,000000; 0,000000)	*	*
South	-20006280	4421176	(-28702132; -11310429)	-4,53	0,000
West	-23316938	4358842	(-31890188; -14743689)	-5,35	0,000
Population					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	-7808446	2351780	(-12434078; -3182814)	-3,32	0,001
Small	-7953477	2989542	(-13833500; -2073454)	-2,66	0,008

Free income					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	-2008703	3449373	(-8793149; 4775744)	-0,58	0,561
Small	-2587816	3800999	(-10063863; 4888231)	-0,68	0,496

Term	VIF
Constant	
Area	1,03
Years after 1996	1,06
Region	
East	3,74
Mid-Norway	3,03
North	2,71
Oslo	*
South	3,81
West	4,28
Population	
Large	*
Medium	1,31
Small	1,66
Free income	
Large	*
Medium	3,08
Small	2,76

Regression Equation

Adjusted Cost = 25735148 + 18976 Area + 1337323 Years after 1996
- 18976920 Region_East - 14130615 Region_Mid-Norway
- 23596526 Region_North + 0,0 Region_Oslo
- 20006280 Region_South - 23316938 Region_West
+ 0,0 Population_Large - 7808446 Population_Medium
- 7953477 Population_Small + 0,0 Free income_Large
- 2008703 Free income_Medium - 2587816 Free income_Small

Fits and Diagnostics for Unusual Observations

Obs	Adjusted Cost	Fit	SE Fit	95% CI	Resid
85	183604320	92870088	4881902	(83268050; 102472125)	90734232
146	69549200	26008108	2887312	(20329158; 31687058)	43541092
166	164761678	103049237	5542210	(92148464; 113950010)	61712441
177	133713911	62256374	3575990	(55222888; 69289859)	71457537
198	131010526	62989663	3846785	(55423561; 70555765)	68020863
223	37989000	72999790	3902876	(65323365; 80676215)	-35010790
248	103457650	43433629	2937239	(37656479; 49210779)	60024021
249	3566073	53160266	3939796	(45411224; 60909308)	-49594194
266	77965101	26032064	3729120	(18697393; 33366736)	51933036
275	165944734	80175011	4183748	(71946147; 88403874)	85769723
300	54460076	108989920	5629377	(97917702; 120062138)	-54529844
301	107138845	42347370	2462274	(37504413; 47190327)	64791475
315	35417800	73780607	4178890	(65561299; 81999915)	-38362807
348	91900000	51506284	2665715	(46263185; 56749383)	40393716

Obs	Std Resid	Del Resid	HI	Cook's D	DFITS	
85	5,31	5,54	0,075513	0,19	1,58198	R
146	2,48	2,50	0,026414	0,01	0,41224	R
166	3,66	3,72	0,097322	0,12	1,22270	R
177	4,11	4,20	0,040517	0,06	0,86398	R
198	3,92	4,01	0,046886	0,06	0,88861	R
223	-2,02	-2,03	0,048263	0,02	-0,45695	R
248	3,43	3,48	0,027335	0,03	0,58349	R
249	-2,86	-2,89	0,049180	0,04	-0,65802	R
266	2,99	3,02	0,044061	0,03	0,64943	R
275	4,97	5,15	0,055459	0,12	1,24741	R
300	-3,24	-3,28	0,100407	0,10	-1,09637	R
301	3,68	3,75	0,019210	0,02	0,52505	R
315	-2,22	-2,23	0,055331	0,02	-0,54080	R
348	2,30	2,31	0,022515	0,01	0,35123	R

R Large residual

Durbin-Watson Statistic
Durbin-Watson Statistic = 2,01782

Model 1c

Regression Analysis: Adjusted Cos versus Area; Years after ; Region; Population

Method

Categorical predictor coding (1; 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS
Regression	9	1,00587E+17	47,98%	1,00587E+17	1,11764E+16
Area	1	5,89190E+16	28,11%	5,14052E+16	5,14052E+16
Years after 1996	1	2,14136E+16	10,22%	1,62570E+16	1,62570E+16
Region	5	1,58680E+16	7,57%	1,07251E+16	2,14502E+15
Population	2	4,38669E+15	2,09%	4,38669E+15	2,19334E+15
Error	347	1,09035E+17	52,02%	1,09035E+17	3,14223E+14
Lack-of-Fit	311	9,98709E+16	47,64%	9,98709E+16	3,21128E+14
Pure Error	36	9,16462E+15	4,37%	9,16462E+15	2,54573E+14
Total	356	2,09623E+17	100,00%		

Source	F-Value	P-Value
Regression	35,57	0,000
Area	163,59	0,000
Years after 1996	51,74	0,000
Region	6,83	0,000
Population	6,98	0,001
Error		
Lack-of-Fit	1,26	0,201
Pure Error		
Total		

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
17726345	47,98%	46,64%	1,18443E+17	43,50%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	23840899	4593767	(14805767; 32876030)	5,19	0,000
Area	18930	1480	(16019; 21841)	12,79	0,000
Years after 1996	1331520	185117	(967427; 1695613)	7,19	0,000
Region					
East	-19174931	4401404	(-27831718; -10518144)	-4,36	0,000
Mid-Norway	-14183826	4667288	(-23363560; -5004093)	-3,04	0,003
North	-22816597	5254478	(-33151230; -12481963)	-4,34	0,000
Oslo	0,000000	0,000000	(0,000000; 0,000000)	*	*
South	-20157857	4370506	(-28753873; -11561841)	-4,61	0,000
West	-23364834	4338893	(-31898672; -14830995)	-5,38	0,000
Population					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	-7704846	2261073	(-12151978; -3257714)	-3,41	0,001
Small	-7233110	2672584	(-12489612; -1976609)	-2,71	0,007

Term	VIF
Constant	
Area	1,02
Years after 1996	1,05

```
Region
  East            3,65
  Mid-Norway      3,03
  North           2,56
  Oslo               *
  South           3,74
  West            4,26
Population
  Large              *
  Medium          1,22
  Small           1,33

Regression Equation
Adjusted Cost = 23840899 + 18930 Area + 1331520 Years after 1996
                - 19174931 Region_East - 14183826 Region_Mid-Norway
                - 22816597 Region_North + 0,0 Region_Oslo
                - 20157857 Region_South - 23364834 Region_West
                + 0,0 Population_Large - 7704846 Population_Medium
                - 7233110 Population_Small

Fits and Diagnostics for Unusual Observations
Obs  Adjusted Cost        Fit   SE Fit          95% CI             Resid
 39       92757000   57948993  3677014  (50716954;  65181033)   34808007
 85      183604320   92798157  4864794  (83229963; 102366351)   90806163
146       69549200   25937741  2611013  (20802337;  31073144)   43611459
166      164761678  103320769  5336388  (92825032; 113816505)   61440909
177      133713911   62240005  3455015  (55444598;  69035411)   71473906
198      131010526   62971088  3838204  (55422015;  70520160)   68039438
211       83415000   47941432  2726588  (42578713;  53304151)   35473568
223       37989000   72959843  3893372  (65302266;  80617420)  -34970843
248      103457650   43796156  2313772  (39245375;  48346938)   59661494
249        3566073   53165230  3930581  (45434470;  60895990)  -49599157
266       77965101   24579366  3037931  (18604291;  30554442)   53385734
275      165944734   80584073  3711020  (73285149;  87882997)   85360661
300       54460076  108752250  5565511  (97805869; 119698631)  -54292174
301      107138845   42269294  2437676  (37474813;  47063774)   64869551
315       35417800   73712157  4014054  (65817220;  81607094)  -38294357
348       91900000   51261352  2562364  (46221633;  56301070)   40638648

Obs  Std Resid  Del Resid         HI  Cook's D     DFITS
 39       2,01       2,02  0,0430281      0,02   0,42751  R
 85       5,33       5,55  0,0753166      0,23   1,58434  R
146       2,49       2,51  0,0216960      0,01   0,37323  R
166       3,63       3,70  0,0906267      0,13   1,16822  R  X
177       4,11       4,21  0,0379893      0,07   0,83636  R
198       3,93       4,02  0,0468833      0,08   0,89078  R
211       2,03       2,03  0,0236592      0,01   0,31669  R
223      -2,02      -2,03  0,0482407      0,02  -0,45731  R
248       3,39       3,45  0,0170374      0,02   0,45389  R
249      -2,87      -2,90  0,0491671      0,04  -0,65944  R
266       3,06       3,09  0,0293709      0,03   0,53829  R
275       4,92       5,10  0,0438277      0,11   1,09165  R
300      -3,23      -3,27  0,0985761      0,11  -1,08158  R  X
301       3,69       3,76  0,0189110      0,03   0,52259  R
315      -2,22      -2,23  0,0512776      0,03  -0,51858  R
348       2,32       2,33  0,0208950      0,01   0,34062  R

R  Large residual
X  Unusual X

Durbin-Watson Statistic
Durbin-Watson Statistic =  2,01308
```

Model 2a

Regression Analysis: Adjusted Cos versus Area; Years after ; Region; ...

Method

Categorical predictor coding (1; 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS
Regression	13	6,00796E+16	51,09%	6,00796E+16	4,62151E+15
Area	1	2,73806E+16	23,28%	2,46460E+16	2,46460E+16
Years after 1996	1	1,85194E+16	15,75%	1,43101E+16	1,43101E+16
Region	5	9,95757E+15	8,47%	6,31423E+15	1,26285E+15
Population	2	3,62899E+15	3,09%	1,32341E+15	6,61707E+14
Tied costs	2	5,83333E+13	0,05%	1,13844E+14	5,69219E+13
Free income	2	5,34695E+14	0,45%	5,34695E+14	2,67347E+14
Error	331	5,75107E+16	48,91%	5,75107E+16	1,73748E+14
Lack-of-Fit	310	5,19488E+16	44,18%	5,19488E+16	1,67577E+14
Pure Error	21	5,56193E+15	4,73%	5,56193E+15	2,64854E+14
Total	344	1,17590E+17	100,00%		

Source	F-Value	P-Value
Regression	26,60	0,000
Area	141,85	0,000
Years after 1996	82,36	0,000
Region	7,27	0,000
Population	3,81	0,023
Tied costs	0,33	0,721
Free income	1,54	0,216
Error		
Lack-of-Fit	0,63	0,948
Pure Error		
Total		

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
13181366	51,09%	49,17%	6,28264E+16	46,57%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	19295929	5795674	(7894929; 30696929)	3,33	0,001
Area	15315	1286	(12785; 17844)	11,91	0,000
Years after 1996	1272933	140263	(997013; 1548854)	9,08	0,000
Region					
East	-14385270	3518582	(-21306872; -7463668)	-4,09	0,000
Mid-Norway	-9784060	3663511	(-16990761; -2577360)	-2,67	0,008
North	-17554666	4188124	(-25793363; -9315969)	-4,19	0,000
Oslo	0,000000	0,000000	(0,000000; 0,000000)	*	*
South	-14647024	3471899	(-21476794; -7817254)	-4,22	0,000
West	-18476443	3446095	(-25255453; -11697433)	-5,36	0,000
Population					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	-5807276	2125061	(-9987604; -1626947)	-2,73	0,007
Small	-4683682	3663969	(-11891284; 2523919)	-1,28	0,202
Tied costs					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	2223464	3195210	(-4062016; 8508944)	0,70	0,487
Small	3365958	4196159	(-4888545; 11620461)	0,80	0,423
Free income					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	-341798	2631729	(-5518822; 4835226)	-0,13	0,897
Small	-3616216	2974785	(-9468084; 2235653)	-1,22	0,225

Term	VIF
Constant	
Area	1,04
Years after 1996	1,06
Region	
East	4,06
Mid-Norway	3,30
North	2,93
Oslo	*
South	4,19
West	4,67
Population	
Large	*
Medium	1,90
Small	4,45
Tied costs	
Large	*
Medium	3,70
Small	7,99
Free income	
Large	*
Medium	3,16
Small	2,96

Regression Equation

Adjusted Cost = 19295929 + 15315 Area + 1272933 Years after 1996
- 14385270 Region_East - 9784060 Region_Mid-Norway
- 17554666 Region_North + 0,0 Region_Oslo
- 14647024 Region_South - 18476443 Region_West
+ 0,0 Population_Large - 5807276 Population_Medium
- 4683682 Population_Small + 0,0 Tied costs_Large
+ 2223464 Tied costs_Medium + 3365958 Tied costs_Small
+ 0,0 Free income_Large - 341798 Free income_Medium
- 3616216 Free income_Small

Fits and Diagnostics for Unusual Observations

Obs	Adjusted Cost	Fit	SE Fit	95% CI	Resid
5	69338896	38170924	3408227	(31466408; 44875440)	31167972
29	13666000	42236564	3188968	(35963364; 48509765)	-28570564
39	92757000	52387724	2875025	(46732100; 58043348)	40369276
80	19884299	46753072	2302745	(42223212; 51282931)	-26868773
145	69549200	27135752	2503183	(22211599; 32059905)	42413448
164	58493093	27545602	1901583	(23804890; 31286314)	30947491
165	71887173	40096713	1793082	(36569441; 43623986)	31790460
168	84454059	53093883	3026225	(47140824; 59046942)	31360176
191	65619800	38839052	3107096	(32726907; 44951197)	26780748
199	74517400	44512308	2050339	(40478968; 48545647)	30005092
207	83415000	44413440	3323904	(37874800; 50952080)	39001560
219	37989000	64798009	3154871	(58591883; 71004135)	-26809009
221	79467561	50344430	3157280	(44133566; 56555294)	29123131
230	66209400	38955848	2418050	(34199165; 43712531)	27253552
232	106337723	70959830	3854441	(63377540; 78542119)	35377894
245	84939267	53761438	3160055	(47545114; 59977761)	31177829
257	59472603	33183966	2365148	(28531349; 37836583)	26288638
263	66470200	40693713	3136395	(34523933; 46863493)	25776487
268	16277670	46159229	1907499	(42406879; 49911579)	-29881559
286	56280310	27112182	3336106	(20549538; 33674826)	29168128
292	65627100	36527359	2375019	(31855324; 41199395)	29099741
308	70523090	35991586	2390951	(31288210; 40694961)	34531504
322	100077600	62004416	3215748	(55678535; 68330297)	38073184

Obs	Std Resid	Del Resid	HI	Cook's D	DFITS	
5	2,45	2,47	0,0668553	0,03	0,660202	R
29	-2,23	-2,25	0,0585301	0,02	-0,560381	R
39	3,14	3,18	0,0475732	0,04	0,710954	R
80	-2,07	-2,08	0,0305190	0,01	-0,369153	R
145	3,28	3,33	0,0360632	0,03	0,643477	R

164	2,37	2,39	0,0208118	0,01	0,348355	R
165	2,43	2,45	0,0185046	0,01	0,336786	R
168	2,44	2,46	0,0527086	0,02	0,580997	R
191	2,09	2,10	0,0555634	0,02	0,509698	R
199	2,30	2,32	0,0241953	0,01	0,365251	R
207	3,06	3,10	0,0635881	0,05	0,807063	R
219	-2,09	-2,11	0,0572852	0,02	-0,519041	R
221	2,28	2,29	0,0573727	0,02	0,565012	R
230	2,10	2,11	0,0336519	0,01	0,394547	R
232	2,81	2,84	0,0855071	0,05	0,867292	R
245	2,44	2,45	0,0574736	0,03	0,606176	R
257	2,03	2,04	0,0321955	0,01	0,371513	R
263	2,01	2,02	0,0566162	0,02	0,495523	R
268	-2,29	-2,31	0,0209415	0,01	-0,337250	R
286	2,29	2,30	0,0640559	0,03	0,602255	R
292	2,24	2,26	0,0324649	0,01	0,413658	R
308	2,66	2,69	0,0329019	0,02	0,495957	R
322	2,98	3,01	0,0595173	0,04	0,758353	R

R Large residual

Durbin-Watson Statistic
Durbin-Watson Statistic = 1,89864

Model 2b

Regression Analysis: Adjusted Cos versus Area; Years after ; Region; ...

Method

Categorical predictor coding (1; 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS
Regression	11	5,99658E+16	51,00%	5,99658E+16	5,45143E+15
Area	1	2,73806E+16	23,28%	2,48529E+16	2,48529E+16
Years after 1996	1	1,85194E+16	15,75%	1,42259E+16	1,42259E+16
Region	5	9,95757E+15	8,47%	6,30442E+15	1,26088E+15
Population	2	3,62899E+15	3,09%	2,67955E+15	1,33977E+15
Free income	2	4,79185E+14	0,41%	4,79185E+14	2,39592E+14
Error	333	5,76246E+16	49,00%	5,76246E+16	1,73047E+14
Lack-of-Fit	308	5,17412E+16	44,00%	5,17412E+16	1,67991E+14
Pure Error	25	5,88335E+15	5,00%	5,88335E+15	2,35334E+14
Total	344	1,17590E+17	100,00%		

Source	F-Value	P-Value
Regression	31,50	0,000
Area	143,62	0,000
Years after 1996	82,21	0,000
Region	7,29	0,000
Population	7,74	0,001
Free income	1,38	0,252
Error		
Lack-of-Fit	0,71	0,900
Pure Error		
Total		

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
13154724	51,00%	49,38%	6,23821E+16	46,95%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	22271764	4433545	(13550479; 30993049)	5,02	0,000

Area	15353	1281	(12833; 17874)	11,98	0,000
Years after 1996	1267211	139762	(992282; 1542139)	9,07	0,000
Region					
East	-14404634	3510752	(-21310683; -7498586)	-4,10	0,000
Mid-Norway	-9911015	3651594	(-17094114; -2727916)	-2,71	0,007
North	-17689172	4176256	(-25904342; -9474002)	-4,24	0,000
Oslo	0,000000	0,000000	(0,000000; 0,000000)	*	*
South	-14722657	3463621	(-21535992; -7909321)	-4,25	0,000
West	-18484876	3433367	(-25238698; -11731054)	-5,38	0,000
Population					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	-6286478	1772484	(-9773155; -2799802)	-3,55	0,000
Small	-6785085	2224810	(-11161539; -2408631)	-3,05	0,002
Free income					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	74398	2575797	(-4992487; 5141282)	0,03	0,977
Small	-2982611	2843657	(-8576406; 2611185)	-1,05	0,295

Term	VIF
Constant	
Area	1,03
Years after 1996	1,06
Region	
East	4,06
Mid-Norway	3,29
North	2,93
Oslo	*
South	4,18
West	4,66
Population	
Large	*
Medium	1,33
Small	1,65
Free income	
Large	*
Medium	3,03
Small	2,72

Regression Equation

```
Adjusted Cost = 22271764 + 15353 Area + 1267211 Years after 1996
                - 14404634 Region_East - 9911015 Region_Mid-Norway
                - 17689172 Region_North + 0,0 Region_Oslo
                - 14722657 Region_South - 18484876 Region_West
                + 0,0 Population_Large - 6286478 Population_Medium
                - 6785085 Population_Small + 0,0 Free income_Large
                + 74398 Free income_Medium - 2982611 Free income_Small
```

Fits and Diagnostics for Unusual Observations

Obs	Adjusted Cost	Fit	SE Fit	95% CI	Resid
5	69338896	38236886	3400131	(31548443; 44925329)	31102010
29	13666000	42277054	3182049	(36017603; 48536505)	-28611054
39	92757000	52351427	2862645	(46720279; 57982575)	40405573
80	19884299	46816213	2279308	(42332555; 51299871)	-26931915
145	69549200	26654784	2173235	(22379785; 30929784)	42894416
164	58493093	27497925	1890471	(23779154; 31216697)	30995167
165	71887173	40068322	1788016	(36551090; 43585553)	31818851
168	84454059	53090288	3020105	(47149399; 59031176)	31363771
199	74517400	44375858	2037403	(40368056; 48383660)	30141542
207	83415000	44680864	3164976	(38454997; 50906730)	38734136
219	37989000	64806017	3148371	(58612814; 70999220)	-26817017
221	79467561	50298212	3150080	(44101647; 56494778)	29169349
230	66209400	38621110	2276688	(34142607; 43099614)	27588290
232	106337723	71561792	3643889	(64393849; 78729736)	34775931
245	84939267	53714893	3152904	(47512773; 59917013)	31224374
257	59472603	32825777	2223978	(28450960; 37200594)	26646827
268	16277670	46054781	1899271	(42318698; 49790863)	-29777111
286	56280310	28564951	2743644	(23167891; 33962011)	27715359

292	65627100	36633247	2338352	(32033442; 41233051)	28993853
308	70523090	35678221	2245056	(31261941; 40094500)	34844869
322	100077600	61960763	3208703	(55648880; 68272647)	38116837

Obs	Std Resid	Del Resid	HI	Cook's D	DFITS	
5	2,45	2,47	0,0668079	0,04	0,659839	R
29	-2,24	-2,26	0,0585127	0,03	-0,562226	R
39	3,15	3,19	0,0473556	0,04	0,711242	R
80	-2,08	-2,09	0,0300222	0,01	-0,367560	R
145	3,31	3,36	0,0272929	0,03	0,562285	R
164	2,38	2,40	0,0206527	0,01	0,348208	R
165	2,44	2,46	0,0184748	0,01	0,337489	R
168	2,45	2,47	0,0527085	0,03	0,582236	R
199	2,32	2,33	0,0239878	0,01	0,366022	R
207	3,03	3,07	0,0578865	0,05	0,761430	R
219	-2,10	-2,11	0,0572807	0,02	-0,520225	R
221	2,28	2,30	0,0573429	0,03	0,566900	R
230	2,13	2,14	0,0299532	0,01	0,376180	R
232	2,75	2,78	0,0767303	0,05	0,801109	R
245	2,44	2,46	0,0574458	0,03	0,608156	R
257	2,06	2,07	0,0285823	0,01	0,354263	R
268	-2,29	-2,30	0,0208454	0,01	-0,335924	R
286	2,15	2,17	0,0435003	0,02	0,461949	R
292	2,24	2,25	0,0315978	0,01	0,407042	R
308	2,69	2,71	0,0291267	0,02	0,470058	R
322	2,99	3,02	0,0594971	0,05	0,760625	R

R Large residual

Durbin-Watson Statistic
Durbin-Watson Statistic = 1,89473

Model 2c

Regression Analysis: Adjusted Cos versus Area; Years after ; Region; Population

Method

Categorical predictor coding (1; 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS
Regression	9	5,94866E+16	50,59%	5,94866E+16	6,60962E+15
Area	1	2,73806E+16	23,28%	2,45051E+16	2,45051E+16
Years after 1996	1	1,85194E+16	15,75%	1,41425E+16	1,41425E+16
Region	5	9,95757E+15	8,47%	6,57667E+15	1,31533E+15
Population	2	3,62899E+15	3,09%	3,62899E+15	1,81450E+15
Error	335	5,81038E+16	49,41%	5,81038E+16	1,73444E+14
Lack-of-Fit	300	5,09817E+16	43,36%	5,09817E+16	1,69939E+14
Pure Error	35	7,12201E+15	6,06%	7,12201E+15	2,03486E+14
Total	344	1,17590E+17	100,00%		

Source	F-Value	P-Value
Regression	38,11	0,000
Area	141,29	0,000
Years after 1996	81,54	0,000
Region	7,58	0,000
Population	10,46	0,000
Error		
Lack-of-Fit	0,84	0,787
Pure Error		
Total		

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
13169816	50,59%	49,26%	6,23014E+16	47,02%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	22538567	3645809	(15367004; 29710131)	6,18	0,000
Area	15212	1280	(12695; 17729)	11,89	0,000
Years after 1996	1262509	139814	(987485; 1537533)	9,03	0,000
Region					
East	-15219132	3480331	(-22065189; -8373075)	-4,37	0,000
Mid-Norway	-10113336	3653703	(-17300429; -2926243)	-2,77	0,006
North	-17545323	4067177	(-25545746; -9544899)	-4,31	0,000
Oslo	0,000000	0,000000	(0,000000; 0,000000)	*	*
South	-15412297	3441887	(-22182731; -8641863)	-4,48	0,000
West	-18807955	3431053	(-25557078; -12058833)	-5,48	0,000
Population					
Large	0,000000	0,000000	(0,000000; 0,000000)	*	*
Medium	-6891896	1702138	(-10240122; -3543670)	-4,05	0,000
Small	-7019379	2001710	(-10956883; -3081875)	-3,51	0,001

Term	VIF
Constant	
Area	1,03
Years after 1996	1,06
Region	
East	3,98
Mid-Norway	3,29
North	2,77
Oslo	*
South	4,12
West	4,64
Population	
Large	*
Medium	1,22
Small	1,33

Regression Equation

```
Adjusted Cost = 22538567 + 15212 Area + 1262509 Years after 1996
                - 15219132 Region_East - 10113336 Region_Mid-Norway
                - 17545323 Region_North + 0,0 Region_Oslo
                - 15412297 Region_South - 18807955 Region_West
                + 0,0 Population_Large - 6891896 Population_Medium
                - 7019379 Population_Small
```

Fits and Diagnostics for Unusual Observations

Obs	Adjusted Cost	Fit	SE Fit	95% CI	Resid
5	69338896	38282956	3403504	(31588022; 44977889)	31055940
29	13666000	42313790	3185440	(36047804; 48579777)	-28647790
39	92757000	52001799	2857662	(46380577; 57623021)	40755201
80	19884299	46338748	2261841	(41889547; 50787950)	-26454450
145	69549200	25252799	1967440	(21382706; 29122892)	44296401
164	58493093	27247136	1885728	(23537776; 30956497)	31245956
165	71887173	39240962	1719344	(35858891; 42623033)	32646211
168	84454059	53083190	3023564	(47135626; 59030755)	31370869
175	29982480	56649967	2813167	(51116270; 62183664)	-26667487
191	65619800	39126568	1720668	(35741892; 42511243)	26493232
199	74517400	44162389	2035662	(40158097; 48166680)	30355011
207	83415000	43675274	2229534	(39289624; 48060924)	39739726
219	37989000	64704966	3151373	(58505994; 70903939)	-26715966
221	79467561	50344699	3153484	(44141572; 56547825)	29122862
232	106337723	70441629	3567748	(63423618; 77459640)	35896095
245	84939267	53736883	3156371	(47528080; 59945687)	31202383
268	16277670	45322092	1849058	(41684865; 48959319)	-29044422
292	65627100	39009209	1826633	(35416093; 42602326)	26617891
308	70523090	37284708	2029100	(33293325; 41276092)	33238382
322	100077600	61920754	3212083	(55602360; 68239149)	38156846

Obs	Std Resid	Del Resid	HI	Cook's D	DFITS	
5	2,44	2,46	0,0667872	0,04	0,657929	R
29	-2,24	-2,26	0,0585032	0,03	-0,562232	R
39	3,17	3,21	0,0470828	0,05	0,714404	R
80	-2,04	-2,05	0,0294961	0,01	-0,357163	R
145	3,40	3,46	0,0223174	0,03	0,522272	R
164	2,40	2,41	0,0205021	0,01	0,349316	R
165	2,50	2,52	0,0170438	0,01	0,331851	R
168	2,45	2,47	0,0527083	0,03	0,581663	R
175	-2,07	-2,08	0,0456280	0,02	-0,455464	R
191	2,03	2,04	0,0170701	0,01	0,268650	R
199	2,33	2,35	0,0238920	0,01	0,367440	R
207	3,06	3,10	0,0286595	0,03	0,532625	R
219	-2,09	-2,10	0,0572585	0,03	-0,517508	R
221	2,28	2,29	0,0573353	0,03	0,565259	R
232	2,83	2,86	0,0733886	0,06	0,805370	R
245	2,44	2,46	0,0574403	0,04	0,606951	R
268	-2,23	-2,24	0,0197125	0,01	-0,317754	R
292	2,04	2,05	0,0192373	0,01	0,287190	R
308	2,55	2,58	0,0237382	0,02	0,401642	R
322	2,99	3,02	0,0594859	0,06	0,760412	R

R Large residual

Durbin-Watson Statistic
Durbin-Watson Statistic = 1,86876