Increasing profitability of multifunctional sport stadiums

A research on using a decision support model to increase profitability and feasibility of multifunctional sport stadiums

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Preface

This master thesis is carried out at the faculty of Architecture of the Technical University Delft, at the Real Estate & Housing Master track. Within this master, the graduation lab is called 'Aligning real estate demand and supply'.

This fifth report is the final one in a series of reports and is also the final master thesis. The report starts with a brief and extended summary of the research, both in Dutch and English. The first chapters provide an explanation on the thoughts behind the choice of the graduation topic. Next, a research proposal is formulated with research questions, goals, aims and methods of researching. A literature study is conducted on the chosen subject in the next chapter. The product of the research, with the addition of the results of the product in use is presented. Also, a simulation of how the results behave under certain circumstances is included. The research is concluded with a conclusion and reflection on the subject, accompanied with the relevant used literature.

I would like to take this opportunity to thank my mentors Dr. Ir. Ruud Binnenkamp and Ing. Peter de Jong for their continued support, supervision and and criticism during the entirety of this graduation research.

Delft, 2015

Bas R. Muijsson

Own image (2015)

Summary

Short Summary (English)

In recent years, the sporting world has become an industry of millions, sometimes even billions (Deloitte, 2012). The commercialising within the world of sports has had several effects. One of these effects is that private investors are starting to see the possibilities of investing in sports real estate, stadiums. In addition, there is a declining willingness of local, national and European governments in facilitating financing for stadiums and other flagship projects (PWC, 2011).
The consequence of this shift in facilitating and thus ownership of sports stadiums is the fact that the focus will change from a more social perspective (government), to a perspective that is purely focussed on financial value (private investors). These investors see much more potential in stadiums than the single-day use that is most common. Investors acknowledge that the potential of modern stadiums could be much broader. Think of other sporting events, concerts, promotional events, business meetings, etc. These make that sport stadiums nowadays have a much more multifunctional purpose than they had previously. Multifunctionality is a major aspect that could increase profitability and should therefore be researched even more (Jakimovska, 2007).

This research will focus on enhancing profitability of sports stadiums through the design of the stadium. The research question that is formulated for this problem is:

> “How can a decision support model contribute in enlarging the return on investment, based on the lay-out of flexible and multifunctional sports stadium projects, in order to increase feasibility?”

The research results in a model of an inductive nature, which means it can also be used for other stadium developments and/or renovations. The model covers all the different areas that have an influence on the potential return on investment over a predefined period of time. This ranges from ticketing, functions but also construction costs. The research therefore covers a number of different areas of expertise.
Besides the field of design and decision support systems, the research also covers building economics, and weighs the costs of a newly built stadium against the costs for renovation an existing one. The created tool can greatly contribute to the decision making process in the early stages of decision making, but can also serve as a useful tool in retrospect.

The case that has been chosen for the research is De Kuip, the stadium of football club Feyenoord in Rotterdam, The Netherlands. Because of its proximity here in The Netherlands, it is a project with more familiarity and it can be visited for a deeper insight into the project.
The stadium of Feyenoord has been a subject of discussion for the past few years, with the owners being unsure if to build a new stadium or to renovate the existing one. The final decision of this issue came in the beginning of 2014, with an advisory commission insisting the renovation of the stadium. Project developer BAM had been awarded the development rights after a competition with another project developer, but failed to come up with a feasible design for the renovation of the existing stadium. The research uses the information of this failed project to investigate if a more feasible design solution had been possible. Two other cases, the Amsterdam ArenA in Amsterdam and the GelreDome in Arnhem are analysed as well to enhance information on the project and to serve as comparison.

The results of the research are according to the initial hypothesis. The two stadiums that were analysed for comparison show a profitability that is in line with the minimal expected Internal Rate of Return that is required for stadium projects. The main case of the Kuip however, shows a feasible project, but a project that is not feasible enough for investors to take part in. The next chapters in the research go into detail on how the design of the stadium can be adjusted to make the project feasible again, and the initial bid of project developer BAM is recreated and analysed as well.

Overall conclusions initially show that no such approach is ever used in stadium projects. Implementations of this method might not be as smooth initially since the approach adds a great deal of transparency to the negotiation process, which is something that is not always beneficial for all involved stakeholders.

Further research and further development of the resulting model has to be carried out to give a more accurate representation of reality, making the model even more useful in the negotiation process.

Short Summary (Dutch)

In de afgelopen jaren is de sportwereld enorm veranderd. De branch is geëvolueerd tot een industrie waar miljoenen en soms zelfs miljarden (Deloitte, 2012) in omgaan. De commercialisering in de sportwereld heeft een aantal effecten gekend. Een van de voornaamste effecten is dat private investeerders de sportmarkt gaan ontdekken. Zij zien investeringsmogelijkheden in het vastgoed van de sportwereld, de sportstadions. Daar komt bij dat lokale, nationale en Europese overheden zich steeds vaker afzien van financiering van grote stadionprojecten en andere grote investeringen die niet direct noodzakelijk zijn (PWC, 2011). Dit komt met name door de verslechterde economie in de laatste jaren waar overheden en gemeentes veel consequenties van ondervinden.
Het resultaat van deze verschuiving van eigendom in sportstadions van de gemeenten naar de private investeerders is een verschuiving in de focus van de projecten. Waar gemeenten voornamelijk een sociaal oogpunt hanteren bij het investeren in stadions, hanteren de investeerders een puur financieel oogpunt. De investeerders zien dan ook veel meer potentieel in stadions dan een wedstrijd die om de week in het stadion plaatsvindt. Zij zien kansen in het organiseren van evenementen, concerten, andere sportevenementen, beurzen, congressen, etc. Dit maakt dat hedendaagse sportstadions multifunctioneel moeten zijn. Multifunctionaliteit is dan ook een aspect dat het rendement kan verhogen en daarom verder onderzocht dient te worden (Jakimovska, 2007).

Dit onderzoek zal naar aanleiding van deze analyse proberen het rendement van sportstadions te doen vergroten door het ontwerp van het stadion multifunctioneler te maken. De onderoeksvraag van het onderzoek luidt:

"Hoe kan een beslismodel bijdragen aan het vergroten van het rendement, gebaseerd op de lay-out van flexibele en multifunctionele sportstadion projecten, om de haalbaarheid te vergroten?"

Het onderzoek resulteert in een inductief model, wat betekent dat het model (na aanpassing) ook ingezet kan worden voor andere projecten/renovaties en niet gebonden is aan een enkel project. Het model beslaat alle mogelijke bronnen van inkomsten en uitgaven die tijdens de gehele levenscyclus van het stadion invloed hebben op het rendement hiervan. Dit varieert van toegangsprijzen, functies in het stadion, maar ook de constructiekosten. Hierdoor beslaat het onderzoek ook verschillende vakgebieden.
Naast het vakgebied van 'Operations Research', raakt het onderzoek ook aan het vakgebied van de bouweconomie, en weegt het de kosten van het bouwen van een nieuw stadion af tegen de kosten van het renoveren van een bestaand stadion. De gecreëerde tool zal van waarde kunnen zijn in de beginfase van het besluitvormingsproces, maar kan ook in retroperspectief gebruik worden als analysemiddel.

De case die gekozen is voor het onderzoek is het stadion de Kuip in Rotterdam, thuishaven van voetbalclub Feyenoord. Feyenoord is een van de grootste voetbalclubs in Nederland, is bekend en bereikbaar, en is bovendien verwikkeld in het proces van nieuwbouw of renovatie van het huidige stadion.
Het stadion staat al een aantal jaar ter discussie, daar de huidige club en eigenaren van het stadion twijfelen tussen nieuwbouw en renovatie. Begin 2014 is het besluit genomen om projectontwikkelaar BAM het recht te geven om met en ontwerp te komen voor de renovatie van het huidige stadion. Het bedrijf lukte het echter niet om met een ontwerp te komen dat haalbaar bleek, ondanks lange onderhandelingen en een vergevorderd ontwerpproces. Dit onderzoek zal deze mislukte onderhandeling als uitganspunt nemen en dit als case behandelen. De uitkomsten zullen aantonen of een succesvolle samenwerking niet alsnog mogelijk was geweest. Twee andere Nederlandse stadions, de Amsterdam ArenA in Amsterdam en het GelreDome in Arnhem worden ook geanalyseerd en toegevoegd aan het onderzoek ter verrijking van de beschikbare informatie. Ook dienen deze als vergelijkingsmateriaal.

De resultaten van het onderzoek ondersteunen in eerste instantie de gestelde hypothese. De twee stadions die ook zijn geanalyseerd laten een rendement zien dat in lijn is met de verwachtingen en ook interessant is voor investeerders. De analyse van de Kuip laat weliswaar een positief rendement zien over 30 jaar, maar niet zodanig dat investeerders het interessant vinden om te investeren. Vervolgens wordt er een poging gedaan om het ontwerp zo aan te passen dat het ontwerp wel interessant is, en er wordt gekeken naar het BAM voorstel dat wordt nagebootst en geanalyseerd.

De conclusie laat zien dat een aanpak als deze nog niet eerder is gebruikt in stadionprojecten. Implementatie van deze methode kan voor wat weerstand zorgen in eerste instantie, aangezien het de transparantie van de projecten vergroot. Dit is niet iets dat alle actoren in eerste instantie zullen accepteren.

Verder onderzoek en ontwikkeling van het model is nodig om het model een realistischere afbeelding van de werkelijkheid te laten zijn, om het op deze manier ook waardevoller te maken in alle onderhandelingsprocessen.

Summary

Summary

Introducing this report, an extended summary will provide some insights in the vision of this research. The ways of working, research techniques, research topic and results will all be discussed briefly in order to provide a clear overview and summarized insight in the reasoning and value of this research. Where a brief description of the essential topics is provided in this summary, an extended view can be found in the corresponding chapters in the report.

Problem Analysis

In recent years, the sporting world has become an industry of millions, sometimes even billions (Deloitte, 2012). The commercialising within the world of sports has had several effects. One of these effects is that private investors are starting to see the possibilities of investing in sports real estate, stadiums. Also there is a declining willingness of local, national and European governments in facilitating financing for stadiums and other flagship projects (PWC, 2011). The consequence of this shift in facilitating and thus ownership of sports stadiums is the fact that the focus will change from a more social (government), to a perspective that is purely focused on financial value (private investors). These investors see much more potential in stadiums than the single-day use that is most common. The potential of modern stadiums could be much broader. Think of other sporting events, concerts, promotional events, business meetings, etc. These make that sport stadiums nowadays have a much more multifunctional purpose than they had previously. Multifunctionality is a major aspect that could increase profitability and should therefore be researched even more (Jakimovska, 2007).
The problem that can be concluded from this literature is that most stadiums are not adapted to these recent changes. The lay-out of the stadium, the flows of people, and the overall focus is still on the sport that is played in the stadiums. The obvious reason for the lack of multifunctionality is the fact that they were built many decades ago, and therefore the problem statement is:

“How can a decision support model contribute in enlarging the return on investment, based on the lay-out of flexible and multifunctional sports stadium projects, in order to increase feasibility?”

Newly built stadiums do have this opportunity. Newly built stadiums can be designed in such a way that optimal flexibility and multifunctionality is reached, thus improving the profitability for the owners and investors of the stadium.

Main Problem

As stated, the main issue that is identified is the lack of flexibility and multifunctionality of sports stadiums. The solution for this gap in demand and supply can be sought in different directions. My focus will be on the Real Estate side of a possible solution. Therefore I would like to look at the physical aspects of a stadium that could improve multifunctionality. This forms the backbone of my research and I would like to focus on this aspect of the problem.

Research Objectives

An objective is described as a requirement which is to be followed to the greatest extent possible (either by minimization or maximization) given the problem constraints.

- In this case one of the main objectives is maximizing return on investment. Both minimizing the invested capital and maximizing income is an aspect of this objective.
- Also, the total experience for the visitor/fan must be optimized, leaving him wanting to come back and visit the stadium once more.
- The third objective is social acceptance of the plan. The influence of such a structure on the surrounding neighbouhoods can be significant, so acceptance from this group of people can be essential for the success of the plan.

Research Constraints

A constraint is described as a fixed requirement which cannot be violated in a given problem formulation. Constraints divide all possible solutions (combination of variables) into two groups; feasible and infeasible.

- The main constraint is formed by the building regulations. These have to be followed in order to complete the project.
- Also, there is a timeframe that has to be taken into account. In case of a renovation, it will cause stands to close temporarily, affecting the club that normally plays in the stadium. There is a timeframe in which the renovation has to be completed in order to avoid harming the club financially.
- The existing stadium also counts as a constraint in this case. The building itself is something that has to be worked with, and therefore counts as a constraint.
- Resources can come in as a constraint. One of the key actors, the municipality, might have a maximum budget from their side for the construction /renovation of the stadium, forming a constraint for the design.

Research Functions

Finally, a function is a fixed requirement which is to be satisfied as closely as possible in a given problem formulation. However often mistaken for objectives, the functions are primarily expressed in facilities for the people using the Real Estate.

- First of all, all guests must be guaranteed a good view on the pitch/field
- The stadium provides food for visitors
- The stadium provides drinks for visitors
- Enough parking spaces are accommodated
- Public transport to and from the stadium is well-organised
- The stadium offers conference rooms for business people
- The stadium offers offices for stadium employees
- The stadium provides a good interior climate

Research Methods

After analysing the research topic and the type of research question that is stated, I came to the conclusion that mathematical decision modelling is the most appropriate way for the research that I will be carrying out. Mathematical decision modelling is in itself a part of the field of operations research (OR). OR can be defined as being:

‘The application of scientific method by interdisciplinary teams to problems involving the control of organized (man-machine) systems so as to provide solutions which best serve the purpose of the organization as a whole’. (Ackoff, 1956)

In this definition we see three characteristics: the systems orientation, interdisciplinary teams and the application of scientific methods. The systems orientation part is based on the theory that all decisions ultimately have an effect on every other part.
In OR the attempt is made to take account of all the significant effects, to make the commensurate, and to evaluate them as a whole. The interdisciplinary team is focussed on multiple scientific disciplines. The challenge is to incorporate as much disciplines into every research to get as much different points of view as possible. The method of OR can be seen as the equation U=f(x,y), in which U is the utility or value of the systems performance. X are the variables that can be controlled and Y are constant an incontrollable variables. In this case, the optimization of the return on investment can be seen as the U, and the variables that have been defined are the X. In addition, inequations can add limits or constraints for certain variables. Once the model is constructed, we can derive an optimized solution for the stated problem by mathematical analysis of the information. Decision makers are presented this result and have to agree to the result to implement it. They can also change weights of variables or add new variables based on the result, so that the model changes and has to be solved again (Ackoff, 1956)

Placing my research within the field of OR is fairly easy, and therefore it is a perfect candidate for this way of researching. The problem is a managerial problem, since the manager is the actor to decide which solution is chosen. He has different ways of determining what is the best solution for each specific problem. Operations Research and mathematical decision modelling is a precise way of determining the best solution for a problem. The fact that my research is focussed on maximizing the return on investment of a project already hints to a mathematical approach.
Also, looking at the definitions of Ackoff (1956), we see that the research is fit for an OR approach. There are multiple variables that all affect each other and need to be evaluated as a whole. There are constraints and limitations of every variable and the whole research based on optimisation of one variable, the return on investment.

The second field of knowledge that I will be making se of during this research is the field of building economics. Knowledge of building economics is essential in the built environment. Questions on costs, revenues, risks, phasing, payback periods and investment proposals are all part of the sector building economics. Every project within the building sector combines a certain number of these specialities. The knowledge is relevant in new construction projects, but also in renovations, restorations, and specific types of structures.
The fact that the topic of this research is closely related to stadium design, a very specific type of real estate, makes that building economics become more important. Investments of this magnitude, on a specific typology, makes that there is a special place for it within the building economics.

The main focus, however, stays on the numerical side of a project. Building economics is a field that is projecting costs of certain investments based on experience and precedents. The combination of OR and Building economics in this specific research is therefore an excellent combination. The two fields cover the areas that have to be covered to make the research useful and reliable for other actors in the future. The mathematical approach of both fields make that they are easily combined in an exact model or representation of a project, which is the main goal of this research.

Summary

Summary

Adapted Research Strategy

To be able to complete this research in the way it was intended in the first place, an adapted research strategy had to be put into place. The reasoning behind this adapted strategy can be found in the report. This new strategy adds two more cases to the existing case of the Feyenoord Stadium, being the Amsterdam ArenA in Amsterdam and the GelreDome in Arnhem. Both stadiums are also situated in The Netherlands and are the home grounds of AFC Ajax and Vitesse Arnhem. The model will then be altered two fit these new cases. This will result into three models with three model outcomes. This step will add a new insight in the research that wasn't available in the previous situation. The inductive nature of the model will be tested and the transformation time of the model between different cases will provide insights in the different areas in which the model can be used in the future. After the completion of the alteration process, the two extra cases will serve as an example for the original case. Easily accessible information on these cases will give a better image of the magnitude of some of the costs for the Feyenoord case. On the other hand, the two extra cases will serve as a reference and outcomes can be compared. After completing the models a new analysing phase starts in which the models and their different qualities are compared in order to be able to make a statement on the end product of this research. This alternate research strategy backs down from the initial one and will not be a perfect representation of reality because of the absence of accurate real-time information on the main case. However, the alternate strategy has a few perks over the initial one in that it displays the inductive nature of the model, helps in achieving an image of the case that is as accurate as possible with the provided information, and provides in reference cases for the analysis phase of the project. This chapter will therefore follow this new research strategy as presented.

Input Sheet

The model that has been developed for the purpose of this research consists out of three main 'sheets'. The main functions of two of these sheets (input and output) are discussed briefly in this summary, but an extended description can be found in the corresponding chapters in the report.

- General information

The general information input sheet is the sheet with the main input. The first and main constraint that is given to the stadium is the size of the stadium, based on a minimum (provided by the club) and a maximum (provided by the municipality and the local residents). Based on the provided historical information of attendances, estimation is made on the average attendance as a percentage of the total capacity of the stadium. The model assumes that during all matches, the stadium is filled with this percentage of seats occupied.

Also, the different floors are introduced in this sheet, with all the floors and their total square meters per floor. These numbers are used by the model as a basis that can be filled with the different functions. Right now, the model assumes a total of five floors, which is two more than the current three, accounting for the new tier within the stadium. The operating period of the model indicates the scope of the model calculations. Right now, this number is set to thirty years. Using twenty or ten years proved to be too short of a period. The thirty year mark is the mark where the cash flows start to level off into a steady cash flow. Cost increase and revenue increase are included in the model as well to be able to determine the future cash flows. In combination with the added interest rate, these three elements form the basis of the future cash flows calculations. The games per year account for the number of official games that will be played by the local football club in the stadium during one year. In the Netherlands, this totals to around 22 games (17 regular season games, 2 cup games, 3 continental games). Revenues of match days are calculated per day and multiplied with the number of games to provide the total revenues from match days throughout the year. The maximum cost per year is an added function for the cash flow model. It is assumable that the stadium owner would like to limit the stadium losses during the first few years of operation. The amount that is put into this cell will serve as a restriction for the model to spread investment costs in such a way that there is no negative cash flow greater than this amount in the operation period.

- Stadium Financing

The stadium financing mechanics that are worked into the model as of now are based on the 'old' plans for the stadium renovation. These plans included financing from three possible stakeholders. These stakeholders are the municipality of Rotterdam, own equity of the stadium owner and the consortium, and two loans with a company and a bank to reassure the last part of the financing structure. These loans have interest payments that have to be made and these are also incorporated into the model. Extra business units and business seats are made available for these investors of the project and are also added in this section of the input sheet. The model calculates the costs of these facilities and adds them to the yearly costs. The total amounts of the three financing structures add up to the total of the initial investment in the renovation of the stadium. The model uses the interest payments each year for the entirety of the cash flow calculations, adapted for cost increase and revenue increases. Besides that, the annual 'performance fee' in the current structure is incorporated, which means that an annual payment is made to the club playing in the stadium for their services.

- Spectators

This is the section of the input sheet that determines the revenues that will be earned through spectator expenditures during game days. Four different categories of expenditures are determined: parking, ticketing, F&B and merchandising. However, not every spectator will spend an even amount of money during his visit to the stadium. To be able to adapt the configuration on these expenditure patterns, four categories of spectators are identified.
The category 1 spectator is the category with the most revenues. This spectator is willing to pay a higher amount for his ticket and better seats in the stadium. A small percentage of the stadiums' capacity will be filled with seats for category 1 spectators. He will also be spending more money on F&B and merchandising.
The category 2 spectator is the spectator that still demands good seats within the stadium, but is not willing to pay the highest price for these seats. He will spend a little less on F&B as well, and some more on merchandising during his stay.
Category three 3 and 4 are the largest categories in terms of seats in the stadium. The seats represent the price range that is most desirable amongst the fans, with decent views of the pitch. Over half of the seats within the stadium is part of category 3 or 4. The fans will spend less on F&B, but more on merchandising, based on sales figures. The parking costs are equal for all visitors and can be adjusted accordingly. The combination of the four types of revenues add up to a total amount of revenues for the match day. Only a percentage of these revenues are destined to be for the stadium owner. The main part of ticket sales will go the the sports club that attracts the fans and guest. The same goes for F&B and merchandising, where only the parking revenues can be added to the total revenues in totality.

- Corporate clients

Corporate clients can be seen as one of the main drivers of revenues in a stadium. Corporate clients demand the best seats in the stadium and a high standard of luxury. Therefore, the trend in stadium design is to incorporate more and more of these types of seats in new stadium projects. The renovation of the Kuip will offer three types of corporate seats: business seats, suites and sky boxes. The business seats are the same as regular seats in the stadium. The only difference is that they have the best view on the pitch and are executed with more luxurious materials such as leather. Often, the clients that make use of these seats are offered drinks and beverages in some sort of lounge and the clients can make use of the main entrance of the stadium. The entire treatment of this customer is of very high standard and prices can be changed accordingly in the model. Per floor, the minimum and maximum number of business seats can be entered into the model, together with a minimum and maximum price of the seats. The sky boxes are well known in the world of football. Private boxes with luxurious seats and catering on demand. Only the high end clients will be using sky boxes and boxes are also available for other parties to rent for a certain time period. Sky boxes are the middle class within the corporate seats, offering more than the business seats, however offering a little less than the suites. Price ranges per person and amounts per floor can again be altered in this part of the input sheet.
The suites are larger rooms within the stadium, behind glass, with view on the pitch, but also the ability to go outside and enjoy the game within the stadium itself in luxurious seats. This private suite with private catering is the most luxurious package the stadium can offer and price ranges for the suites can be entered into the model as well. Since sky boxes and suites use up the same amount and same type of space, the maximum number of sky boxes and suites per floor can be added as well, leaving the model to decide the distribution between the two per floor. Using the same mechanic as with the regular fans, only a percentage of all revenues will remain for the stadium owner and this percentage can be adjusted in this part of the input sheet as well.

- Sponsorships

Another important source of revenues is the sponsorship money. The model distinguishes three types of sponsorships for the stadium. Regular sponsorships: These sponsorships could be for multiple purposes. One of these purposes could be the naming of a room within the stadium, an own conference room, or otherwise.
Naming rights: Naming rights of the stadium are more common these days. Although not many clubs are willing to change the name of the stadium in favour of a certain sponsor, this function is made available to incorporate into the model.
Advertising: The main revenues will be advertising within the stadiums. Think of billboards, advertsing on the screens within the stadium and many more possibilities. Of all the sponsorship revenues, the largest part will go towards the stadium owner and this percentage is once more adaptable in the input sheet.

- Phasing

Because of the fact that not every year will be exactly the same and the renovation is to be carried out in the next few years, the model is able to apply phasing to the calculations. Cost increases and decreases, under influence of several factors, can be added here. One of the main examples is the revenue decrease because of the construction in the first few years. In this part of the input sheet these costs can be estimated and spread out over several years if wished. The model will then add or subtract these costs from the total revenues of that specific year, including discounting for cost increase, revenue increase and interest rates for that specific year. This allows for greater detail in the model and this tool has a big impact on the outcome of the model as well.

Output Sheet

The output sheet is the information sheet that displays the results of the model runs. The sheet consists out of three types of information. The first information is the financial component of the model. The revenues over the different years are displayed in both a numerical as a graphical way. The model calculates the IRR (internal Rate of Return), an important component of each investment proposal from the investors' point of view. The defenition of the IRR is:

'The interest rate at which the Net Present Value (NPV) of all the cash flows (both positive and negative) from a project or invest¬ment equal zero.'

So, every positive IRR equals an investment with a positive NPV. A positive NPV is always an indicator of a profitable investment and the rule of thumb is to invest in projects with a positive NPV. However, risks on the investment are involved as well and most investors therefore predefine a MARR (Minimum Attractive Rate of Return) or MIRR (Minimal Internal Rate of Return). If the IRR of a new project exceeds a company's MIRR, that project is desirable. If IRR falls below the MIRR, the project should be rejected. In this case, defining the MIRR for a stadium project is difficult. The MIRR is dependant on many factors such as the type of investor, the global economic situation, the location, the market and many more. In this day and age in The Netherlands and the thriving Sports economy, stadium projects can be seen attractive if the IRR is somewhat lower than the MIRR of housing because of the many benefits of invesment in sports Real Estate. Housing projects can be seen as attractive with an IRR of over 6% (Sinha & Poole, 1987), and therefore this research sets the bar for the MIRR of stadium projects at 4%. This remains an important and arbitrary estemation and this will be also reflected on at the end of this report.
The next part of the output sheet shows the actual impact of the design. For each specific floor, the function that are located on that floor are displayed, accompanied by the square meters of that function. These all add up to the total floor space of that floor so that every square meter of the stadium is allocated a function. These functions are also visualized in the form of pie charts to visually see the distribution of the different functions over the different floors.
The output sheet is there to give the actors that have to work with the model and analyse its outcomes a feeling for the impact of their actions. Other representations of the results can easily be added to the sheet if there is a demand from certain actors.

Results the Kuip

If we look at the results of the model run for the Kuip, we can distinguish a few things. On the level of the function allocation the model does what it is supposed to do and it assigns all the functions within the set boundaries. It prefers to allocate the most profitable functions and these functions are often represented as much as possible. This is in line with the purpose of the model in achieving a maximised ROI. Out of the three models, this model run should be the most interesting one, as it should represent the situation that caused the collaboration between the FFC and BAM to end. Looking at the financial cashflow over thirty years, the first five years are displayed as years without revenues, and even a loss in the third year of over €6 million. This is in line with one of the reasons the collaboration did not work out between the FFC and BAM. The FFC demanded a high ROI in the first few years to be able to attract high profile players for the club to ensure quality results of the team on an international level. The model does not represent this demand. The graph of incomes then keeps on rising and reaches a high at a little over €16 million ROI per year, which is lower than the Amsterdam ArenA, despite the greater capacity. A number of reasons for this abnormality can be explained and will be in the following paragraphs. Also, the planned renovation causes an interruption in the graph and is clearly visible. The total IRR of the project is calculated at 1,7% as of now. This IRR is too low for most investment proposals, despite the fact that a positive IRR represents a positive Net Present Value of the project (see chapter VI). Developers aim for an IRR of 4% or higher to mark a project as attractive for an investment. Although the result of the model run can be summarized in a negative investment advice, it does however represent reality well. The gap between an infeasible and a feasible project can be bridged in a number of ways, and an analysis of the possible explanation of the results is discussed in the corresponding chapters in the report.

Adapted Model Run
Adaptions were made to the model to see when the project would have been feasible. Running the new model with the adjusted constraints should define a greater solution space and should calculate a higher IRR for the project. Running the model with this adjusted input, the outcome is greatly increased compared to the first 1,7% with a newly calculated IRR of 8,8%. We have to bear in mind that this model run is very optimistic and maximizes a number of variables to a value that probably won't be achieved in real life. The positive lesson from this model run is that the model is able to find a solution that meets the requirement of a minimal IRR of 4%. The next step is to tone down some of the extreme constraints to come to a set of constraints that is feasible in terms of achieved IRR and feasible in terms of realism.
Out of the adjusted constraints, the constraints with the highest 'IRR dual value' (the influence of that constraint on the IRR) have the best opportunity to change the outcome of the calculations. However, the constraints with this power are also the constraints that are most unrealistic. A well-deliberated choice has to be made on the constraints that will be altered and to what extend. By altering the constraints one by one, the model outcome is forced towards the desired 4% IRR. The solution space is made big enough to achieve this IRR, but is not made any bigger to restrain the model in terms of realism as well.
After altering some of the constraints slightly, the desired 4% IRR was reached. The changes that were made to the input sheet of the model obviously could have been made in a different way, resulting in the same IRR.
The alterations that were made to the model to achieve the desired IRR don't seem to be very rigorous. However, keeping in mind the fact that no safety margins have been put into place in this model, it is still optimistic. Know¬ing that relatively small alterations can have such a great impact on the end result of the model is something that is exploited in the table, but can become an issue if the effect is turned around. Small setbacks in the design and construction process of the stadium renovation can also drop the ROI and IRR of the project dramatically as shown in the model runs. The sensitivity of the model is therefore an opportunity to tweak the model to force it in the desired direction, but is also a dangerous characteristic of the model.

Conclusions
The main conclusion that can be made upon the initial results of the model runs is the fact that the model displays reality as desired. Without forcing the model in a certain direction, all the model outcomes depict reality well with the available information. The hypothesis of the three model runs was for the ArenA and the GelreDome to result in two good investment opportunities, with the GelreDome as most interesting one. This because the stadium is also an entertainment centre, with a retractable roof, moving pitch and is in all aspects the most multifunctional of the three. The original case of the Feyenoord stadium shows a low IRR of only 1,7% and is not a viable investment for any private investor. This is also in line with reality, since negotiations on this stadium design eventually broke down.

The research has succeeded in the creation of a tool that did not exist until now. Design decisions are often made in a formal setting where discussions between stakeholders, in combination with a certain power distribution, determine the design process and decision. Although decision support systems exist for residential and commercial real estate, a decision support system for stadium development had not been created yet. Therefore, it adds a new aspect to the negotiation and design process of stadiums as it dramatically increases transparency and can be used to speed up the analysis of certain design solutions.
Decision support systems as this model increases transparency of the entire process. Whereas too much transparency can also work in a negative manner for some stakeholders. For example, high profit margins for a certain stakeholder that used to be invisible for the other ones, now becomes clearly visible in the model. In order to nullify such aversions to this approach, it is made possible to set constraints to the model that aren't visible for other stakeholders. Each stakeholder could use his own input sheet with only the constraints that are of their interest.

The model now projects the cash flows 30 years into the future. We can conclude that this a realistic amount of time to rightfully see the cash flows develop over the years and incorporate new investments over time. Setting the horizon too far ahead is also not realistic, since modern technology evolves quickly and it is not realistic to assume conditions stay the same over such a long period of time.

The main conclusion that can be drawn from analysing the model and it's mechanics is the sensitivity of the model itself. It was surprising to see how small alterations to certain input variables could have a big effect on the result of the model run. Analysing this sensitivity and the realism of such sensitivity in a model is one of the subjects that must be investigated further, since it is not clear yet if this represents the real situation in the best possible way.

Summary

Summary

In the three model runs, two expected results surfaced. The ArenA and the GelreDome proved to be feasible and interesting investments for a private investor if no alterations are made to these two stadiums. If alterations will be made to them, they would be even more interesting for investors, marking the potential of such investment opportunities. However, the Kuip project didn't prove to be very feasible, despite the positive IRR of the model run. Also, the FFC demanded a certain cash flow structure where high revenues in the first years after completion would contribute to the financial position of the club and player budget to ensure competitiveness in the coming years. The model run however predicts a negative cash flow in the first few years, giving investors reasons for extra contemplation before investing.

The outcomes of the model runs of the Feyenoord stadium are analysed and the solution space for the model is made bigger by widening some of the constraints in the model. Suitable constraints are identified and a realistic reasoning to the extend of the widening is provided. After running the model with these alterations the IRR is raised from 1,7% to 8,8%. In order to reach the minimal required IRR of 4,0%, some of the widened constraints are narrowed again and therefore the solution space is adjusted to facilitate the desired IRR. The desired IRR of 4,0% is reached with a slight increase in some of the model variables. The real discussion on these results is if the widened constraints are realistic and how safety margins for the project are built in. Slight alterations have a large impact and the sensitivity of the model shows that relatively small issues in the design and construction process could lead to a stadium that is much less feasible than initially projected.

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Introduction

I.I Motivation

My motivation to choose for the 'Aligning Real Estate Demand and Supply' has been very clear. I've always had a preference for the beta-side of the bachelor curriculum within the faculty of Architecture. Especially the financial side with the financial models and investment proposals has been something I am passionate about. Choosing this lab for my graduation has therefore been nothing more than the obvious choice.
When it came down to picking a graduation topic, I went back to a topic that has been my passion for my entire life, and that is sports. Whenever I got the chance to involve sports into an assignment during the bachelor phase and the first year of my master, I did so, and my master thesis has been no exception. It is not only my hobby, but the combination of Real Estate with Sports would be combining my two main fields of interest. The logical result of these passions is that I have chosen a topic that has to do with the real estate in the world of sports: stadiums.

Current changes in the field of professional sports (Dobson, 2011) make that the real estate in this sector has also had to cope with changes. Further on in this report I will explain what these changes are and how they make an interesting research topic.

I.II Vision

My vision on this research subject is quite positive. I think I've chosen a subject that is not that common, since stadiums encompass a special group within the Real Estate sector. Researching this special type of building and its possibilities in this time and age is something that hasn't been looked into much. Therefore I think that my research can contribute to current and future developments in this sector. I won't be trying to develop some sort of blueprint for future stadium design, since this is impossible in my opinion. My ultimate vision is to focus on one specific case in order to open the eyes of other actors that are involved with other stadiums and show them what kind of possibilities there are and providing some insights in the possibility of using optimisation models in designing.

I.III General Study Targets

I would love to combine my two passions for architecture and sports and end up doing something within the world of stadiums. In general, my study target is to familiarise myself with the special kind of real estate that stadiums are. The specific nature of a stadium make that conventional ways of dealing with real estate are not always applicable. Digging deep into this subject and really familiarise and specialise myself will be necessary. Furthermore, working with a model is something I'm really interested in. Basing decisions on an extensive model that you've made yourself is, I think, very fulfilling. Specialising in the way these models work and are made is therefore another study target.

I.IV Personal Study Targets

On a more personal level, I would like to get some more experience from practice. The entire education until now has been solely theoretical, so working with real stakeholders and experiencing how it is to be active in this field of work is something I would like to experience. Also, I think there is an absence of knowledge for every student when it comes to real estate that is not residential, an office or industrial. Flagship projects like stadiums, towers and other special buildings is a subject I know really little about, so enriching myself with the theory I will be studying the coming months can be seen as a personal study target. Learning the ropes in this sector of the Real Estate sector, so to say.

Research

II.I Type of Research

We can identify two types of researches: Empirical Science and Engineering Science. The first one is knowledge-based and the second one is based on a knowledge question. Operations Research/Management has a focus on design problems and decision making problems.

II.II Problem Analysis

In recent years, the sporting world has become an industry of millions, sometimes even billions (Deloitte, 2012). The commercialising within the world of sports has had several effects. One of these effects is that private investors are starting to see the possibilities of investing in sports real estate, stadiums. Also there is a declining willingness of local, national and European governments in facilitating financing for stadiums and other flagship projects (PWC, 2011).
The consequence of this shift in facilitating and thus ownership of sports stadiums is the fact that the focus will change from a more social (government), to a perspective that is purely focussed on financial value (private investors). These investors see much more potential in stadiums than the single-day use that is most common. The potential of modern stadiums could be much broader. Think of other sporting events, concerts, promotional events, business meetings, etc. These make that sport stadiums nowadays have a much more multifunctional purpose than they had previously. Multifunctionality is a major aspect that could increase profitability and should therefore be researched even more (Jakimovska, 2007).
The problem that can be concluded from this literature is that most stadiums are not adapted to these recent changes. The lay-out of the stadium, the flows of people, and the overall focus is still on the sport that is played in the stadiums. The obvious reason for the lack of multifunctionality is the fact that they were built many decades ago, and therefore the problem statement is:

> "How can a decision support model contribute in enlarging the return on investment, based on the lay-out of flexible and multifunctional sports stadium projects, in order to increase feasibility?"

Newly built stadiums do have this opportunity. Newly built stadiums can be designed in such a way that optimal flexibility and multifunctionality is reached, thus improving the profitability for the owners and investors of the stadium.

II.III Main Problem

As stated in the previous paragraph, the main issue that is identified is the lack of flexibility and multifunctionality of sports stadiums. The solution for this gap in demand and supply can be sought in different directions. My focus will be on the Real Estate side of a possible solution. Therefore I would like to look at the physical aspects of a stadium that could improve multifunctionality. This forms the backbone of my research and I would like to focus on this aspect of the problem. The objectives, constraints and functions that will be identified in the next paragraphs will therefore have two 'layers' First of all, the general layer with a focus on the research in general, and second of all, a focus on the model itself and what it should be.

II.IV Objectives

An objective is described as a requirement which is to be followed to the greatest extent possible (either by minimization or maximization) given the problem constraints.

General

- The general objective is to solve the problem that is identified in the previous chapter(s). The inadequacy of stadiums to cope with changing demands in the world of sports is a problem that is recognised these days.

Model specific

- In this case one of the main objectives is maximizing return on investment. Both minimizing the invested capital and maximizing income is an aspect of this objective.
- Also, the total experience for the visitor/fan must be optimized, leaving him wanting to come back and visit the stadium once more.
- The third objective is social acceptance of the plan. The influence of such a structure on the surrounding neighbourhoods can be significant, so acceptance from this group of people can be essential for the success of the plan.

II.V Constraints

A constraint is described as a fixed requirement which cannot be violated in a given problem formulation. Constraints divide all possible solutions (combination of variables) into two groups; feasible and infeasible.

General

- The main constraint for the research is the time limit. In order to complete the master thesis within the academical year, the research has a limited timeframe to be carried out in.
- The recources of information are also a constraint. I probably won't be able to talk with the highest executive of the involved actors, who is the person that could be most valuable for this research. It is much more realistic that I'll be communicating with a person who has not got 100% knowledge of the case.

Model specific

- The main constraint is formed by the building regulations. These have to be followed in order to complete the project.
- Also, there is a timeframe that has to be taken into account. In case of a renovation, it will cause stands to close temporarily, affecting the club that normally plays in the stadium. There is a timeframe in which the renovation has to be completed in order to avoid harming the club financially.
- The existing stadium also counts as a constraint in this case. The building itself is something that has to be worked with, and therefore counts as a constraint.
- Resources can come in as a constraint. One of the key actors, the municipality, might have a maximum budget from their side for the construction /renovation of the stadium, forming a constraint for the design.

II.VI Functions

Finally, a function is a fixed requirement which is to be satisfied as closely as possible in a given problem formulation. However often mistaken for objectives, the functions are primarily expressed in facilities for the people using the Real Estate.

General

- The thesis must be of good academical quality in order to pass the requirements for graduating
- The subject is of academical relevance
- The ways of researching are academically viable

Model specific

- First of all, all guests must be guaranteed a good view on the pitch/field
- The stadium provides food for visitors
- The stadium provides drinks for visitors
- Enough parking spaces are accommodated
- Public transport to and from the stadium is well-organised
- The stadium offers conference rooms for business people
- The stadium offers offices for stadium employees
- The stadium provides a good interior climate

II.VII Main Research Question

The two previous paragraphs have made clear that there is a gap between demand and supply in sports real estate. I want to research a possible solution for this problem on a real estate level. Therefore my main research question will be:

> "How can a decision support model contribute in enlarging the return on investment, based on the lay-out of flexible and multifunctional sports stadium projects, in order to increase feasibility?"

Definitions

- Decision support model: Computer-based information system that supports business or organizational decision-making activities
- Return on Investment: A performance measure used to evaluate the efficiency of an investment
- Lay-out: The design of the stadium, on different levels of scale
- Flexible: The ability to adapt to changes, in this case multiple events
- Multifunctional: The ability to host different types of events
- Sports Stadium: A large structure for open-air sports or entertainment
- Feasibility The determination as to whether the assigned tasks could be accomplished by using available resources

II.VIII Actors

Prior to the research, the initial thoughts on the potential actors in the stadium development are:

- Municipality
- National Government
- Sports Club (Main user)
- Sports Club(s) (other potential users)
- Organisers of events (other potential users)
- (Current) Stadium Owner
- (Future) Stadium Owner
- Architect
- Contractor
- Employees
- Guests/Fans
- Surrounding residents
- Business people
- Police (safety)
- Fire Department (safety)
- Shop owners within the stadium

II.IX Variables

When researching the main question and making the model that should help solving the main problem, variables are needed to base the model on. These variables are the input for the model and the final outcome of the research. Variables are not stand-alone numbers or figures. Most variables are dependent on each other and interconnected. This paragraph will briefly describe the initial set of main variables that will be used in the model that is to be made. Variables will be expanded based on the literature study, model, interviews with involved actors and are by no means definitive at this stage in the research.

Capacity (seats)

The capacity of the stadium is a variable that is of influence on different levels. It will determine the kind and size of events that can be held in the stadium. Not only the number of seats, but also the capacity of the middle section of the stadium can count towards the total capacity in some cases. The capacity is in most cases a limitation if the stadium turns out to be too small or too big.

Costs (€)

Costs are of course an important variable. The investment costs serve as a limitation, since there is a maximum amount of money companies and/or investors are willing to invest into the stadium. This is a variable that is obviously closely related to the revenues variable.

Revenues (€)

Revenues, in combination with the costs, might be the two most important variables in the model. The final return on investment can be leading for the investor in his decision for a certain option.

Ticket prices (€)

Ticket prices are a variable that have a major influence. Higher prices can mean more revenues, but also lower attendances. Multiple actors have interests in influences on this variable. Optimising thicket prices towards satisfaction for all actors involved is the goal of this variable.

Attendance (visitors)

Closely related to the ticket prices is the attendance. Attendances are vital for the success of the stadium. The investors may not need full attendances every week in order to receive high revenues. The club however can benefit greatly from a full stadium with an enthusiastic crowd. Therefore this variable plays a role in the model.

Type of other activities

The master thesis is probably going to have a Dutch stadium as its main focus. In The Netherlands it is most likely to pick a soccer stadium, since they are stadiums with the biggest capacity and for the criteria of the problem statement best. However, one of the main focus points of the research is the organisation of other events in the stadium. It is therefore necessary to research if the stadium is fit to host concerts (acoustics, capacity, etc.), other sporting events, conferences and many other possible activities. The ability of the stadium to host different kind of events is the variable in this case.

Type of seats (luxury/basic)

The type of seats determine the type of people the stadium will attract. The skyboxes will attract high class society, while the standard seats will attract a totally different type of person. This has influence on the lay-out of the stadium. For instance, the type of shops and catering must be adapted to the type of people that will visit them.

Distance to court/field (m)

The distance to the field or court is important for the experience of the spectators. It is also a constraint when it comes to the type of events that can be organised in the stadium. Not every sport or event will be suitable to organise inside a stadium that is designed to host football matches. Therefore, a study needs to show which type of other sporting events and/or concerts will be suitable for each specific stadium design.

Time of transport (min)

Logistics are always important. Visitors have a preference for good logistics around and inside the stadium.

Time to transport (min)

Also, the time to transport is important. The distance to the closest train station, bus station or taxi stand is essential for this variable.

Time to beverages and/or food (min)

The final variable that I will discuss is the time to beverages and/or food. Visitors have a maximum amount of time they are willing to walk to their catering and a maximum amount of time that they are willing to wait in line. The stadium needs to provide sufficient supply of food and drinks within a certain distance.

Figure 1 - Feyenoord supporters - Vak W(2014)

II.X Research Methods

After analysing the research topic and the type of research question that is stated, I came to the conclusion that mathematical decision modelling is the most appropriate way for the research that I will be carrying out. Mathematical decision modelling is in itself a part of the field of operations research (OR). OR can be defined as being:

'The application of scientific method by interdisciplinary teams to problems involving the control of organized (man-machine) systems so as to provide solutions which best serve the purpose of the organization as a whole'. (Ackoff, 1956)

In this definition we see three characteristics: the systems orientation, interdisciplinary teams and the application of scientific methods.
The systems orientation part is based on the theory that all decisions ultimately have an effect on every other part. In OR the attempt is made to take account of all the significant effects, to make the commensurate, and to evaluate them as a whole.
The interdisciplinary team is focussed on multiple scientific disciplines. The challenge is to incorporate as much disciplines into every research to get as much different points of view as possible.
The method of OR can be seen as the equation U=f(x,y), in which U is the utility or value of the systems performance. X are the variables that can be controlled and Y are constant an incontrollable variables. In this case, the optimization of the return on investment can be seen as the U, and the variables that have been defined are the X. In addition, inequations can add limits or constraints for certain variables. Once the model is constructed, we can derive an optimized solution for the stated problem by mathematical analysis of the information. Decision makers are presented this result and have to agree to the result to implement it. They have the ability to alter constraints or add new constraints based on the result, so that the model input changes and has to be solved again (Ackoff, 1956)

Placing my research within the field of OR is fairly easy, and therefore it is a perfect candidate for this way of researching. The problem is a managerial problem, since the manager is the actor to decide which solution is chosen. He has different ways of determining what is the best solution for each specific problem. Operations Research and mathematical decision modelling is a precise way of determining the best solution for a problem. The fact that my research is focussed on maximizing the return on investment of a project already hints to a mathematical approach.
Also, looking at the definitions of Ackoff (1956), we see that the research is fit for an OR approach. There are multiple variables that all affect each other and need to be evaluated as a whole. There are constraints and limitations of every variable and the whole research based on optimisation of one variable, the return on investment.

The second field of knowledge that I will be making se of during this research is the field of building economics. Knowledge of building economics is essential in the built environment. Questions on costs, revenues, risks, phasing, payback periods and investment proposals are all part of the sector building economics. Every project within the building sector combines a certain number of these specialities. The knowledge is relevant in new construction projects, but also in renovations, restorations, and specific types of structures.
The fact that the topic of this research is closely related to stadium design, a very specific type of real estate, makes that building economics become more important. Investments of this magnitude, on a specific typology, makes that there is a special place for it within the building economics.

The main focus, however, stays on the numerical side of a project. Building economics is a field that is projecting costs of certain investments based on experience and precedents. The combination of OR and Building economics in this specific research is therefore an excellent combination. The two fields cover the areas that have to be covered to make the research useful and reliable for other actors in the future. The mathematical approach of both fields make that they are easily combined in a model or representation of a project, which is the main goal of this research.

II.XI Ways of Research

During the course of this research, different methods were used.

The first obvious step was to perform a literature study. The literature that has been used for the creation of the literature study in this report can be found in the literature chapter of the report. This information was used to get an initial idea for the problem that is to be solved, the current solutions and the lacks of knowledge in the field of study.

Based on this initial information, the first basic model was created. This model was made to provide an indication of the problem, the possible solutions and above all to get a better feel for the issues that needed to be addressed. This model was based purely on the aformentioned assumptions.

With the literature study done and the first model made, it was important to enrich the information from real life actors who are experts in this particular field of interest. The provided document of the BAM design proved to be a key document for the enrichment of the model and research, and contact with the involved stakeholders also proved to be of value.

Over the course of the research, the decision was made to change the aproach and also incorporate two more stadiums as two extra case studies. This research technique is therfore also used in this research.

A creative process of model alterations and different design solutions was nescessary to come up with a feasible design that met all the stated demands and constraints of the actors. An extended analysis of this proces can also be found in this report.

This cyclical process repeated itself a number of times before the result was satisfactional and of the level that it was inteded to be. This is the moment where the exit out of the loop of development (Figure 2) occured and the final report with the conclusions were made.

II.XII Relation with Research Theme

This paragraph is meant to define the relationship between my research and the research programme of RE&H. First of all, the research is about optimising a real estate portfolio. In my case, I have chosen a specific type of real estate in the form of a sports stadium. Within this stadium I am researching the differences in demand and supply and will try to align them to optimise the multifunctionality of the stadium for all involved actors. Therefore, I think my research relates really well to the RE&H research programme, and also the lab I am working in right now.

II.XIII Conceptual Model

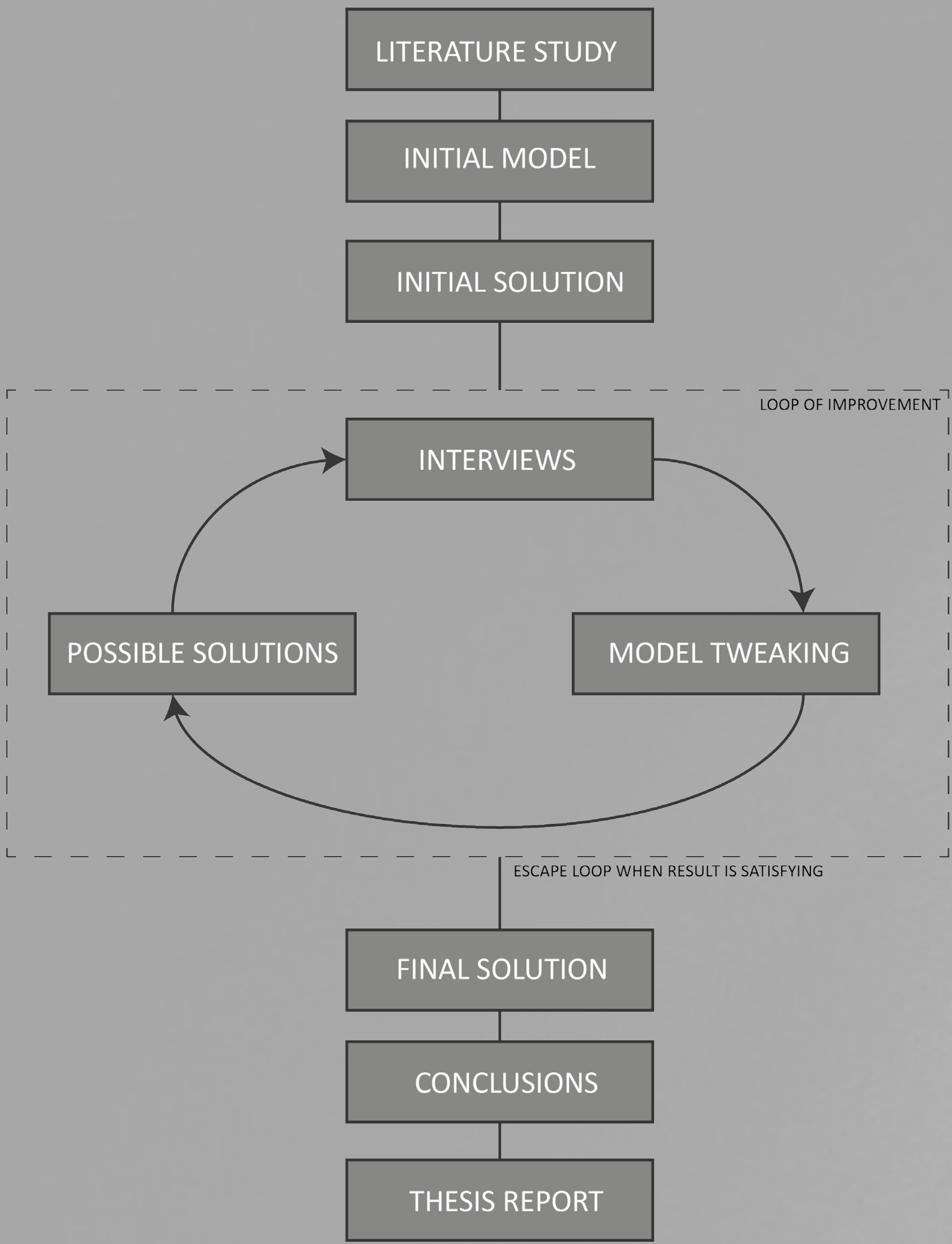


Figure 2 - Conceptual Model - Own Image(2015)

Theoretical Framework

The theoretical framework will serve as de backbone of the research and will provide all the necessary documentation and information fro the research to be carried out. The theory that is discussed in this chapter will switch between a general outlook on the problem analysis and a more case specific theoretical framework. Since 'De Kuip' in Rotterdam is the case of this master thesis, it is also valuable to get an insight in the history of Dutch stadium design, the Future of Dutch stadium design and also the current situation of the planned renovation of this specific stadium.

III.I History of stadium design

In order to understand the concept of stadium design and the way stadiums have become part of the sporting industry, it is useful to go back in time to get a feeling for the history that has driven stadium design to what is it has become nowadays.

Stadiums originated in ancient Greece as athletics stadiums, also called hippodromes or amphitheatre. In the 8th century BC, the first stadium was formed around an athletic track and had a U-shape. As sports became more and more popular amongst the general public, the Panathenaic stadium in Athens was built. This stadium hosted the first modern Olympic Games in 1896 and was renovated again for the 2004 Olympic Games in Athens (Romano, 1985). In de 1st and 2nd century BC, the uprising of a new type of entertainment mainly caused the evolution from this typology to the stadium that we all know nowadays: the circus. The circus was the host of horse races where natural slopes served as tiers for the spectators. It was part of Roman tradition, and the Romans closed off the traditional U-shape with buildings on the remaining fourth side of the structure. The parts closest to the track where often made of stone and the upper tiers where made of a wooden structure (Bale, 1993).
A new period arrived, a long period in which sports activities where kept to a minimum due to political interventions. Many sports stadiums where turned into market squares or houses to make the most of the available land. This period lasted until the Renaissance, in which the equestrian events had been introduced again. The games were not hosted at a special location, but at public location that would be turned into sporting areas for the time the game would last. The transition from this outlook on sports to the sports we know nowadays took a few more centuries.

Halfway through the nineteenth century, the popularity of new sports grew enormously. Especially in Britain and its colonies, new sports like soccer, tennis and rugby were gaining fans (Holt, 1989). The urbanization of the country meant that many fans of sports now were located in close range of each other, making the need for a place for all these people to come together to enjoy their sport more urgent. This trend was also picked up by the Greek and the reinstatement of the Olympic Games was a fact in 1896, marking the start of global acceptance of sports and the first real stadium in Athens.

Dunning &Sheard (2005) identified five generations of stadia after 1896. These generations mark the evolution of stadium design over the last century, in which stadiums have evolved immensely.

1. The First Stadium (1900's)

The first stadiums had only one goal in mind: high capacity for a large numbers of spectators. Entertainment through television or the internet was not available at that time so witnessing the action live was the only way. Standing in the stadium was the norm and seats/shelter was a luxury that was only available for the most important spectators. The stadium itself was often a concrete structure with no attention to architectural detail. In Britain this stadium type was built the British way; four separate stands on each side of the soccer field. Later, new grounds with athletic tracks were designed and this meant that stadiums were formed to the tracks in an oval shape.

2. The Equipped Stadium (1950's)

If we fast-forward to the late fifties, we see an entirely new trend. The TV coverage of major sporting events had the biggest influence on this trend. Potential spectators preferred the comfort of their own homes above travelling to the stadium and watching the game whilst standing on uncomfortable stands in a stadium without facilities. This forced the stadium owners to adapt the stadiums to the spectators' wishes such as greater comfort and better views to attract a new breed of spectators (Bale, 1993). Stadiums were renovated, seats and roofs were installed and other facilities were made available. Two important implications of these physical changes to the stadiums environment were noticeable. The image of the spectator as someone who can only be tempted to watch a game if it offers the same comfort as back home. Secondly, the spectator is forced to watch the game seated, dispassionately critical, instead of standing. The spectator is waiting to be entertained during the match and served in the gaps of the game (Clarke, 1978). Despite these alterations to the stadiums, the character of the majority of the stadiums was still focussed on the inside. The outside was still an element of anonymity and the stadium did not serve as an icon in it's close surroundings for the next three decades

3. The Commercial Stadium (1980's)

During the late eighties, the world was shocked by multiple horrible events involving stadiums. The event that was most notable is the collapsing of the main stand of the Hillsborough Stadium in 1989 in the United Kingdom. Also, hooliganism started to develop and some older wooden stadiums went up in flames. These incidents made spectators feel unsafe inside the stadium. It became a dangerous place from their point of view and interventions were necessary. The government issued a national survey that was summarized in the Taylor Report (Taylor, 1991). This safety measures posed in this report were copied by the government and were obligatory from that moment on. The measures involved the demand that all stadiums became all-seaters, and upgrades in accessibility, safety and amenities. This opened the door for target groups that were not interested in the stadium before, such as business contacts. These contacts attracted the likes of sponsors, restaurants, premium seating in sky boxes and much more (Critcher, 1979). Also, leisure activities for the regular crowds were upgraded noticeably. In hindsight, this was the start of the multifunctional stadium, as we know it now. Stadiums became family attractions, but also operational seven days a week for different target groups. This British example was soon followed by the rest of Europe and after that the rest of the world.

4. The Flexible Stadium (1990's)

The initial commercial stadiums proved to be successful. The concept of a technological hub with state of the art facilities for not only sports, but also meetings, events and concerts was exploited. Stadiums with (retractable) roofs, moveable stands and even flexible pitches that can be moved were designed. Marketing and media became a more important factor and sponsors were given more perks than other actors. The commercialisation of the stadium was lifted to a new level in this decade.
The exploitation of the stadium became an all year round task, and the off-season of the local club was now an opportunity instead of a period without income. The image of the stadium evolved into a social hub that could serve as a catalyst for surrounding neighbourhoods.

5. The Urban Icon (2000's)

Now that stadiums have become unique facilities with state of the art broadcasting techniques for the spectator at home, the same threat occurs as in the fifties. Why would spectators come to the stadium when they can watch the match comfortably and with the best view from their couch at home? This has stimulated stadium owners to make the stadium experience something special. An entertainment that is unique and nothing like watching a sports game at home. To do so, stadiums are offering improved security and a wide variety of amenities and facilities. Besides that, the exterior of the stadium has become important. Stadiums are growing to be icons by themselves through spectacular architecture. The potential urban regeneration that could be achieved by present stadiums is a motive for many developers to enter into a stadium project (Thornley, 2002).

An imagined sixth step into the future would see stadiums as the centre of a city, providing a boost for all the facilities in the neighbourhood, bringing all people together at one central cultural and architectural highlight of the city for a wide range of events.

Figure 3-7 - Eveloving Stadiums - World Stadium (2013)

III.II History of stadium design in The Netherlands

In order to get a better understanding of the situation in the case of 'de Kuip' in Rotterdam it is useful to have a look at the Dutch history of stadium design. Where each country has followed the trends discussed in the last paragraph, each country has also done so in its own way. This is because of different reasons like culture, government, climate or financial related issues. Tummers (1993) has described the history of stadium design in The Netherlands and has defined seven periods from the end of the 19th century until the present based on certain key events in its development. This structure will be used to explain the Dutch history of stadium design.

1. Development of soccer to public sport (1880's)

Soccer has been introduced in The Netherlands in 1879 as an elite sport. The rules that the English used for the sport were copied and the Dutch started playing it as well, mostly in parks or on meadows. Soccer clubs did only exist on paper, without any facilities such as dressing rooms or a clubhouse. More and more people saw soccer as entertainment and started showing up on match days, and Sparta Rotterdam was the first club to lay down a special pitch with a fence and was therefore also the first club that was able to ask entry fees of the spectators.

2. Stands and international games (1900's)

The first international match between Holland and Belgium was played in may 1905 on the Schuttersveld in Rotterdam. Between 20.000 and 30.000 people watched the game live, even from rooftops in the surroundings to catch a glimpse of the game (Verkamman, 1989). Until 1911, when a small wooden stand collapsed during the international game of Holland against England, the national team played throughout the country in accommodations that were not capable of hosting such an event. The incident caused the government to set out rules for stands and maximum capacity. The investment cost for small clubs to host such a large event once didn't weigh op to the benefits of the game, so a central place for the national team to play in was needed. A stone stadium was built in Amsterdam in 1914 that could host up to 30.000 spectators. Because of the flat character of the Dutch landscape, Dutch stadiums have always been built out of these wooden and stone structures. Because of weather conditions the rule for building stands in The Netherlands has always been to build the southern stand first, to keep spectators out of the sun and the wind. Other European countries often used natural hills as stand.

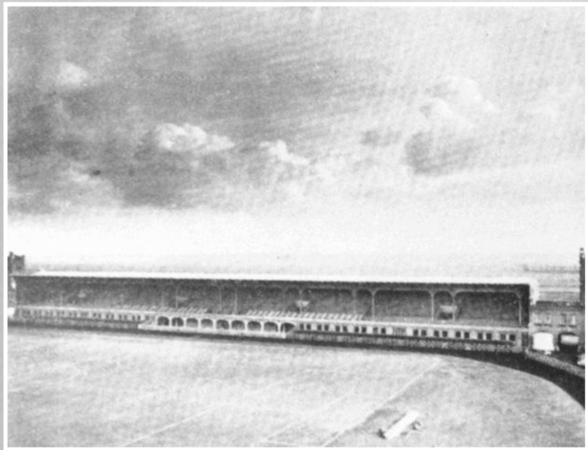


Figure 8 - Nederlandsch Sportpark - Wikipedia (2015)

3. NOC rules, sport complexes and crisis (1920's)

In 1917, the 'Nationaal Olympisch Comité' presents a report with new rules for stadium design and stadium construction. Upon this document, many municipalities decide to invest in a municipal sportground, including a (soccer) stadium. The transition from the elite to the masses gets stronger in this period and soccer becomes the biggest practised sport in the country. During WWII some stadiums, such as De Goffert in Nijmegen, were used by occupiers of the country for storage, ammunition depots or they were demolished for their materials. Plans for the demolition of De Kuip in Rotterdam were even put into place, but were never carried out (De Wolff, 1997).

Theoretical Framework

4. Rebuilding and growth of populartity (1940's)

After the war had ended, there weren't many possibilities due to a lack of materials. Slowly more money became available for stadium construction. The stadiums were built in different ways, and the NOC rules weren't followed as strictly as they used to be. Renovating the stadiums, and not building a new stadium solved expansions of the stadiums due to greater demand of seating. This is mainly due to the fact that the stadiums were built in an urban context, not allowing for newly built stadiums. This was the case for stadiums like the Oosterpark in Groningen and the Haarlem Stadion in Haarlem.

5. Stagnation and decline (1960's)

As in the rest of the world, vandalism became an issue during the sixties and seventies. The first measure was the placing of fences to separate the home and away spectators, but later on also a fence around the pitch to protect the players from the fans. The sport was ready for new innovations to resolve these issues and stadium design had to be brought to the next level to cope with demands. De Galgenwaard in Utrecht was the first stadium with a 'canal' around the pitch, separating the players and crowd without the use of fences that would disturb the sight of the spectators (Röhner, 1981). For a long time, it was considered to be the safest stadium in the world. The incorporation of offices and prefab concrete elements made the financing of larger and safer stadiums more feasible during this period. The safety regulations became even stricter due to the earlier mentioned accidents in Brussels (1985) and Hillsborough (1989) (Wright, 1993).

6. Commercialising and renovations (1980's)

Where Utrecht was the founder of the multifunctional stadium, PSV in Eindhoven was the real innovator. The club was forced to come up with an entirely new concept because the new main stand of their stadium began to show cracks. This was solved by adding business seats, a restaurant and offices. The revenues of these facilities made it possible to reconstruct the stand (Wich, 1993). The new stand also incorporated these functions and later on the other two stands were also converted. This made the Philips Stadion the first stadium of real multifunctional use. During this period, Ajax celebrated many success on the pitch and were therefore able to invest in their stadium, since De Meer was not big enough for the growing club. This was solved by adding skyboxes for their sponsors, hanging from the roof of the stadium. These units have been sold out from the point that they were installed in the stadium (Van Hoof 1996). This financially lucrative concept was successfully copied by many clubs. Feyenoord, the second largest club in the country was playing in De Kuip, the case of this thesis. Since De Kuip is a monument, their options were limited. In order to comply with the increasing higher standards in the business the club added the Maasgebouw, a separate structure next to the stadium to welcome important guests, with all the functionalities in place. Gangways (aerial connections) between the Maasgebouw and de Kuip were constructed to connect the two buildings and incorporate the facilities of the two structures with one another.

7. New built and multifunctionality (1990's)

As stated, renovation was the norm during these decades. The first newly built was the stadium of SC Heerenveen, represented in the highest Dutch league. The municipality planned a hospital at the location of the stadium, forcing the club to build a new one. They took up this chance to build a small stadium with lots of opportunities to expand. The cub slowly transformed the stadium into the modern, luxurious, packed with facilities stadium it is now (van Loock, 1999).
The Heerenveen stadium is an exception and many big Dutch clubs still play in a renovated stadium with limited room for expansion and adaption to new techniques and demands. The fact that these stadiums were built so many decades ago with limited knowledge about future demands is now a constraint for the current use and also for possible renovation activities.

Figure 9 - Abe Lenstra Stadium, SC Heerenveen - Wikipedia (2015)

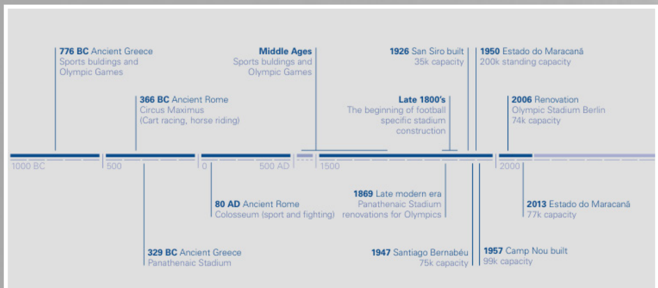


Figure 10 - History of Stadiums - KPMG (2013)

Theoretical Framework

III.III Current trends in sports

The sporting industry is an economy on its own. It displays trends as does any other economy. In recent decades the sporting industry has been growing in a rapid pace in many ways. When focussing on the soccer industry solely, we see an immense increase in the money that has been spend in the industry, ranging from transfer fees to player budgets, but also stadium tickets. These trends also have an influence on the demands of the (new) stakeholders that are involved in the industry. All these stakeholders together are responsible for the changing requirements that a stadium has to meet. Therefore, in this paragraph, the changes in the demands of the different stakeholders are discussed in order to understand the current situation. Stadiums of the present and the future must do their best to meet all of these demands to make the stadium economically successful.

- Municipality

Municipalities in general in The Netherlands are facing though times. Budgets are being cut and there is a reluctant attitude towards new investments because of the lack of funds. This means that investments that are not necessary won;t be given any priority. Often, stadium projects are subject to these budget cuts of municipalities. Previously, municipalities invested in the construction of a soccer stadium because of the public benefit. Operating at a breakeven level was sufficient for the municipality since the stadium contributed to the society as a social promoter.
People would get together every other week at the stadium and the stadium served the social cohesion within the municipality. Investments in the renovation or construction of a sports stadium are among the first budgets that are being cut. Contributing to the costs for such a renovation is the fact that stadium demands are growing at the same rate as the sport, with spectators demanding more and more comfort and safety restrictions becoming stricter by the day. This makes that the costs for stadium maintenance and stadium constructions are rising rapidly.

- National Government

The municipality and national government are two interrelated actors in this process. Because of the magnitude of the project and the interest of the Dutch population in this specific project, the national government also has to express their point of view and their interest. The amount of capital involved is also of such a scale that the national government is involved. If the government is to vouch for such an investments, it demands a clear vision on the public benefits of the project. In addition, the government and also municipalities put up constraints by issuing demands focussing on sustainability, energy costs and operational costs now that sustainability is a popular topic in the building industry (Rotterdam Climate Initiative, 2010). A lifecycle cost approach incorporation in the solution model would help satisfying the demands from the government on this topic.

- Sports Club (Main user)

As the main user of the stadium, the club that plays their home games in the stadium has the most benefit of a well-functioning stadium. Recent trends in sports makes that demands from the club are increasing. The three actors that the club is serving are the fans, the players and their business partners. Fans have to be provided with better F&B, better entertainment before and after the match and preferably half-time entertainment. The players demand better treatment on and of the field. This means that the stadium has to provide in better dressing room characteristics and more safety on and off the field. The business partners, the last category, are arguably the most important. These are the investors in the club by renting sky boxes and ultimately cash injections in the club through sponsorships and other deals. While the profit of sky box rentals is already a major part of income for most stadiums, the satisfaction of a business partner, boosted by a well functioning and well organized stadium is priceless. Therefore, demands for facilities within the stadium for this specific target group are increasing rapidly. The stadium has to provide in these demands by hosting restaurants, bar, great views, and a high standard of luxury.

- Sports Club(s) (other potential users)

Other potential users also notice a change in their respective field of sport. The increasing professionalism in sports is a widespread phenomenon. Potential sports that are to use the stadium of a football club therefore demand certain things of the stadium. The high standard that football sets in its quality of serving spectators and other invitees is often sufficient for other sports. The fact that soccer is the national sport in the majority of the countries in the world helps. When it comes to other sports, the view is therefore the main point of criticism. Since every sport is watched in different ways flexibility in the seating is an important demand. Facilities like moving stands, or stands that can be removed for people to stand during the game can be a demand. Flexibility is therefore an important aspect.

- Organisers of events (other potential users)

Organisers of events can be seen as organisers of concerts, shows, fairs and many more. Most of these events will be held on the pitch of the stadium or in the areas reserved for business. The fact that there are so many venues for specific events like concerts, with perfect acoustics and perfect view, make it harder for stadiums to attract these concerts. The main reason for artists to keep coming to grand sports stadiums is the capacity of the venue. It makes that roofs on stadiums become a demand for organising concerts. A retractable or permanent roof is such an advantage over a stadium without any, because of planning in case of bad weather. In the case of the Feyenoord stadium, we see that all the main artists schedule their performances in the Amsterdam Arena or the Gelredome in Arnhem (Uden, 2005). A roof would make the Kuip a third player in this competition.

- (Current) Stadium Owner

The growth of the football society has multiple effects on the stadium owner. The owner has to comply with all the demands of the different stakeholders in order to keep operating the stadium in a successful manner. Critical actors are the municipality (if not the owner), the club, and of course the fans. Keeping these three actors satisfied, and in doing so as many of the other actors will result in a higher profit for the stadium owner.
Now that stadiums are being built with more flexibility and the possibilities for multifunctionality, investors see opportunities in the exploitation of sports stadiums. The fact that stadiums can not only host a soccer game once every two weeks, but can operate as a multifunctional business with every day activity and high potential revenues makes that investors have become very interested in these type of projects. For the stadium this means a shift from a social point of view to a view that is purely focussed on profit. In order to be as profitable as possible, investors are continuously looking for ways to enlarge the return on their investments by hosting as many and as profitable events as possible in the stadium.

- Guests/Fans

Fans and guests of the stadium are the people visiting the stadium on match days and on other weekdays. The fans nowadays don’t have much higher expectations of their visit to the stadium(Tomlinson et. al., 1995). They demand comfortable and dry seating, easy access to the stadium, short distances to F&B, and they expect guaranteed safety during their visit. The VIP’s or business people visiting the stadium have higher expectations, and are satisfied when offered business lounges or sky boxes during the game. In the weekdays they demand a high quality restaurant and meeting rooms.

- Other

Beside these actors there are many more, such as the architect, contractor, police, shop owners and so on. Their demands haven’t change in recent years due to the growing sporting economy, and their demands are fairly logical. The police must be offered a separate space within the stadium, just like the fire department, and they have their demands concerning the safety of the people within the stadium. Shop owners demand a certain quality of their shop location within the stadium and, for instance, a respectable amount of counter length.

Concluding this paragraph, we can see that the growing sporting industry, with soccer in particular, has had its influence on the stadium and the demands of the stakeholders involved. Newly built stadiums are designed with all these demands incorporated to the best of the ability of the architect and the budget available. Renovations however, are more difficult to works with because there is an existing stadium involved that has been built many decades ago and is not prepared for the changes that are proposed and wished. The shift from the social point of view from the municipality towards the financial point of view of the investors is crucial in this case.

Figure 11 - Seats in the Kuip - Skyscrapercity (2011)

III.IV Effects on demand

Stadium design is a specific field within the real estate sector. Due to the high complexity, experts in this area of expertise are necessary. A strict planning during the entire process, combined with the right facilities in the right place make that the stadium is as efficient and effective as possible, maximising the opportunities that it is presented with. This paragraph will therefore provide an insight in the development process and trending market aspects in stadium design nowadays.

Vision

Developing a vision for the stadium is the first step in the entire design process, often initiated by one party. The vision for the stadium that I will be focussing on in this thesis is the multifunctional soccer stadium, with the ambition to host mega events such as the FIFA World Cup or UEFA European Championship. The ability to host a project of this magnitude is also dependent on the ownership structure that is in place currently. Most of the stadiums in Europe are publicly owned, with the note that the recent trend of clubs is to gain more control on the ownership situation of the stadium, enhancing their control over the stadium and its revenues consequently. The figure to the right shows the ownership situation as of 2010. We can see that from 'Big 5' (Criado et. al., 2013) competitions (England, France, Germany, Italy and Spain) only England and Spain have a high percentage of ownership of their stadiums (KPMG, 2013). These two competitions are also considered to be the two strongest ones out of the five.
The Netherlands has a respectable place in this figure with between 10 and 29% privately owned.

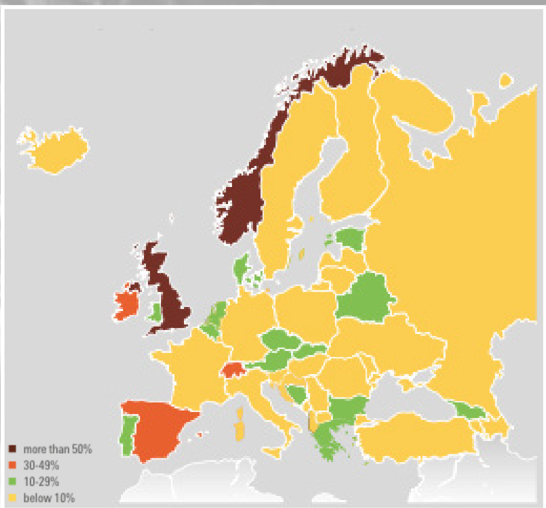


Figure 12 - NEurope Stadium Ownership - KPMG (2013)

If the ownership situation is clear and all owners are willing to cooperate with a renovation or new built the vision is enhanced with goals, stating the wishes, demands and affordability restrictions.

After identifying the stakeholders that are to be involved in the process the vision is clear.

Planning and feasibility

The next phase of the process is the planning and feasibility phase. This phase can be divided into 5 different phases (KPMG, 2013). The final three phases are part of a continuous refinement cycle and can be repeated indefinitely.

1. Location and site assessment

Analysis of the site requirements. Questions on the size, location and visibility of the stadium. A stadium of 70.000 seats (de Kuip) is estimated to use up 55.000 to 60.000 square meters. All other aspects, like public transport, community support and the costs of new infrastructure are determined in this phase. The trend for stadiums is now to return to the city centres as they were previously driven out of the city centre and into the suburbs.

2. Market Analysis

A market analysis is a key element in the feasibility study and a driving force of the project. 'The size and cultural aspects of the population, growth and purchasing power of potential spectators and the government support for football infrastructure, within a respective country, are factors to consider when profiling the services of a new football stadium.' (KPMG, 2013). Also the seating capacity is a crucial factor. Extra costs occur when constructing more seats than necessary, compared to losing sales when designing not enough seats. A third factor is that the atmosphere in a stadium that is not fully filled with people is less encouraging, possibly affecting the performances on the pitch. We also see a rise in the amount of premium seating compared to regular seating, with percentages of newly built stadiums averaging at around 10-12% of the total capacity of the stadium.

Considering multifunctionality is done in this phase of the project. The advantages of multifunctionality in revenues might be compensated by the loss of atmosphere. Also, event organisers tend to capture a majority of the earnings of extra events. However, the extra functions of a stadium, such as shopping facilities or residential areas, are a more secure investment and might help with the financing of the stadium. Shortly stated, these are the main arguments for and against a multifunctional stadium.

Another major source of income, F&B (Food & Beverages), is also dealt with in this phase of the project. Engaging with potential organisers of F&B, or have an analysis done on the potential demand is key in this phase. Besides that, location is key for F&B facilities to maximise return on investment. Determining the location, standard of quality and the quantity of F&B locations is therefore of importance for the efficiency and maximisation of return on investment. A rule of thumb in this branch is that you need 10 meters of counter per 1.000 visitors (KPMG, 2013).

3. Stadium Conceptualisation

The next phase can be seen as a test run of the stadium and is the first of the three phases in the cycle. In this phase the optimal configuration of the stadium is determined. Examples are the optimum amount of F&B restaurants, premium seating, general seats, pricing of VIP packages, etc. This closely relates to the subject of this thesis. It is important to have an overview on the development costs of the stadium, often expressed as the 'development costs per seat' in the stadium. These numbers usually range from around €1500 (cheap) up to €6000 (expensive) per seat.

4. Operational Forecasts

The operational forecasts can be divided into two categories: Operating Revenues and Operating Costs.

Operating Revenues:

Individual spectators
Corporate Clients
Event promoters/organisers
Advertisers/sponsors
Lease of commercial areas
Other commercial activities

Operating Costs:

Staff and personnel
Security
Maintenance/repairs/cleaning
Suppliers
Marketing & Events
Utilities
Security
Management

5. Financial Feasibility and Funding

In the financing of the stadium, the owners have a number of options to attract capital. The most used forms of financing are stated below.

Contract-backed revenues
Equity financing
Debt financing
Securitisation
Public authorities

Theoretical Framework

Permitting and design

In the permitting and design phase, the stakeholders are faced with a number of restrictions and opportunities. The restrictions come from the side of the UEFA and FIFA. Complying to their restrictions is essential for future revenues if assigned a major tournament or event. The design is influenced significantly by these restrictions.
One of the most influential constraints is the so called ‘C-value’. This is a measurement of the distance a spectator can see over the heads of the spectator below at an angel to the nearest point of focus. FIFA expects a minimum C-value of 60mm in the entire stadium. Compromises have to be made on this issue, because granting the lower tiers a good C-value will affect the C-values of the higher tiers in a negative way.

This fourth phase is also the phase for a number of essential decisions. The structure of the stadium is determined for the design, influencing the costs of the stadium tremendously. Also, measures for sustainability and the possibility of a roof are discussed in this phase.

Construction

The construction phase is not of major influence for this thesis. However, the initiators have to minimize the risk of the construction phase. In achieving this, they have the choice between three options of collaboration:

Design & build
Traditional
Construction management

Each tender process has its own perks, and the best form of collaboration is different for every case.

Operation

The last phase for the stadium is the operation phase in which the stadium is being occupied and used. The operation structure, the stakeholder that is responsible for operating the stadium, can differ. Three operation structure types have been defined:

Lease agreement: The owner leases the facility, collecting a fixed rent. The club is responsible for operations. Low risks are carried for the owner because of the fixed rent, but no benefits can be collected if the stadium exceeds expected returns.
Owner operated: The owner sets up a team of operations. Often the structure chosen if the club is the owner of the stadium. This means complete control for the owner, but is capital intensive because of the management team.
Management agreement: Owner transfers the operation responsibilities to a company with experience. The upside is the availability of this experience, however this may result in high management fees.

All three strategied have certain risks, in combination with certain responsibilities involved with these risks.

Figure 13 - Stands of the Kuip 1938 - geheugenvannederland (2010)

III.V UEFA/FIFA regulations

Newly built and renovated soccer stadiums often have high ambitions. Besides complying with the demands of the stakeholders that have already been discussed, there is an extra special stakeholder. The high ambitions often involve the possibility to host international soccer events. There are different types of events thinkable. The team playing in the stadium could qualify for an international tournament like the UEFA Europa League or the UEFA Champions League. Besides that, the stadium owners often have the ambition to host home games of the national team in friendlies, the UEFA European Championship Qualifiers or FIFA World Cup Qualifiers. The highest ambition is to host the UEFA European Championship or FIFA World Cup. The UEFA (Union of European Football Associations) and FIFA (Fédération Internationale de Football Association) are the administrative bodies of soccer on a European and global level. They are renowned for their strictness when it comes to their selection criteria and selection procedures. Also, sustainability is part of their selection criteria. To be selected by the UEFA or FIFA for international games is a boost for ticket sales and also the reputation of the stadium. Therefore it is a wish of most stadium owners to be selected for such an honour. It is important to analyse the official documents of these organisations to be able to adapt to their demands.

UEFA

The UEFA works with a star-rating, where a five star rating is the highest (UEFA, 2014) . The only two stadiums in the Netherlands that are currently at a five star UEFA level are the Arena in Amsterdam and the Kuip in Rotterdam. The requirements for any new stadium should be to achieve a five star rating. The demands of the organisation are displayed below:

Field of Play	105 m long, 68 m wide
Minimum size of referees' dressing room	20 m2
Minimum floodlighting	1400 lux, all directions
VIP Parking	150
Spectator standing allowed	No
Minimum Seated capacity	8,000
Minimum total VIP seats	500
VIP seats for visiting team	100
VIP hospitality area	400 m2
Minimum media working area	200 m2 for 75 people
Minimum number of photographers	25
Minimum space for main camera platform	10 m2 for 4 cameras
Minimum number of seats in the press box	100, 50 with desks (covered)
Minimum number of commentary positions	25
Minimum number of TV studios	2 with pitch view (2,3x5x5 m)
Minimum post-match interview positions	4 (2,5x2,5m)
Minimum outside broadcast van area	1,000 m2
Minimum number of seats in press conference room	75

Table 1 - UEFA demands - UEFA (2014)

FIFA

The FIFA has released a public document with recommendations and requirements for stadiums to host different FIFA Tournaments, called 'Football Stadiums: Technical recommendations and requirements' (2007). Depending on the ambitions of the stadium owner, club and municipality, an ambition can be chosen for the stadium. This document then provides an extensive list of the requirements, ranging from capacity to hospitality, pitch sizes and so on. These requirements can then be used to design the stadium or the alterations in case of a renovation to achieve the wished FIFA standard. The main demands of the FIFA are that the capcity of the stadium for a World Cup semi-final is at least 60.000 and for the final 80.000.

III.VI History of 'De Kuip'

The Feyenoord Stadium, also known as 'De Kuip', is the home of Dutch football club Feyenoord. It was designed by Leendert van der Vlugt in 1935 and opened in 1937 (Wijnen et. al., 1989). The idea for the stadium was revolutionary at the time. The chairman of the club came up with the idea for a second tier on the usual tiers that football stadiums were known for in those years. This second tier should be hanging from a structure, without obstructing the view for any spectators. The design was meant to be as sober as possible, with the pocus on simplicity instead of detail. Beside the mentioned requirements, the board of the club asked for room for meetings, dressing rooms for teams and officials, a police station, a fire department and even four dwellings were realised in the stadium. The stadium was built in record time and the missing infrastructure around the stadium made that is was opened a couple months later in March 1937. The stadium had a capacity of 65.000, of which the majority was standing. After some renovations and the addition of seats in all areas of the stadium, the maximum capacity as of now is 51.117 people. The stadium hosted the home games of Feyenoord and has hosted more than 100 international games of the Dutch national football team. Also, ten European finals have been played in the stadium. During the second world war the stadium was on the verge of being demolished for the revenues its steel. However, the tale is that someone changed the numbers so that the profit was far less then calculated and the stadium was saved.

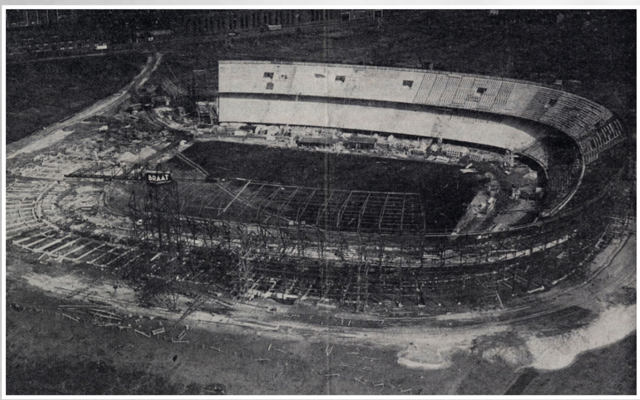


Figure 14 - Construction of the Kuip - geheugenvannederland (2010)

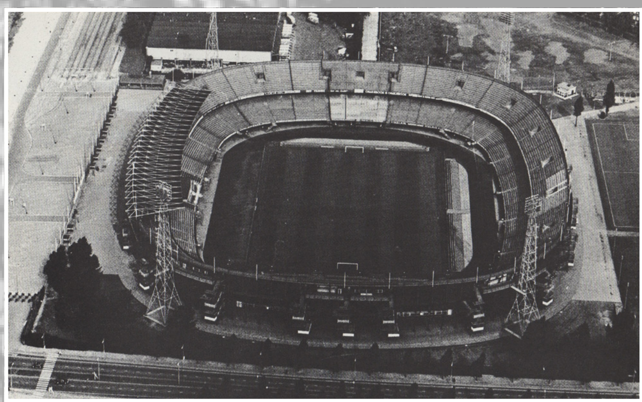


Figure 15 - Construction of the Kuip - geheugenvannederland (2010)

The second time it was almost demolished was in 1984, when The Netherlands were preparing a bid for the 1992 summer Olympics, and the ground of de Kuip was reserved for a new Olympic stadium. This plan was also cancelled. In the 90's, inspectors discovered some decay of concrete and erosion in the structure of the stadium. This was the third time the stadium was almost demolished, but the municipality chose a renovation of the stadium instead.

This renovation in 1994 was carried out by Broekbakema, an affiliate company of the old architect van der Vlugt. The goal was to make the stadium more multifunctional and profits had to be boosted. The Maasgebouw, was built for the invited guests and sponsors, and gangways to the stadium were made to connect the two buildings. Also, a museum, offices, a reception and a restaurant were located in the Maasgebouw. A canal between the pitch and the spectators has been added and the steel construction of the stadium has also been renovated. Finally, 40 business units were created for business and sponsor relations. The stadium is now capable of hosting major concerts and other events. It has also been given the status of a national monument, making it a protected piece of heritage of the Dutch nation.

After the renovation, 85% of all seats were covered by the roof, but the building of the Arena in Amsterdam and the Gelredome in Arnhem, two stadiums with retractable roofs, the Kuip had severe competition for concerts. These sort events prefer an indoor climate above an outdoor climate.

In 2004, the Olympiagebouw on the other side of the stadium as the Maasgebouw, has also undergone some major renovations.

Looking at the architecture of the stadium, De Kuip is the first stadium with a second tier hanging from the structure, without any visible structures and because of that without any obstructions for the visitors in the stadium. It has an continuing round shape with closed corners, compared to the traditional square English design with four stands along every side of the pitch with open corners. The stadium is built with a steel structure, allowing for smaller dimensions of the materials and a more open and light atmosphere. The glass on the top of the first tier even lets the second tier optically 'fly'. The expansion of the roof in the 1994 renovation gave the stadium its nickname, De Kuip. It looks like the shape of a traditional bathtub (Badkuip in Dutch).

Figure 16 - First International Game in the Kuip - geheugenvannederland (2010)

Figure 17 - First International Game in the Kuip - geheugenvannederland (2010)
Figure 18 - First International Game in the Kuip - geheugenvannederland (2010)

III.VII The 'Nieuwe Kuip'

As stated in the previous paragraph, De Kuip was subject of demolition on several occasions. This has also been the case very recently. Plans for a new Feyenoord stadium have been around for a couple of years now, and these plans are finally being followed through. The main question for this new project was if a new stadium should be built, or if a renovation of the old stadium would be in the best interest of the involved stakeholders. Since soccer is part of public property in The Netherlands it became an issue of national importance in 2013 and 2014. Different solutions for the stadium, including renovations and new designs were presented.

In the end, Dutch companies VolkerWessels and BAM were selected for the competition. At this point in time, the plan for a new stadium was rejected due to the high costs. Both firms were to focus on the renovation of the existing stadium. An advisory group of three prominent members of the club and municipality was formed to research the two proposals. The group advised in favour of BAM and the company was chosen to execute the renovation. In this paragraph the design of BAM (FFC, 2014) will be elaborated on and discussed briefly. The definitive design is still to be approved, and it is to be expected that this will be done by the end of January 2015, initiating the real start of the project.

Figure 19 - the new Kuip design - Red de Kuip (2014)

Figure 20 - the new Kuip design - AD (2011)

Figure 21 - the new Kuip design - FFC (2014)

Vision

Where many people think BAM is the only responsible party in the design, it is actually a consortium of BAM, AM and Siemens. This consortium has been an affiliate of Feyenoord for over 20 years. The main partner, BAM, has experience in building over 200 stadiums worldwide. The vision for the renovated stadium consisted out of the following ambitions:

- The biggest stadium in The Nehtherlands
- An icon for Rotterdam
- Incubator for South Rotterdam
- Preserve the typical 'Kuip' atmosphere
- Multifunctional
- Modern
- Sustainable
- Innovative and Smart
- Catalyst function for the area around the stadium

Design and execution

On the design scale of the stadium, the consortium also stated ten (partly overlapping) ambitions for the design to be based on.

- New stadium with the existing Kuip experience
- Seated/standing stand around the pitch
- Double the capacity and rebuild the business facilities
- New parterre boulevard for more comfort and exploitation possibilities
- New promenade with modern facilities for the second tier
- New promenade with supporters plaza for the new top tier
- Great points of view on the pitch from every seat
- Smart skin LED façade for ultimate exposure
- Retractable membrane roof structure
- Minimal interference during construction

The new stadium achieved all the mentioned ambitions in their preliminary design for the stadium. The main alterations will be briefly discussed. The current Maasgebouw, which is a structure apart from the stadium, will be demolished. Two new additions on the long sides of the stadium will be realised. These two buildings, also called the Maasgebouw and the Olympiagebouw, will be the main entrance for business partners and VIP guests. Restaurants, business lounges and skybox entrance is situated in these buildings. On top of each building, the supporters' plazas are created for the regular visitors to come together. Between the buildings, a special circulating circuit is constructed, so guests can travel from one to the other building without moving through publicly accessible areas. A total of 88 business lounges and sky boxes will be created, more than doubling the current revenues of these facilities. Structural adaptions will be made to accommodate the new ring on top of the stadium. This will have an effect of over 15.000 extra seats, increasing the capacity of 51.000 to 70.000 seats. On the lower level, the supporters are renowned for not using the seats provided and standing the entire 90 minutes of a football match. Therefore, the club will install new folding chairs for improved atmosphere in these parts of the stadium. A new promenade for this extra ring with facilities is also constructed. To top things off, a new roof installation is installed. The roof consists out of a light material membrane for a maximum feeling of openness when the roof is open. The roof can be closed in about 15 minutes, closing off the entire stadium.

A special planning of the project has been designed to cause minimal disturbance of the regular football season during the construction. The estimated construction time of the stadium is around three years.

with an estimated cost of around €200 million (€240 million including new training facilities), is displayed in the image below.

Smart Stadium Concept

The stadium has incorporated different smart and sustainable systems. The Smart system means that different systems will operate simultaneously. A central control room controls the different system elements. This system makes the stadium more sustainable in its energy consumption. The main elements are:

- A LED skin façade with sustainable LED technology, for commercial activities and is also adaptable for other events.
- Hanging from the structure is a large cubical video screen, right above the centre of the pitch. The four screens serve to entertain the public, provide match statistics and replays, interviews and commercial activities.
- Intelligent ticketing systems, where the ticket for the game is also a 'payment card' used for purchasing F&B within the stadium. This is faster and increases revenues.
- Smartphone app system for communication with fans

Operation

The stadium has a very high percentage of business seats, sky boxes and business lounges, increasing the often high revenues compared to regular ticket revenues. The consortium has also partnered with IMG, a specialist in sale strategies, for the exploitation of the facilities in the stadium. This company will be responsible for the restaurants, shops, and other financing strategies.

Financing

The financing structure for the stadium, It is a combination equity financing and debt financing. The actors involved in the debt financing will be NordBank, Brookfield, NIBC and Siemens. In this case, the club Feyenoord gets paid a performance fee to play in the stadium, where in most other cases it is the other way round and the club has to pay to play in the stadium.
The chosen tendering process is the Design and Build. During the exploitation phase, the stadium has the aforementioned management agreement in place to generate maximum revenues.

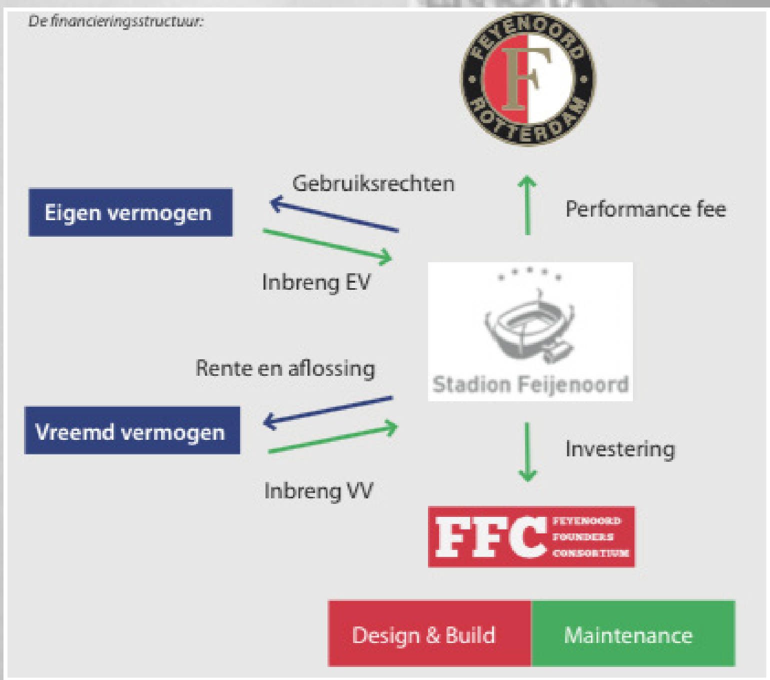


Figure 22 - Finance Structure - FFC (2014)

It is a combination equity financing and debt financing. The actors involved in the debt financing will be NordBank, Brookfield, NIBC and Siemens. In this case, the club Feyenoord gets paid a performance fee to play in the stadium, where in most other cases it is the other way round and the club has to pay to play in the stadium.
The chosen tendering process is the Design and Build. During the exploitation phase, the stadium has the aforementioned management agreement in place to generate maximum revenues.

Research Organisation IV

IV.I Scientific Domains

1. Design and Decision Systems

2. Building economics, building costs and high rise

IV.II Mentors

1st mentor(Domain):	Dr. Ir. R. (Ruud) Binnekamp	Design and Decision Systems
2nd mentor(Domain):	Ing. P. (Peter) de Jong	Building Economics, building costs and high rise

IV.III Planning

Figure 23 - Rough Planning - Own Image (2015)

V.I Model Scope

This next part of the report will cover the entire model creation. First of all, I will explain the assumptions that were to be made to provide myself with a framework in which I was able to create this model, the scope. The next step is to identify and profile the stakeholders that are involved in the project. This is the step where the stakeholders' goals are defined, and these goals are then translated into variables. These variables are vital to determine, since they are the data that will be put in the model to serve as boundaries of the solution space. The origin of these variables is discussed, in combination with their influence on the outcome of the model, their 'dual value'. This part of the report is then concluded with a reflection on the creation process of the model.

Since a graduation project has a limited time frame in which it has to be carried out, it is unfortunately not possible for me to make a 'complete' model that is able to consider all possible options before deciding which one is most suited. The decision was made to purely focus on the financial aspects of the stadium structure, since the goal of the project sought for on a financial level. The level of detail for the model has therefore also been focussed on a financial level, leaving out any distractions or extra options to further alter the input of the model. In addition, creating a model that is more extensive will be harder to comprehent and operate and will decrease the inductiveness of the model. It is hard to alter a tailor-made model for one specific case to suit other cases. Taking all these aspects in consideration, the financial level has been chosen as a clear boundary and any aspect that does not have a significant influence on the financial results has not been taken into account. With this in mind, the goal to make the model as realistic as possible, therefore making the result as realistic as possible as well.

The main restriction given to the model is that it focuses on one stadium at a time. While this might seem obvious, it is important to highlight this as the main scope of the model. It is meant to make calculations for one stadium only. In this case, it is making calculations for the renovations of an existing stadium.

It is possible to use the model for other cases than the Feyenoord stadium. However, in order to make the model optimal for the Feyenoord case, distinct variables and choices for the Feyenoord case have been put into place. This ables the model to give a more detailed outcome on the case, but this specialization also means that the model will lose the instant transferability to other cases. This decision has been made early on in the process, with the most important argument for this strategy being the fact that the results of the analysis are verifiable and creditable due to the increased depth of the research because of this specialization. Making the model usable for other renovation cases or projects on new stadiums is possible. The adaption process of the model will take some time, but the experience with this first model will contribute to the adaption process. The main structure of the model will remain and specific features and demands to this new case have to be added to the model in order to make it useable and to validate the outcomes. Moreover, restrictions to the size of the stadium in the model have to be implemented. The size of the model is expressed in the number of tiers that the stadium will have. Corresponding to that, the number of seats and floor area of the stadium will increase. More than three tiers in a stadium is highly unlikely. The view on the playing field is not optimal anymore and very high construction costs come into play when constructing a fourth tier. Because the Kuip already has three tiers in the plans for the renovation it will be only looking at options for a stadium with three tiers.

The following part of the scope is that the decision is made for the model will not be able to make a design for the floor plans within the stadium. What the model does, is that it assigns square meters of a certain function to certain floors based on the restrictions within the model. It makes decisions on capacity, ticket prices and for instance, the number of other events as well. The added value of this function did not weigh up to the advantages of a more realistic model development within the time restrictions of this research. Also, the model will not be able to fill certain spots with a certain function based on the demand. The designer will have to manually place the functions the model suggested for each floor. If this is not possible, the restrictions for the model have to be changed to force it to come up with a different solution. The model is set up this way because of the fact that most stadium designs have a clear view on the desired functions per floor.

Figure 24 - COnstruction of the Kuip - geheugenvannederland (2010)

Model

In order for the model to run properly, it needs boundaries within which it is allowed to find solutions. This is effectively the definition of a solution space. If there were no boundaries for the model to work with, it would be allowed to do everything to optimize the ROI. Each stakeholder will have their wishes and demands. These will be translated into constraints in this chapter for the model to take into account when finding the optimal solution. All these variables together limit the space in which the model is allowed to find a solution. If the constraints prove to be formulated in such a way, that no solution con possibly be found, the model mechanics will not be able to find a solution and an 'Infeasible' result will be displayed. To assure a solution is found, a stakeholder might be forced to alter the constraints that were entered into the model, making his constraints more lenient. This can have the effect that a solution space is available that was not available before and the model is able to find a feasible solution. This is also the point in time where the 'Dual Value' of the constraints can be used. The dual value of a constraint is the effect that it has on the optimization function, expressed in the unit of the function. So, in this case for example, a dual value of 150 will mean that if the variable is increased by 1, the ROI increases by 150. A higher dual value therefore means a higher influence on the end result. If the model is not solvable, the best way to create a solution space is to approach the stakeholder who is responsible for the constraints with high dual values. Lowering these values has the highest impact on the ROI and these constraints have the most potential in creating a solution space.

In this next part, the different stakeholders will be introduced one by one. Their goals will be discussed and will be translated into constraints for the model. Also, the dual value of these constraints will be presented so that the influence of the specific stakeholder is visualised as well.

Figure 25 - the Kuip - J. Brink (2014)

V.II Stakeholder Profiling & Demands

- Municipality

Profile

The Rotterdam municipality is a crucial stakeholder in the entire project. It possesses multiple tools to prevent the project as a whole, with the urban city planning plans within the municipality. Furthermore, it is one of the stakeholders that has other goals than pure financial based ones. First and foremost, the municipality is responsible for a safe and pleasant living environment for all it's inhabitants, so there is a big social component in the demands. Expressing this social aspect into demands is difficult, but the municipality has published a document in which it states the vision for the city as a whole. On top of that, being involved in the project from an early stage onwards, the municipality has stated some goals for the stadium project specifically as well. A popular topic like sustainability has to be incorporated to a certain extent, as well as plans for noise nuisance, air pollution and other types of nuisance for the inhabitants surrounding the stadium. However, the main investments from the municipality point of view will be those in the public space around the stadium, with a planned remodelling of the area around the stadium for an amount of €90 million.

Goals

For the Rotterdam municipality, based on the stakeholder profile, we can formulate a set of goals for the stadium project. In terms of finances, the municipality has a maximum amount of subsidies reserved for the project, and won't be willing to invest more than that amount. This aspect is incorporated into the input sheet of the model, with a maximum investment of a pre-defined percentage of the investment sum. The social aspect of their demands is a combination of certain factors. The stadium capacity has it's limitations, and the crowd has to be controlled at all times, therefore the municipality has a demand for the maximum capacity of the stadium. Safety precautions have to be implemented and demands for areas for police and the fire department have been stated. The sustainability aspect is expressed in a certain BREEAM certificate level. BREEAM indicates the sustainability in construction projects during the construction phase and the operation phase. Extra costs for this certificate have also been taken into account in determining the construction costs.

Constraints

Maximum capacity:	72.000
Sustainability	BREEAM certificate
Initial investment	€200.000.000
Area for police and fore department	>200 sq.m. (part of technical area)

Table 2 - Constraints Municipality - Own Image (2015)

- Police & Fire Department

Profile

The Police and fire department are public services that have only one goal as a stakeholder in this project, being safety. The stadium has to be constructed in a safe manner, complying with safety demands that apply to stadium design. From a police point of view, crowd control is the main safety issue that is to be dealt with.

Goals

The goals of both services are safety combined with a good overview of the stadium area. Entrances and exists have to be easily guarded as well. The current lay-out of the stadium is already complying with the demands for the safety in and around the stadium, although a special room reserved for the police and fire department is absent at this point in time. This results in only one constraints for this stakeholder.

Constraints

Area for police and fire department	>200 sq.m. (part of technical area)

Table 3 - Constraints Police & Fire Department - Own Image (2015)

- Stadium Owner

Profile

The stadium owner is the focus of this research and can therefore rightfully be seen as the most important stakeholder in this entire research. First of all, the stadium owner is to be identified. As stated in the problem analysis and also the theoretical framework of the research, the current trend in stadium ownership is a combination of clubs owning their stadiums themselves, or a private investor from the outside. In some cases, the municipality can also be involved in the ownership situation. In this research, the focus is on the optimisation of the ROI of the stadium as a whole, so the type of owner with this ambition is most likely to be the investor. The investor has only one goal when investing in the stadium, and that is a maximised return on investment. This means that in all aspects of the stadium, the ROI is leading for design decisions. Every function by itself is approached with this mind-set, but also the combination of functions is a variable. A higher investment in one area of the stadium might make revenues higher in another part of the stadium. For humans, it is impossible to structure and organise these millions of different combinations of variables and constraints given by the stakeholders to find the optimal design. However, the model is able to take into account influences of design decisions on every aspect of the project. Translated to the decision model, it makes that the investor is responsible for the largest amount of constraints with this one goal.

Goals

As stated in the profile description, the investor has one specific goal; a maximised ROI. This goal can be explained as the optimal distribution and balance between income and expenditure. Features like ticket prices, area distribution within the stadium, extra sporting events, extra corporate events, F&B and many more restrictions have to be put into place to ensure this goal is reached. The goal of the incest or is translated into specific constraints for the stadium in the next paragraph.

Constraints

Ticketing category 1 min.	€35,00
Ticketing category 1 max.	€45,00
Ticketing category 2 min.	€25,00
Ticketing category 2 max.	€35,00
Ticketing category 3 min.	€20,00
Ticketing category 3 max.	€30,00
Ticketing category 4 min.	€15,00
Ticketing category 4 max.	€20,00
Ticketing business seats min.	€100,00
Ticketing business seats max.	€150,00
Ticketing sky boxes min.	€800,00
Ticketing sky boxes max.	€1000,00
Ticketing suites min.	€400,00
Ticketing suites min/max.	€600,00
Seat % category 1 min.	10%
Seat % category 1 max.	15%
Seat % category 2 min.	15%
Seat % category 2 max.	25%
Seat % category 3 min.	30%
Seat % category 3 max.	40%
Seat % category 4 min.	30%
Seat % category 4 max.	45%
F&B category 1 revenues	€12,00
F&B category 2 revenues	€10,00

Table 4.1 - Constraints Stadium Owner - Own Image (2015)

F&B Category 3 Revenues	€8,00
F&B Category 4 Revenues	€6,00
Merchandising category 1 revenues	€6,00
Merchandising category 2 revenues	€8,00
Merchandising category 3 revenues	€10,00
Merchandising category 4 revenues	€12,00
Concerts min	6
Concerts ticketing	€60,00
Corporate events min	15
Corporate events ticketing	€100,00
Private events min	50
Private events ticketing	€40,00
Fairs & Exhibitions min	2
Fairs & Exhibitions ticketing	€20,00
Sporting event 1 min	2
Revenues sporting event 1	€500.000
Sporting event 2 min	2
Revenues sporting event 2	€500.000
Sporting event 3 min	2
Revenues sporting event 3	€500.000
Museum ticketing	€10,00
FTE	80
FTE salaries	€50.000
PTE	600
PTE salaries	€3000
Maintenance/repairs min.	€2.500.000
Maintenance/repairs max.	4.000.000
Cleaning min.	3.000.000
Cleaning max.	4.000.000
Marketing events min.	3.000.000
Marketing events max.	4.500.000
Utilities min.	2.500.000
Utilities max.	4.000.000
Management min.	4.000.000
Management max.	5.000.000
Suppliers min.	4.000.000
Suppliers max.	6.000.000

Table 4.2- Constraints Stadium Owner - Own Image (2015)

- National Government

Profile

The national government is one of the actors in this process with bit of a dubious function. On the one hand, the municipality is the main governmental body responsible for this project, since it is a project that is undertaken within their jurisdiction. On the other hand, the stadium has been in national media for several years now, and the national benefit of the renovation lies in the increased suitability for major national events. Concerts, games of the Dutch national football team and maybe even world cups and/or Olympic games can be held in the stadium once it is converted, making it a national project as well.

Goals

The goals from a national government view are multiple. The stadium is to be of improved quality compared to the other three big stadiums in the Netherlands: the Amsterdam ArenA (Amsterdam), the Philips Stadion (Eindhoven) and the Gelredome (Arnhem). With the increased capacity and the promise of a roof for the stadium, the national government has been satisfied in these demands. These demands are incorporated in the fundamentals of the calculation model, so these do not add any specific constraints that the model has to take into account.

- Sports Club (Main user)

Profile

There are different types of relationships between sports clubs and stadium owners. In some cases the sports club is the owner of the stadium itself and also acts like one. In that situation, the club has two divide the focus between the performances and the stadium operation. Both of them will have a positive or negative cash flow but have to be treated as one. In most cases, however, a third party is the stadium owner. The club plays their games in the stadium and benefits form ticket sales, while the owner of the stadium benefits from F&B income and a contribution from the club to be able to play in the stadium. In the new Feyenoord stadium a special kind of contract between the club and the stadium owner has been put into place. The club is now the one receiving a so called ‘performance fee’ for playing in the stadium. The stadium owner is paying the club for their services and attracting fans and visitors to the stadium. For the club, the main user of the stadium, it is important to be able to perform certain actions. Clubs of this magnitude demand a stadium that is suitable for all competitions, like the UEFA Europa League and UEFA Champions League. Besides that, they have demands for the number of seats in the stadium, the number of corporate seats for their business partners and sponsors. Other amenities like venues for merchandising sales for example are also demanded.

Goals

The club goals are mainly concentrated on the stadium facilities for the team and the fans of the team. Minimal floor space for certain functions are defined from the clubs perspective. Also, the number of suites, sky boxes and corporate seats must be higher than a predefined number by the club. Also, the club is responsible for the number of visitors during the match days, and therefore for the average attendancy percentage within the stadium.

Constraints

Minimal capacity	68.000
Average attendancy	70%
Business seats min.	5800
Business seats max.	6200
Sky boxes min.	48
Sky boxes max.	86
Suites min.	13
Suites max.	86
Museum visitors min.	30.000
Museum visitors max.	50.000
Min. commercial sq. m.	4600
Max. commercial sq. m.	5600

Table 5.1 - Constraints Sports Club (main user) - Own Image (2015)

Min. merchandise shop sq. m.	300
Max merchandise shop sq. m.	600
Min. F&B sq. m.	2800
Max F&B sq. m.	5000
Min. supportershome sq. m.	2400
Max. supportershome sq. m.	3000
Min. VIP entrance sq. m.	1000
Max. VIP entrance sq. m.	1300
Min. Player area sq. m.	1000
Max. Player area sq. m.	1500
Min. Media area sq. m.	1000
Max. Media area sq. m.	1500
Min. Business club sq. m.	6400
Max. Business club sq. m.	10000
Min. Business entrance. m.	500
Max. business entrance sq. m.	700
Min. Museum sq. m.	300
Max. Museum sq. m.	600

Table 5.2 - Constraints Sports Club (main user) - Own Image (2015)

Figure 26 - Atmosphere in the Kuip - M. van Driest (2013)

- Sports club (other potential users)

Profile
Other sports clubs are one of the main focus points in this research since they will be responsible for the extra revenues the stadium owner is looking for. Multifunctionality of the stadium itself is required to be able to host different other sporting events when it is the off seasson for the football club, and/or in the regular season between matches. These other parties also include the use of the stadium for other major sporting events like the Olympics and International football tournaments. If we look at the trends around the world in multifunctional stadiums when it comes to using it for other sporting events, we see different sports stand out. The main sports that suit the typology of the football stadium are American Football and Rugby since they use the same pitch sizes as football. Other sports like baseball, field hockey, cricket, volleyball and even ice skating can possibly been hosted by a football stadium.

Goals
The goal of the other sports clubs is to make the stadium as multifunctional as possible. In accomplishing this, the stadium must be able to arrange other seating arrangements like the Gelredome in Arnhem and Ahoy Rotterdam, who are capable of altering their seating arrangements according to type of event that it will host. Besides these goals, some other clubs might expect the stadium to be able to cover the playing field with a roof, something that is already incorporated in the initial plans. All in all, the wishes of these sports clubs to play in the stadium are to be accommodated by the stadium owner, who in return will benefit from the extra visitors. The constraints for the stadium are therefore part of the stadium owners' constraints and not those of the sports clubs.

- Event organisers

Profile
Within the event business branch, stadiums provide the best possible location for most events. The main events are concerts, fairs & exhibitions and also corporate events. The ability of a stadium to host concerts as well is a combination of acoustics, a roof and the ability to convert the pitch into an open field with a main stage on it. Since the Netherlands already has two football stadiums with retracting roofs, and multiple other venues specifically built for concerts, a roof is a crucial demand to be competitive. The fact that it will be the largest capacity venue out of all the other venues is the advantage de stadium has over the other competitors. The corporate facilities for corporate events have to be up to the highest standards as well to be competitive in this branch. A new business club is required with a high end restaurant and enough room for big corporate events. The category of fairs and exhibitions can be accommodated on the pitch itself or in the facilities in the stadium itself.

Goals
Concerts require a convertible pitch, a roof and sufficient acoustics in the stadium. The corporate events require a certain amount of floor space reserved for these types of events, in combination with a high end restaurant. Also, the ability to combine corporate events and regular games is wished, which can be accommodated by the corporate seats, sky boxes and suites

Constraints

Concert Capacity	90000
Private event Capacity	15000
Fairs & Exhibitions Capacity	90000
Corporate events Capcity	4000
Concerts min.	6
Private event min.	50
Fairs & Exhibitions min.	15
Corporate events min.	2
Min Business Club sq. m.	6400

Table 6 - Constraints Event Organisers - Own Image (2015)

- Guests/Fans

Profile

The fans and guests that visit the stadium are the most important stakeholders for the stadium owner, since they are the people bringing in the revenues. The fans are the people visiting for sporting purposes and will mainly be visiting to watch the game. Fans nowadays have big HD television sets to their exposal with great broadcasting from sporting events. Camera's in almost all angles, replays of big plays and the comfort of their own house, their own couch and relatively cheap F&B. This poses a real challenge for the stadium owner and sports club to keep attracting fans to the stadiums. The live experience of the game will have to be made into something special that is less spectacular than watching the game from your home. Most stadiums work towards this experience, with live entertainment, half-time-shows, big screens with replays in the stadium, more comfort and a wider variety of F&B.
Guests of the stadium are mainly corporate clients and visitors of events within the stadium. These guests often arrive in the stadium to watch the game as well, but their corporate contacts are more important, with the game being merely a form of entertainment during their networking activities. These guests have high demands when it comes to comfort and luxury, and extra facilities like restaurants are necessary to comply with all their wishes.

Goals

In short, the goal of the fan is the optimal stadium experience in all it's aspects. Many factors contribute to this goal, so many demands can be appointed to this stakeholder. The main ones have been listed in the constraints section.
For the stadium guests, the goals focus on the luxurious part of the stadium. Their main purpose in visiting the stadium is to meet their corporate contacts is a pleasant environment. This wish is also transformed in a couple of constraints for the stadium itself

Constraints

Ticketing max. Cat 1	€45,00
Ticketing max. Cat 2	€35,00
Ticketing max. Cat 3	€30,00
Ticketing max. Cat 4	€20,00
Ticketing Business seats max.	€150,00
Ticketing Sky box max.	€1000,00
Ticketing Suites max.	€600,00
Min. Commercial sq. m.	4600
Min. Merchandise shop sq. m.	300
Min. F&B sq. m.	2800
Min. Supportershome sq. m.	2400
Min. VIP Entrance sq. m.	1000
Min. VIP Restaurant sq. m.	5000
Min. Terrace sq. m.	400
Min. Toilet sq. m.	2900
Min. Museum sq. m.	300
Min. Supporters plaza sq. m.	2400

Table 7 - Constraints Guests/Fans - Own Image (2015)

- Employees

Profile
The employees that work in the stadium are the drivers of the revenues, enabling the stadium to function as it wishes. Employees can be divided into two groups; a large group that is being called upon during gamedays, and a group of full time employees that work in the stadium all year round.

Goals
The goal of the employees is fairly simple. They demand a pleasant workspace within the stadium. The part-time employees that only work on gamedays will probably get to see a part of the game while working, which is a perk of the job. The FTE's have demands for certain amount of office space available within the stadium.

Constraints

Min Office sq. m. 1900	1900
FTE	80
FTE Salaries	€50.000
PTE	3000
PTE Salaries	€6.000

Table 8 - Constraints Employees - Own Image (2015)

- Surrounding residents

Profile
The surrounding residents of the stadium area can profit from the stadium presence. However, there are also downsides to living close to a stadium. The upsides can vary from improved parking availability, increase in property value, short travel times to the stadium and more. The downsides can be nuisance in the form of sound, traffic and fan nuisance. This last category is a widely heard issue, with increased violence amongst 'fans' of certain football clubs. The Feyenoord supporters are amongst the most violence one sin the Netherlands. However, most issues occur in the city centre or during away games, so the surrounding residents have little nuisance. Their safety however must be guaranteed.

Goals
The goals of the surrounding residents are mainly safety issues and nuisance issues. While safeguarding the safety of the residents, they would like to profit from the increased infrastructure quality and avoid the downsides of living in close quarters of a football stadium when it comes to traffic, noise nuisance and violence.

Constraints

Parking p.p. max.	2,00
Max. Capacity	72000

Table 9 - Constraints Surrounding Residents - Own Image (2015)

- Shop owners within the stadium

Profile

The profile of the shop owners is fairly simple. They have the same goal as the stadium owner in earning as much revenues as possible. To to so, they require certain quality in their spots within the stadium, as well as the right amenities to be able to serve their costumers.

Goals

Shop owners of F&B and merchandising need a certain amount of square meters within the stadium to function. F&B locations might also demand a certain length of their counter to be able to serve more costumers as well.

Constraints

Min. F&B sq. m.	2800
Min. Promenade sq. m.	21500
Merchandising p.p. cat 1	€6,00
Merchandising p.p. cat 1	€8,00
Merchandising p.p. cat 1	€10,00
Merchandising p.p. cat 1	€12,00
F&B p.p. cat 1	€12,00
F&B p.p. cat 1	€10,00
F&B p.p. cat 1	€8,00
F&B p.p. cat 1	€6,00

Table 10 - Constraints Shop Owners - Own Image (2015)

Model Explanation

In this next chapter, the actual decision making model will be explained systematically. Since it is impossible to explain every single cell within the model itself, the main mechanics and inputs of the model will be presented in such a way that people with substantial knowledge on decision making models will be able to work with the model. Also, it will be a guideline for the people that are responsible for the data within the model, the stakeholders. Assuming none of the stakeholders are familiar with this technique, the explanation has to be a guideline when filling in the input sheet. Step by step, following the input sheet, model sheet and output sheet, explaining the system mechanics, the reader will work through the model.

VI.I Input Sheet

- General information

The general information input sheet is the sheet with the main input. The first and main constraint that is given to the stadium is the size of the stadium, based on a minimum (provided by the club) and a maximum (provided by the municipality and the local residents).
Based on the provided historical information of attendances, estimation is made on the average attendance as a percentage of the total capacity of the stadium. The model assumes that during all matches, the stadium is filled with this percentage of seats occupied.
Also, the different floors are introduced in this sheet, with all the floors and their total square meters per floor. These numbers are used by the model as a basis that can be filled with the different functions. Right now, the model assumes a total of five floors, which is two more than the current three, accounting for the new tier within the stadium.
The operating period of the model indicates the scope of the model calculations. Right now, this number is set to thirty years. Using twenty or ten years proved to be too short of a period. The thirty year mark is the mark where the cash flows start to level off into a steady cash flow.
Cost increase and revenue increase are included in the model as well to be able to determine the future cash flows. In combination with the added interest rate, these three elements form the basis of the future cash flows calculations.
The games per year account for the number of official games that will be played by the local football club in the stadium during one year. In the Netherlands, this totals to around 22 games (17 regular season games, 2 cup games, 3 continental games). Revenues of match days are calculated per day and multiplied with the number of games to provide the total revenues from match days throughout the year.
The maximum cost per year is an added function for the cash flow model. It is assumable that the stadium owner would like to limit the stadium losses during the first few years of operation. The amount that is put into this cell will serve as a restriction for the model to spread investment costs in such a way that there is no negative cash flow greater than this amount in the operation period.

- Stadium Financing

The stadium financing mechanics that are worked into the model as of now are based on the 'old' plans for the stadium renovation. These plans included financing from three possible stakeholders. These stakeholders are the municipality of Rotterdam, own equity of the stadium owner and the consortium, and two loans with a company and a bank to reassure the last part of the financing structure. These loans have interest payments that have to be made and these are also incorporated into the model. Extra business units and business seats are made available for these investors of the project and are also added in this section of the input sheet. The model calculates the costs of these facilities and adds them to the yearly costs. The total amounts of the three financing structures add up to the total of the initial investment in the renovation of the stadium. The model uses the interest payments each year for the entirety of the cash flow calculations, adapted for cost increase and revenue increases. Besides that, the annual 'performance fee' in the current structure is incorporated, which means that an annual payment is made to the club playing in the stadium for their services.

- Spectators

This is the section of the input sheet that determines the revenues that will be earned through spectator expenditures during game days. Four different categories of expenditures are determined: parking, ticketing, F&B and merchandising. However, not every spectator will spend an even amount of money during his visit to the stadium. To be able to adapt the configuration on these expenditure patterns, four categories of spectators are identified.

Model Explanation

The category 1 spectator is the category with the most revenues. This spectator is willing to pay a higher amount for his ticket and better seats in the stadium. A small percentage of the stadiums' capacity will be filled with seats for category 1 spectators. He will also be spending more money on F&B and merchandising.
The category 2 spectator is the spectator that still demands good seats within the stadium, but is not willing to pay the highest price for these seats. He will spend a little less on F&B as well, and some more on merchandising during his stay.
Category three 3 and 4 are the largest categories in terms of seats in the stadium. The seats represent the price range that is most desirable amongst the fans, with decent views of the pitch. Over half of the seats within the stadium is part of category 3 or 4. The fans will spend less on F&B, but more on merchandising, based on sales figures.
The parking costs are equal for all visitors and can be adjusted accordingly. The combination of the four types of revenues add up to a total amount of revenues for the match day. Only a percentage of these revenues are destined to be for the stadium owner. The main part of ticket sales will go the the sports club that attracts the fans and guest. The same goes for F&B and merchandising, where only the parking revenues can be added to the total revenues in totality.

- Corporate clients

Corporate clients can be seen as one of the main drivers of revenues in a stadium. Corporate clients demand the best seats in the stadium and a high standard of luxury. Therefore, the trend in stadium design is to incorporate more and more of these types of seats in new stadium projects. The renovation of the Kuip will offer three types of corporate seats: business seats, suites and sky boxes. The business seats are the same as regular seats in the stadium. The only difference is that they have the best view on the pitch and are executed with more luxurious materials such as leather. Often, the clients that make use of these seats are offered drinks and beverages in some sort of lounge and the clients can make use of the main entrance of the stadium. The entire treatment of this customer is of very high standard and prices can be changed accordingly in the model. Per floor, the minimum and maximum number of business seats can be entered into the model, together with a minimum and maximum price of the seats.
The sky boxes are well known in the world of football. Private boxes with luxurious seats and catering on demand. Only the high end clients will be using sky boxes and boxes are also available for other parties to rent for a certain time period. Sky boxes are the middle class within the corporate seats, offering more than the business seats, however offering a little less than the suites. Price ranges per person and amounts per floor can again be altered in this part of the input sheet.
The suites are larger rooms within the stadium, behind glass, with view on the pitch, but also the ability to go outside and enjoy the game within the stadium itself in luxurious seats. This private suite with private catering is the most luxurious package the stadium can offer and price ranges for the suites can be entered into the model as well. Since sky boxes and suites use up the same amount and same type of space, the maximum number of sky boxes and suites per floor can be added as well, leaving the model to decide the distribution between the two per floor.
Using the same mechanic as with the regular fans, only a percentage of all revenues will remain for the stadium owner and this percentage can be adjusted in this part of the input sheet as well.

- Events

The next category of the input sheet is the 'Events' category. Since events are becoming more and more important in the total revenues of stadiums in general, this is an important part of the model. The types of events that can be hosted in the stadium are divided into four categories: Concerts, Fairs and Exhibitions, Corporate events and Fairs & Exhibitions. Each event has its own capacity depending on the venue within the stadium and a minimum and maximum number of times during the year that that type of event can be hosted. Also, attendances of the events and revenues per visitor can be described in this section of the sheet. The model will, depending on the input variables, choose a number of events, the capacity and ticket prices and add it to the total revenues. A percentage is reserved for the stadium owner.

- Sporting Events

The multifunctionality of the stadium is stretched in this part of the model. Besides typical stadium events, the stadium is also able to change its configuration to host other sporting events. This can mean moveable stands for instance. A great example is the Gelredome in Arnhem with the techniques to replace the pitch when other sports are being played within the stadium. The Kuip is also able to change its configuration. As of now, the model is able to incorporate these events into the calculations by stating the transformation costs for the stadium, the revenues of the events and the number of times the events will and can be organised during the year. Again, a percentage of the revenues are reserved for the stadium owner.

- Museum

The museum is a special function that is situated in most stadiums that host clubs with a rich history in the world of football. Feyenoord is such a club and already has a museum in the existing stadium. The stadium owner will receive a percentage of the revenues depending on the revenues of the museum. The museum has a ticket price range and the estimated number of visitors to be filled in in the sheet.

- Lease of commercial area

The lease of the commercial areas outside of the stadium also brings in revenues. Therefore, the square meters outside of the stadium that have a commercial use can be entered here, along side with the revenues per square meter of the lease agreement. The model counts all these revenues towards the total revenues per year

- Sponsorships

Another important source of revenues is the sponsorship money. The model distinguishes three types of sponsorships for the stadium.
Regular sponsorships: These sponsorships could be for multiple purposes. One of these purposes could be the naming of a room within the stadium, an own conference room, or otherwise.
Naming rights: Naming rights of the stadium are more common these days. Although not many clubs are willing to change the name of the stadium in favour of a certain sponsor, this function is made available to incorporate into the model.
Advertising: The main revenues will be advertising within the stadiums. Think of billboards, advertsing on the screens within the stadium and many more possibilities.
Of all the sponsorship revenues, the largest part will go towards the stadium owner and this percentage is once more adaptable in the input sheet.

- FIFA/UEFA regulations

In order to make the stadium ‘FIFA-proof’ or ‘UEFA-proof’, both organizations state a number of demands to which the stadium has to comply in order to be a candidate for continental football on different levels. Since these are demands, none of them will be adaptable for the model, but the model will have to comply to the constraints that are given by the demands in this section of the input sheet.

- Operating Costs

The operating costs of the stadium are the counterpart of the revenues of the stadium. To supply every guest with the treatment they expect the stadium has to invest in certain functions. The model distinguishes a number of FTE’s and PTE’s. The PTE’s are mostly employees that will be working on match days. Salaries for both groups of people can be entered into the model as well. Other costs like maintenance, cleaning costs, marketing, utilities, management costs and costs of suppliers can also be entered in this part of the sheet. Since it forms the main type of costs in the model, this section is essential in the eventual outcome of the model when it is filled completely.

- Phasing

Because of the fact that not every year will be exactly the same and the renovation is to be carried out in the next few years, the model is able to apply phasing to the calculations. Cost increases and decreases, under influence of several factors, can be added here. One of the main examples is the revenue decrease because of the construction in the first few years. In this part of the input sheet these costs can be estimated and spread out over several years if wished. The model will then add or subtract these costs from the total revenues of that specific year, including discounting for cost increase, revenue increase and interest rates for that specific year. This allows for greater detail in the model and this tool has a big impact on the outcome of the model as well.

- Facilities and Function Distribution

This is the part of the input sheet that is responsible for the eventual lay-out of the stadium. In the Facilities section, one can enter the function that is desired per floor, the minimal amount of square meters of the function and the maximum square meters of this function. This process is deliberately done per floor to allow for greater detail in the outcome. Also, the costs of implementing the function per square meter can be altered in the function distribution section. This is also the section in which the model will automatically add all the square meters per function per floor to provide the total amount of square meters of a certain function in the entire stadium.

Model Explanation

STADIUM MODEL INPUT SHEET

General	
Min. capacity	68.000
Max. capacity	72.000
Average attendancy	70%
Square meters ground floor	28.000
Square meters 1st floor	9.500
Square meters 2nd floor	9.000
Square meters 3rd floor	6.250
Square meters 4th floor	12.000
Square meters 5th floor	11.000
Operating period (years)	30
Revenue increase	1,0%
Cost increase	3,0%
Maximum loss per year	€ 5.000.000
No. of soccer games/year	22
Interest Rate	3,0%

Stadium financing	
Initial investment	€ 200.000.000
Own equity (42%)	€ 82.000.000
Investment Municipality (0%)	€ -
Leverage (58%)	€ 118.000.000
Interest percentage	4%
Performance Fee Feyenoord E	€ 12.000.000
58 Business Units (10yr)	€ 1.885.000
2000 Business seats (10 yr)	€ 250.000

Spectators	
Ticketing min. Cat 1	€ 45,00
Ticketing max. Cat 1	€ 60,00
Min. % Cat 1	10,00%
Max. % Cat 1	15,00%
Ticketing min. Cat 2	€ 35,00
Ticketing max. Cat 2	€ 45,00
Min. % Cat 2	15,00%
Max. % Cat 2	25,00%
Ticketing min. Cat 3	€ 25,00
Ticketing max. Cat 3	€ 35,00
Min. % Cat 3	30,00%
Max. % Cat 3	45,00%
Ticketing min. Cat 4	€ 20,00
Ticketing max. Cat 4	€ 25,00
Min. % Cat 4	30,00%
Max. % Cat 4	45,00%
Food & Beverages p.p. cat 1	€ 12,00
Food & Beverages p.p. cat 2	€ 10,00
Food & Beverages p.p. cat 3	€ 8,00
Food & Beverages p.p. cat 4	€ 6,00
Merchandising p.p.cat 1	€ 6,00
Merchandising p.p.cat 2	€ 8,00
Merchandising p.p.cat 3	€ 10,00
Merchandising p.p.cat 4	€ 12,00
Percantage investor ticketing	10%
Percentage investor F&B	10%
Percentage investor Merch.	10%
Parking p.p. min.	€ 1,00
Parking p.p. max.	€ 2,00

Corporate Clients	
Business seats 2nd floor min	2.200
Business seats 2nd floor max	2.200
Business seats 5th floor min	3.600
Business seats 5th floor max	4.000
Ticketing min. business seats	€ 100,00
Ticketing max. business seats	€ 150,00
Sky boxes 2nd floor min	24
Sky boxes 2nd floor max	40
Sky boxes 3rd floor min	24
Sky boxes 3rd floor max	46
Sky box min. people	15
Sky box max. people	20
Ticketing min. sky box	€ 800,00
Ticketing max sky box	€ 1.000,00
Suites 2nd floor min	6
Suites 2nd floor max	40
Suites 3rd floor min	7
Suites 3rd floor max	46
Suite min. people	50
Suite max. people	80
Ticketing min. Suite	€ 400,00
Ticketing Max Suite	€ 600,00
Hospitality revenues per sq m	€ 5,00
Max Suites & Boxes 2nd floor	42
Max Suites & Boxes 3rd floor	46
Percentage investor business	10%
Percentage investor sky boxes	10%
Percentage investor suites	10%

Events	
Concerts min.	4
Concerts max.	6
Ticketing average	€ 60,00
Capacity	90000
Corporate events min.	10
Corporate events max.	20
Ticketing average	€ 100,00
Capacity	4000
Private events min.	40
Private events max.	50
Ticketing average	€ 40,00
Capacity	15000
Fairs & Exhibitions min.	2
Fairs & Exhibitions max.	4
Ticketing average	€ 20,00
Capacity	90000
Percentage investor concerts	10%
Percentage investor corp. evei	10%
Percentage investor priv. even	10%
Percentage investor fairs/exhit	10%

Figure 27 - Input Sheet Part 1 - Own Image (2015)

Sporting Events		
Sporting event 1	Rugby	
Transformation costs	€	200.000
Renvenues	€	500.000
Min. no. of events		2
Max. no. of events		4
Sporting event 2	Hockey	
Transformation costs	€	200.000
Renvenues	€	500.000
Min. no. of events		2
Max. no. of events		4
Sporting event 2	Cricket	
Transformation costs	€	200.000
Renvenues	€	500.000
Min. no. of events		2
Max. no. of events		4
Percentage investor Sp. Event		10%

Other Commercial	
Meseum min. visitors	30000
Meseum miax. visitors	50000
Ticketing	€ 10,00
Percentage investor museum	10%

Lease of Commercial Area	
Min. sq. m. outside stadium	1000
Lease revenues per sq m	€ 150,00
Percentage investor lease con	100%

Sponsors	
Naming rights min.	€ 800.000
Naming rights max.	€ 1.000.000
Sponsorship min.	€ 2.000.000
Sponsorship max.	€ 4.000.000
Advertising min.	€ 800.000
Advertising max.	€ 1.000.000
Percentage investor naming rig	80%
Percentage investor sponsors	80%
Percentage investor advertisin	80%

FIFA/UEFA Regulations	
TV-studio sq. m.	50
Min. no. TV-studios	2
Max. no. TV-studios	4
Min seat capacity	8000
Min. no. of toilets areas	35
Max. no. of toilets areas	50
Toilet area sq. m.	75
No. of private toilets	15
Private toilet sq. m.	15
Min. no. of F&B sales points	72

Figure 28 - Input Sheet Part 2 - Own Image (2015)

Phasing						
Investment name	Costs of renovation		Expansion			
Total costs	€ 50.000.000		€ 35.000.000		€ 5.000.000	
Percentage year 1	10%	€ 5.000.000		€ -		
Percentage year 2	10%	€ 5.000.000		€ -		
Percentage year 3	20%	€ 10.000.000		€ -		
Percentage year 4	20%	€ 10.000.000		€ -		
Percentage year 5	30%	€ 15.000.000		€ -		
Percentage year 6	10%	€ 5.000.000		€ -		
Percentage year 7		€ -		€ -		
Percentage year 8		€ -		€ -		
Percentage year 9		€ -		€ -		
Percentage year 10		€ -	30%	€ 10.500.000		
Percentage year 11		€ -	30%	€ 10.500.000		
Percentage year 12		€ -	40%	€ 14.000.000		
Percentage year 13		€ -		€ -		
Percentage year 14		€ -		€ -		
Percentage year 15		€ -		€ -		
Percentage year 16		€ -		€ -		
Percentage year 17		€ -		€ -		
Percentage year 18		€ -		€ -		
Percentage year 19		€ -		€ -		
Percentage year 20		€ -		€ -		
Percentage year 21		€ -		€ -		
Percentage year 22		€ -		€ -		
Percentage year 23		€ -		€ -		
Percentage year 24		€ -		€ -		
Percentage year 25		€ -		€ -		
Percentage year 26		€ -		€ -		
Percentage year 27		€ -		€ -		
Percentage year 28		€ -		€ -		
Percentage year 29		€ -		€ -		
Percentage year 30		€ -		€ -		
Total	100%		100%		0%	

Figure 29 - Input Sheet Part 3 - Own Image (2015)

Facilities			
Ground floor North/Sout	**Plan**	**Min**	**Max**
Promenade	10.000	9.000	11.000
Toilets	1.000	800	1.200
F&B	1.500	1.200	1.800
Supportershome	1.500	1.200	1.500
Coen Moulijn' room	1.500	1.200	1.500
Museum	400	300	600
Olympiagebouw			
VIP entrance hall	1.300	1.000	1.300
Player area	1.200	1.000	1.500
Media area	1.400	1.000	1.500
Technical area	600	400	800
Other	1.300	1.000	1.600
Maasgebouw			
Business entrance hall	700	500	700
Commercial	2.600	2.000	2.600
Merchandise shop	400	300	600
Technical area	300	200	500
Kitchen	300	200	500
Other	2.000	1.600	2.400
Total	28.000	22.900	31.600
Used in Model	**28.000**		

Figure 30 - Input Sheet Part 4 - Own Image (2015)

Function Distribution						
	Promenade		**F&B**		**1600000**	**1600000**
	Min	Max	Min	Max	Min	Max
Ground floor	9.000	11.000	1.200	1.800	2.400	3.000
1st floor						
2nd floor	1.500	3.000				
3rd floor						
4th floor	3.500	5.500	800	1.600		
5th floor	7.500	10.200	800	1.600		
Total	**21.500**	**29.700**	**2.800**	**5.000**	**2.400**	**3.000**
€/sq.m	50		200		200	
	Commercial		**Merchandise shop**		**Kitchen**	
	Min	Max	Min	Max	Min	Max
Ground floor	2.000	2.600	300	600	200	500
1st floor	2.600	3.000				
2nd floor					300	600
3rd floor					300	600
4th floor						
5th floor						
Total	**4.600**	**5.600**	**300**	**600**	**800**	**1.700**
€/sq.m	300		300		280	

Figure 31 - Input Sheet Part 5 - Own Image (2015)

Operating Costs	
FTE	110
FTE salaries	€ 50.000
PTE	600
PTE salaries	€ 3.000
Maintenance/repairs min.	€ 3.000.000
Maintenance/repairs max.	€ 4.000.000
Cleaning min.	€ 3.500.000
Cleaning max.	€ 4.000.000
Marketing events min.	€ 3.500.000
Marketing events max.	€ 4.500.000
Utilities min.	€ 3.000.000
Utilities max.	€ 4.000.000
Management min.	€ 4.000.000
Management max.	€ 5.000.000
Suppliers min.	€ 4.500.000
Suppliers max.	€ 6.000.000

Figure 32 - Input Sheet Part 6 - Own Image (2015)

VI.II Model Sheet

Model mechanics

The What'sBest! model operates according to a predefined formula, the ABC, which stands for Adjustable, Best and Constraints. The model creation follows these steps:

Identify Adjustable Cells: The adjustable cells are the cells in the worksheet that What'sBest! can adjust in its quest for a solution. In mathematical programming terms, these are called variables. These can be defined using either the special What'sBest! menu.
Define Best: The best cell is the goal, or objective, of your solution. Typically, this is to maximize or minimize an adjustable cell or some function of the adjustable cells. What'sBest! allows only one best cell in the model. No best cell is needed when equation solving or goal seeking. The special toolbar is able to appoint a cell to be the best cell.
Specify Constraints: The constraint cells identify any limitations in a model. For example, "The maximum capacity of the stadium". The constraint cells enforce these restrictions.
Once you've specified the ABC's, you can solve your worksheet model and find the best answer to your problem.

This part of the sheet is not to be used by the person filling in the input sheet. He/she is only supposed to provide the constraints for the model to comply to. However, knowing what goes on within the model itself is useful to understand how the model works and how to be able to adjust certain outcomes or to force the model into solving in a particular direction.

Stadium Model

The stadium model that is created for this thesis follows the basic ABC rules provide by What'sBest!. The best cell is the cell that maximizes the ROI from an investor/stadium owner point of view. It complies with all the stated constraints if the input sheet while doing so. The function for the best cell is in essence the addition of the cashflows of multiple years. As of now, this is set to a maximum of 30 but this can be altered. The model tries to express the different areas of revenues into a specific revenue per year. Following this, the amount is discounted for 30 years into the future where it will be added up to form the total revenues over these 30 years. The output sheet is added to analyse the results and visual them in order to give the stakeholders a clear idea of the solution the program has come up with.

	Endogenous variables	Total ex year 30	Yearly Income	Income Saldo	Yearly Expenditure	Exp. Saldo						
	X-Value	€ 7.873.064	€ 44.174.970	€ 992.061.893	€ 47.655.000	€ 701.102.133						
	Objectives								MAX			
	Maximize Return on Investment	-1							€ 290.959.761			
	Constraints								Required		Available	Dual Value
General	Stadium min. seats								72000	>=	68.000	0,0
	Stadium max. seats								72000	=<=	72.000	2602,5
	Capacity Utilization degree								0	=	0	-3717,8
	Square meters ground floor								28000	=<=	28000	2245,8
	Square meters 1st floor								9500	=<=	9500	2245,8
	Square meters 2nd floor								9000	=<=	9000	1122,9
	Square meters 3rd floor								6250	=<=	6250	6175,8
	Square meters 4th floor								12000	=<=	12000	3368,6
	Square meters 5th floor								11000	=<=	11000	1122,9
	Income per year		1						0	=	0	22,5
	Income over exploitation period			1					0	=	0	0,0
	Expenditure per year				1				0	=	0	-13,5
	Expenditure over exploitation period	-1				1			0	=	0	0,0
	Income year 1		-0,981						0	=	0	1,0
	Expenditure year 1				-0,942				0	=	0	-1,0
	Income year 2		-0,962						0	=	0	1,0
	Expenditure year 2				-0,887				0	=	0	-1,0
	Income year 3		-0,943						0	=	0	1,0
	Expenditure year 3				-0,835				0	=	0	-1,0
	Income year 4		-0,925						0	=	0	1,0
	Expenditure year 4				-0,787				0	=	0	-1,0
	Income year 5		-0,907						0	=	0	1,0
	Expenditure year 5				-0,741				0	=	0	-1,0
	Income year 6		-0,889						0	=	0	1,0
	Expenditure year 6				-0,698				3,72529E-09	=	0	-1,0
	Income year 7		-0,872						0	=	0	1,0

Figure 33 - Model Sheet Part 1 - Own Image (2015)

	Endogenous variables	General		Stadium Financing				Spectators								
		Capacity	Used seats avg	Loan	Performance fee	Suites Fee	Bus. Seats Fee	Cat. 1 seats	Cat. 2 seats	Cat. 3 seats	Cat.4 seats	Cat 1	Cat 2	Cat 3	Cat 4	F&B Cat. 1
	X-Value	72000	50400	4.720.000	12.000.000	1.885.000	250.000	7560	12600	15120	15120	453.600	567.000	529.200	378.000	90.720
Spectators	Ticketing min. Cat 1							-45,00				1				
	Ticketing max. Cat 1							-60,00				1				
	Min. % Cat 1		-10%					1								
	Max. % Cat 1		-15%					1								
	Ticketing min. Cat 2								-35,00				1			
	Ticketing max. Cat 2								-45,00				1			
	Min. % Cat 2		-15%						1							
	Max. % Cat 2		-25%						1							
	Ticketing min. Cat 3									-25,00				1		
	Ticketing max. Cat 3									-35,00				1		
	Min. % Cat 3		-30%							1						
	Max. % Cat 3		-45%							1						
	Ticketing min. Cat 4										-20,00				1	
	Ticketing max. Cat 4										-25,00				1	
	Min. % Cat 4		-30,00%								1					
	Max. % Cat 4		-45,00%								1					
	Food & Beverages p.p. cat 1							-12,00								1
	Food & Beverages p.p. cat 2								-10,00							
	Food & Beverages p.p. cat 3									-8,00						
	Food & Beverages p.p. cat 4										-6,00					
	Merchandising p.p.cat 1							-12,00								
	Merchandising p.p.cat 2								-10,00							
	Merchandising p.p.cat 3									-8,00						
	Merchandising p.p.cat 4										-6,00					
	Percantage investor ticketing											10%	10%	10%	10%	
	Percantage investor F&B															10%
	Percentage investor merch.															
	Parking p.p. min.		-1,00													
	Parking p.p. max.		-2,00													
	Total seats		1					-1	-1	-1	-1					

Figure 34 - Model Sheet Part 2 - Own Image (2015)

	Endogenous variables		Revenues				Corporate								
		Merch. Cat 4	Inv. Tickets	Inv. F&B	Inv. Merch	Parking	Business 2nd fl	Business 5th fl	Sky Boxes 2nd fl	Sky Boxes 3rd fl	Suites 2nd fl	Suites 3rd fl	Business rev.	Sky Boxes rev.	Suites rev.
	X-Value	90.720	192.780	42.840	42.840	100.800	2200	4000	24	24	18	22	930.000	960.000	1.920.000
Corporate Clien	Ticketing min. business seats						-100,00	-100,00					1		
	Ticketing max. business seats						-150,00	-150,00					1		
	Business seats 2nd floor min						1								
	Business seats 2nd floor max						1								
	Business seats 5th floor min							1							
	Business seats 5th floor max							1							
	Sky boxes 2nd floor min								1						
	Sky boxes 2nd floor max								1						
	Sky boxes 3rd floor min									1					
	Sky boxes 3rd floor max									1					
	Sky box min. people								-15	-15				0,0013	
	Sky box max. people								-20	-20				0,0010	
	Suites 2nd floor min										1				
	Suites 2nd floor max										1				
	Suites 3rd floor min											1			
	Suites 3rd floor max											1			
	Suite min. people										-50	-50			0,0025
	Suite max. people										-80	-80			0,0017
	Max Suites & Boxes 2nd fl								1		1				
	Max Suites & Boxes 3rd fl									1		1			
	Persentage investor business												-10%		
	Persentage investor sky boxes													-10%	
	Persentage investor suites														-10%

Figure 35 - Model Sheet Part 3 - Own Image (2015)

Endogenous variables	29	Total ex year 29	30	30	Total ex year 30	Yearly Income	Income Saldo	Yearly Expenditur	Exp. Saldo
X-Value	8.360.057	8.360.057	24.530.180	7.873.064	7.873.064	44.174.970	992.061.893	47.655.000	701.102.133
Income year 1						-0,981			
Expenditure year 1								-0,942	
Income year 2						-0,962			
Expenditure year 2								-0,887	
Income year 3						-0,943			
Expenditure year 3								-0,835	
Income year 4						-0,925			
Expenditure year 4								-0,787	
Income year 5						-0,907			
Expenditure year 5								-0,741	
Income year 6						-0,889			
Expenditure year 6								-0,698	
Income year 7						-0,872			
Expenditure year 7								-0,657	
Income year 8						-0,855			
Expenditure year 8								-0,619	
Income year 9						-0,838			
Expenditure year 9								-0,583	
Income year 10						-0,822			
Expenditure year 10								-0,549	

Figure 36 - Model Sheet Part 4 - Own Image (2015)

VI.III Output Sheet

The output sheet is the information sheet that displays the results of the model runs. The sheet consists out of three types of information. The first information is the financial component of the model. The revenues over the different years are displayed in both a numerical as a graphical way. The model calculates the IRR (Internal Rate of Return), an important component of each investment proposal from the investors' point of view. The defenition of the IRR is:

The interest rate at which the Net Present Value (NPV) of all the cash flows (both positive and negative) from a project or investment equal zero.

So, every positive IRR equals an investment with a positive NPV. A positive NPV is always an indicator of a profitable investment and the rule of thumb is to invest in projects with a positive NPV. However, risks on the investment are involved as well and most investors therefore predefine a MARR (Minimum Attractive Rate of Return) or MIRR (Minimal Internal Rate of Return). If the IRR of a new project exceeds a company's MIRR, that project is desirable. If IRR falls below the MIRR, the project should be rejected.

In this case, defining the MIRR for a stadium project is difficult. The MIRR is dependant on many factors such as the type of investor, the global economic situation, the location, the market and many more. In this day and age in The Netherlands and the thriving Sports economy, stadium projects can be seen attractive if the IRR is somewhat lower than the MIRR of housing because of the many benefits of invesment in sports Real Estate. Housing projects can be seen as attractive with an IRR of over 6% (Sinha & Poole, 1987), and therefore this research sets the bar for the MIRR of stadium projects at 4%. This remains an important and arbitrary estemation and this will be also reflected on at the end of this report.

The next part of the output sheet shows the actual impact of the design. For each specific floor, the function that are located on that floor are displayed, accompanied by the square meters of that function. These all add up to the total floor space of that floor so that every square meter of the stadium is allocated a function. These functions are also visualized in the form of pie charts to visually see the distribution of the different functions over the different floors.

The output sheet is there to give the actors that have to work with the model and analyse its outcomes a feeling for the impact of their actions. Other representations of the results can easily be added to the sheet if there is a demand from certain actors.

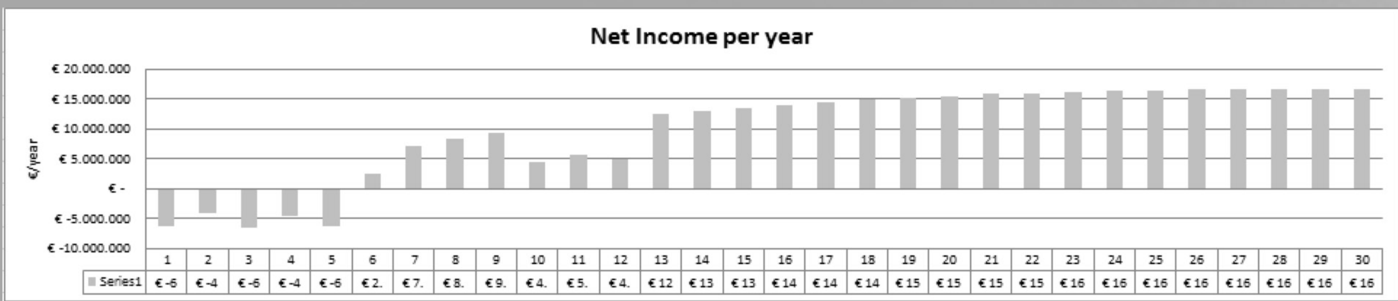


Figure 37 - Output Sheet Part 1 - Own Image (2015)

	IRR		Total Revenues	
Initial investment	€	-200.000.000		
Net income year 1	€	-6.270.515	€	-6.270.515
Net income year 2	€	-4.223.021	€	-4.223.021
Net income year 3	€	-6.503.588	€	-6.503.588
Net income year 4	€	-4.507.211	€	-4.507.211
Net income year 5	€	-6.362.294	€	-6.362.294
Net income year 6	€	2.539.654	€	2.539.654
Net income year 7	€	7.201.653	€	7.201.653
Net income year 8	€	8.277.645	€	8.277.645
Net income year 9	€	9.261.919	€	9.261.919
Net income year 10	€	4.398.897	€	4.398.897
Net income year 11	€	5.552.720	€	5.552.720
Net income year 12	€	4.908.685	€	4.908.685
Net income year 13	€	12.394.765	€	12.394.765
Net income year 14	€	13.002.254	€	13.002.254
Net income year 15	€	13.548.540	€	13.548.540
Net income year 16	€	14.037.688	€	14.037.688
Net income year 17	€	14.473.520	€	14.473.520
Net income year 18	€	14.859.622	€	14.859.622
Net income year 19	€	15.199.364	€	15.199.364
Net income year 20	€	15.495.911	€	15.495.911
Net income year 21	€	15.752.233	€	15.752.233
Net income year 22	€	15.971.118	€	15.971.118
Net income year 23	€	16.155.186	€	16.155.186
Net income year 24	€	16.306.891	€	16.306.891
Net income year 25	€	16.428.540	€	16.428.540
Net income year 26	€	16.522.296	€	16.522.296
Net income year 27	€	16.590.187	€	16.590.187
Net income year 28	€	16.634.117	€	16.634.117
Net income year 29	€	16.655.869	€	16.655.869
Net income year 30	€	16.657.116	€	16.657.116
Result		**1,7%**	**€**	**290.959.761**

Ground Floor	
Promenade	9000
F&B	1800
Suppurtorshome	3000
VIP entrance	1300
Player Area	1500
Media Area	1500
Technical Area	600
Other	3100
Business Entrance	700
Museum	600
Commercial	2600
Merchandising	600
Kitchen	500
Toilets	1200
Total	**28000**
1st Floor	
Technical Area	500
Other	1300
Commercial	3000
VIP Restaurant	2600
Terrace	400
Offices	1700
Total	**9500**
2nd Floor	
Promenade	1800
Kitchen	600
VIP Restaurant	4200
Toilets	600
Business Club	1800
Total	**9000**
3rd Floor	
Kitchen	600
Offices	900
Toilets	300
Business Club	4450
Total	**6250**

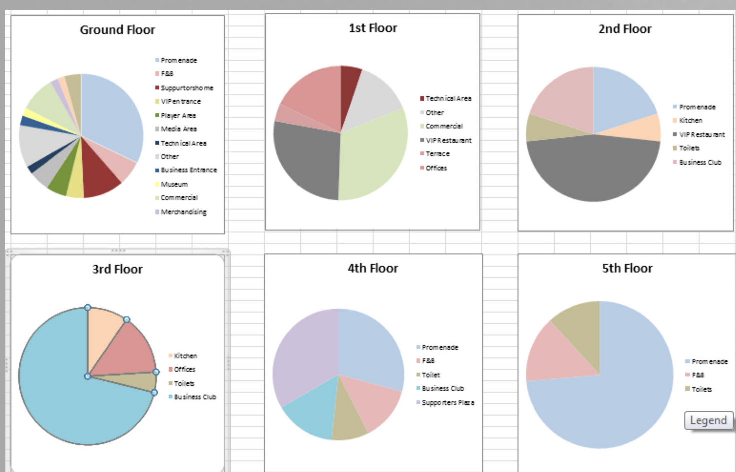


Figure 38 - Output Sheet Part 2 - Own Image (2015)
Figure 39 - Output Sheet Part 3 - Own Image (2015)
Figure 40 - Output Sheet Part 4 - Own Image (2015)

Results

VII.I Research influences

Since the start of the execution of this master thesis research, some situational changes have occurred. The first major influence on the research has been the end of the collaboration between BAM and the FFC. After a long period of negotiating and several designs for the stadium, the differences between demand and supply of both parties proved to be too big. The official statement of the FFC stated that the difference between the desired construction costs and the final construction costs was €15 million. Besides this relatively small gap in both offers, the BAM design also proved to be non-beneficial in the short term. One of the main goals of the FFC was to improve the transfer budget of the club to remain competitive in the next few years. The BAM design did not comply with this desire as well as couple of other demands.

The influence of this development on this research was minimal. In fact, the research became somewhat more interesting. This research could prove to be a critical factor in the design process and the negotiation process. The decision was made to continue the research as planned with a focus on the BAM case in order to provide an insight in the situation and the causes that led to the ending of the collaboration between BAM and the FFC.

The model would have to be adapted to this situation and to do so Feijenoord Stadion B.V. was approached. Feijenoord Stadion B.V. is the owner of the stadium and a critical stakeholder in the development process. A special team, assigned to the development plans for the renovated stadium could provide this research with all the documents needed for the completion of the model. However, because of the fact that this information became more sensitive and therefore more classified after the failed collaboration with BAM, Feijenoord Stadium B.V. could not provide this research with the required information.

VII.II Adapted Research Strategy

To be able to complete this research in the way it was intended in the first place, a new strategy has been put into place. This new strategy adds two more cases to the existing case of the Feyenoord Stadium, being the Amsterdam ArenA in Amsterdam and the GelreDome in Arnhem. Both stadiums are also situated in The Netherlands and are the home grounds of AFC Ajax and Vitesse Arnhem.

The model will then be altered two fit these new cases. This will result into three models with three model outcomes. This step will add a new insight in the research that wasn't available in the previous situation. The inductive nature of the model will be tested and the transformation time of the model between different cases will provide insights in the different areas in which the model can be used in the future.
After the completion of the alteration process, the two extra cases will serve as an example for the original case. Easily accessible information on these cases will give a better image of the magnitude of some of the costs for the Feyenoord case. On the other hand, the two extra cases will serve as a reference and outcomes can be compared.
After completing the models a new analysing phase starts in which the models and their different qualities are compared in order to be able to make a statement on the end product of this research.

This alternate research strategy backs down from the initial one and will not be a perfect representation of reality because of the absence of accurate real-time information on the main case. However, the alternate strategy has a few perks over the initial one in that it displays the inductive nature of the model, helps in achieving an image of the case that is as accurate as possible with the provided information, and provides in reference cases for the analysis phase of the project. This chapter will therefore follow this new research strategy as presented.


Figure 41 - Amsterdam ArenA - Wikipedia (2015)


Figure 42 - GelreDome - Google Earth (2015)

VII.III History of the Amsterdam ArenA

The Amsterdam Arena is the largest stadium in the Netherlands and the home ground of football club AFC Ajax, the most successful football club in the countries' history. Construction plans for the stadium were initially prepared in the late eighties, preparing for the summer Olympics of 1992 that Amsterdam had been in the running for. An Olympic stadium, with football pitch and athletics track had been designed in 1986 to be built in Strandvliet, an area in the south-east of Amsterdam. Unfortunately, Amsterdam lost de Olympic bid against Barcelona and the plans were put on hold for a couple of years to come. In 1987, the 'Stichting Amsterdam Sportstad' was founded to boost the culture of sports in the capital. This foundation made plans for a new stadium with a capacity of around 55.000 seats. Based on the Olympic plan and the plan of the foundation, a new design was made in 1990 for a stadium with a football pitch, athletics track, and a fixed roof. Especially this roof was a newly added feature that had never been seen in Dutch football stadium design up until that moment. At this point in time, AFC Ajax needed a new stadium. The 80's and 90's were the most successful decades for the club with national and European trophies. Their stadium De Meer proved to be to small and the club had been playing their main matches in the old Olympic stadium that had been built for the 1928 Olympic games in Amsterdam. Because of this new situation, the design was altered: the athletics track was removed, the capacity was brought down to 50.000 and a retractable one replaced the fixed roof. The stadium is now one of only two stadiums in the Netherlands with a retractable roof. The building permit was issued in 1993 and construction initiated in November of that year. Ballast Nedam and BAM were appointed the construction contract and took almost three years to complete the project, and did so within budget. The stadium was officially opened an the 14th of August 1996 by Queen Beatrix.

The total sum of the construction costs was €140 million, including the retractable roof. The stadium has a final maximum capacity of 53.346 seats. During concerts, the stadium can accommodate between 68.000 and 90.000 guests depending on the placement of the main stage. During the last two decades the stadium has hosted many other events, ranging from concerts to sporting events. The main sporting events that have taken place in the stadium include major kickboxing events and American football matches (the stadium functioned as the home ground of the Amsterdam Admirals up until 2007).

The only renovation to date has been carries out in 2011. In the off-season of AFC Ajax, the stadium replaced all the seats within the stadium because of a new so called 'Green Deal' contract with Brazilian company Braskem.

Architect Rob Schuurman had foreseen some issues with the stadium. Because of the retractable roof, the grass within the stadium wouldn't grow and the pitch had to be replaced up to four times a year. Since the level of the pitch is 8 meters above surface level and placed into a big concrete structure, the plan was the roll the pitch out of the stadium after each game. A part of the parking lot would be sacrificed to be able to perform this new technology. Unfortunately, this option proved to be infeasible. The natural growth of the grass is still an issue for the stadium, however artificial solutions have been found to resolve the problem and lamps are placed over the pitch after each game to ensure a perfect pitch. The pitch is now only replaced once every year.
Another flaw of the stadium, an opinion that is shared by most concert visitors, is the bad acoustics of the stadium. Although the stadium has been known for its bad acoustics, major stars have performed in the Amsterdam Arena in the past decades. A grasp of the artists that have performed in the Arena include Tina Turner (opening of the stadium), Michael Jackson, The Rolling Stones, The Backstreet Boys, Bon Jovi, Robbie Williams, David Bowie, Genesis, U2, Madonna and Muse.

Figure 43 - Amsterdam ArenA - Plazilla (2013)

VII.IV Model Alterations

The alteration process for the case of the Amsterdam ArenA to the initial model has been of minimal length. The advantage of the model is that it is built for a five level, high capacity stadium in the first place. Adaptions for smaller stadiums are therefore easily made by adding zero costs to the functions and costs of the extra levels. Expanding the model for larger stadiums than the initial case in Rotterdam would mean a longer adaption time, since extra calculations will have to be added to the existing model.

The input of the model can be divided into two different types of data. The financial data and the data on the stadium lay-out. Where the more general information on the stadium finances can be looked up easily, the exact distribution of functions within the stadium was harder to obtain.

The main difference to the original case in a more general perspective is initially the ownership situation of the stadium. As of now, Ajax is a 13% stakeholder in the stadium, where the municipality of Amsterdam possesses all the other stakes in the stadium. The club is now in a healthy financial situation, with four championships in the last four years, high UEFA Champions League revenues and the high transfer sums for some of the clubs' players that have moved on to more reputable clubs. The club is now even considering buying the stadium through obtaining another 38% of the stakes in ownership and becoming a majority stakeholder of the stadium. The model however runs with the current situation as perspective. Therefore the ownership situation is depicted in the model as a high performance fee for Ajax and the alteration of the income percentages of the stadiums' revenues.

Besides the ownership situation, the general data has been adapted for the stadium, meaning that it is one size smaller than the renovated stadium in Rotterdam, with a maximum capacity of a little over 53.000 seats. The initial investment costs for the stadium that was built in 1996 have also been adjusted to present time and are estimated at €140 million. Revenue decrease because of construction work and a renovation for a sum of roughly a quarter of the stadiums value after ten years is incorporated as well.

Income of suites and skyboxes have also been adjusted to the available information and sponsorship incomes have been changed as well. This is one of the major incomes for the club and stadium, since Ajax has the largest fan base in the Country and can also profit from a big reputation in Europe and the rest of the world because of successes in the 90's and football legends that have played for the club. Here we see a difference with the Feyenoord case in that sponsorship revenues for Ajax are a quite a bit larger. Also, revenues from the museum tend to be more because of this popular reputation and the situation of the club in the capital of the country makes it a tourist attraction.

Other events that can be held in the stadium have also been adjusted. The large stadium can host up to 90.000 people during major concerts and is known to host a number of those concerts each year. It has a new competitor in that segment now that the Ziggo Dome is completed right next to the stadium. Although it has a much lower capacity, it is already world renowned for its' high quality acoustics. Other sporting events can be hosted in the stadium, but transformation costs are much higher than for the GelreDome with their moveable pitch. The model also incorporates this data.

The number of FTE's and the general costs of maintenance of the stadium are adjusted to the available data and the size of the stadium, as is the function distribution within the stadium.

VII.V Results Amsterdam ArenA

If we look at the results of the model run for the Amsterdam ArenA, we can distinguish a few things. On a function allocation level we cannot see many strange results. The model stays within the boundaries that were set in the input and favours the more profitable functions over the less profitable ones as expected. The model does this to create the highest ROI as possible.

On a financial level the model the model looks to be representing reality well. The ROI graph starts with a negative for the first few years. This negative is the result of a decrease in revenues that is an input of the model. It represents the decrease of the stadiums revenues because of stands that are closed and other functions of the stadium that cannot create revenue yet in the development phase of the project. However, the losses do not surpass the -€3 million per year barrier.

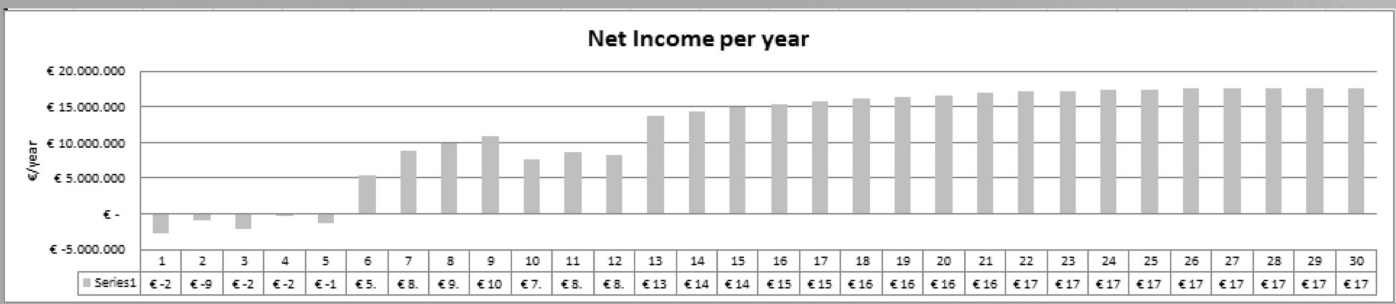
The graph then keeps on rising and reaches a high at a little over €17 million ROI per year. This is the highest ROI of the three stadiums, despite the Feyenoord stadium having a capacity that is almost 20.000 seats greater.

The total IRR of the project is calculated at 4,9% as of now. This depicts that the stadium is a pretty good investment and investors should be willing to get involved with the stadium. As stated before, Ajax is currently deliberating buying a majority stake in the stadium to gain power over all decisions involved with the stadium. This is also a signal that they also see the stadium as a safe investment that is profitable for all involved stakeholders. The model can therefore be seen as a good representation of the real situation.

	IRR		Total Revenues	
Initial investment	€	-140.000.000		
Net income year 1	€	-2.814.276	€	-2.814.276
Net income year 2	€	-915.085	€	-915.085
Net income year 3	€	-2.083.508	€	-2.083.508
Net income year 4	€	-293.620	€	-293.620
Net income year 5	€	-1.233.026	€	-1.233.026
Net income year 6	€	5.326.359	€	5.326.359
Net income year 7	€	8.888.658	€	8.888.658
Net income year 8	€	9.913.523	€	9.913.523
Net income year 9	€	10.848.733	€	10.848.733
Net income year 10	€	7.584.745	€	7.584.745
Net income year 11	€	8.597.437	€	8.597.437
Net income year 12	€	8.306.276	€	8.306.276
Net income year 13	€	13.803.986	€	13.803.986
Net income year 14	€	14.371.297	€	14.371.297
Net income year 15	€	14.878.931	€	14.878.931
Net income year 16	€	15.330.881	€	15.330.881
Net income year 17	€	15.730.899	€	15.730.899
Net income year 18	€	16.082.507	€	16.082.507
Net income year 19	€	16.389.012	€	16.389.012
Net income year 20	€	16.653.519	€	16.653.519
Net income year 21	€	16.878.944	€	16.878.944
Net income year 22	€	17.068.024	€	17.068.024
Net income year 23	€	17.223.325	€	17.223.325
Net income year 24	€	17.347.259	€	17.347.259
Net income year 25	€	17.442.085	€	17.442.085
Net income year 26	€	17.509.924	€	17.509.924
Net income year 27	€	17.552.765	€	17.552.765
Net income year 28	€	17.572.473	€	17.572.473
Net income year 29	€	17.570.796	€	17.570.796
Net income year 30	€	17.549.372	€	17.549.372
Result		**4,9%**	**€**	**349.082.214**

Figure 44 - IRR Amsterdam ArenA - Own Image (2015)

Figure 44 - Cash Flow Amsterdam ArenA - Own Image (2015)



VII.VI History of the GelreDome

The GelreDome is a Football Stadium in Arnhem, The Netherlands. It is the home of Football club Vitesse Arnhem and also serves as an event stadium. Plans for the stadium initiated in the eighties, when Vitesse was still playing their games in a stadium called 'Nieuw-Monnikenhuize'. Planning of the stadium took several years and the construction works initiated in July of 1996. This was also the date that the new name of the stadium was presented, a composition of Gelderland (the Provence of the country Arnhem is situated in) and the word Dome (Stadium). The stadium is also often called the Karel Aalbers Stadium, a tribute to the initiator of the stadium and the chairman of Vitesse during the first years of the stadiums existence. The stadium was opened in 1998, costing €95 million with a capacity of 29.600 seats. During concerts, the stadium can accommodate up to 41.000 spectators depending on the placement of the main stage. A financial crisis for the club, as well as the stadium, caused the stadium not to be finished entirely. The east stand still misses a façade on the bottom side and the corners of the stadium were finished with concrete elements that haven't been placed yet. A loan of over €18 million saved the stadium from bankruptcy. Still, the football club had major debts and a bankruptcy of the club would mean the stadium losing their main tenant. The club was saved, but the maintenance costs of the stadium still proved to be too high for the municipality of Arnhem and the stadium was put up for sale. In 2006 Eurocommerce bought the stadium and the surrounding area for €16,5 million.

Three of the four stands are constructed out of concrete, with the last one being constructed out of steel. This fourth stand, oriented on the south side of the stadium and one of the 'short' sides as well, has been made of steel so it is able to 'float' above the ground. A concrete structure would have been to heavy for this purpose with the risk of collapsing. Consequence of this design decision is that the stand is prone to movement of the spectators and is known to sway or bounce during games. The reason this stand is floating is an ingenious quality of the stadium, where it 'rolls' the pitch out of the stadium. This has two benefits. The grass within the stadium is rolled out to the south in a concrete bowl weighing over 11.000 tons and can grow there with a perfect orientation on the sun. No artificial lamps are needed for growing the grass. Second advantage is that the stadium is easily transformable for other events. Where most stadiums have to cover up the grass to protect it from damages, the GelreDome is able to roll the pitch out of the stadium and create the accommodation for other events within 6 hours.

The second floor consists out of a 600 meter long promenade around the stadium, capable of hosting different activities like fairs, exhibitions, presentations, markets, diners, parties and more. The areas in the corners of the stadium form four large areas for other events. These rooms can host up to 350 people each. On top of that, the stadium has 49 suites for up to 12 people with a perfect view on the pitch.

The stadium was one of the most modern stadiums in the world when it opened its doors for the first time. Main contributors were the movable pitch, the retractable roof and the ability to heat the entire stadium.
Heating a stadium is common in the United States, but unusual in Europe. An ingenious system that makes use of a geothermal heat pump. Cold water cools the stadium in the summer and warm water heats it during the winter. This enables the stadium to host events throughout the entire year. A renovation to the east stand in 2005 is the only renovation to date.

The GelreDome does not have its main focus on football as opposed to the other two stadiums. Their main focus is on concerts and other events, but also meetings and congresses. It has been the stadium that hosted the most and the biggest events for the last decade in The Netherlands with almost double the amount of visitors for events than for Vitesse matchdays. The financial distribution of revenues between events and football is 80%-20%.

Main events that were held in the stadium are: Monsterjam (monster trucks), EO-Jongerendag, Circus Herman Renz, Qlimax (hardstyle event) and many more.
Major artist that have performed in the stadium include: Spice Girls, The Backstreet Boys, Symphonica in Rosso (week long series of concerts), Lionel Richie, Diana Ross, André Rieu, Sting, Rihanna, Madonna, Justin Bieber, Lady Gaga, Tiësto and more.

Figure 45 - GelreDome - bigsoccer (2012)

VII.VI Model Alterations

The alteration process for the case of the GelreDome to the initial model has been of minimal length. The advantage of the model is that it is built for a five level, high capacity stadium in the first place. Adaptions for smaller stadiums are therefore easily made by adding zero costs to the functions and costs of the extra levels. Expanding the model for larger stadiums than the initial case in Rotterdam would mean a longer adaption time, since extra calculations will have to be added to the existing model.

The input of the model can be divided into two different types of data. The financial data and the data on the stadium lay-out. Where the more general information on the stadium finances can be looked up easily, the exact distribution of functions within the stadium was harder to obtain.

The ownership situation of the GelreDome is different form the two other cases. In the early years after the completion of the stadium, financial struggles of the municipality of Arnhem and Vitesse made that payments of the stadium couldn't be made anymore. After long debate the stadium was put up for sale and was eventually sold to Eurocommerce, a company that lowered rental fees for the club in order to save Vitesse from bankruptcy. As of now, the stadium is ownership of private investor Eurocommerce, which fits the problem statement of this research. The model is created for this situation and adaptions hardly had to be made on a constructive level.

Besides the ownership situation, the general data has been adapted for the stadium, meaning that it is quite a few sizes smaller than the renovated stadium in Rotterdam, with a maximum capacity of 25.000 seats on matchdays. The initial investment costs for the stadium that was built in 1998 have also been adjusted to present time and are estimated at €95 million. Revenue decrease because of construction work and a renovation for a sum of roughly a quarter of the stadiums value after ten years is incorporated as well.

Income of suites and skyboxes have also been adjusted to the available information and sponsorship incomes have been changed as well. Where the other cases benefit from their high reputation within the Netherlands and Europe, Vitesse only has a national reputation and has to work with a much lower sponsorship budget. The stadium can compensate for this with sponsorship revenues from other events.

Other events that can be held in the stadium have also been adjusted. The large stadium can host up to 41.000 people during major concerts and is known to host many of those concerts each year. As stated previously, the distribution of football revenues compared to event revenues is 20%-80% for the GelreDome. The component of events in the model is therefore much higher in comparison to the other two cases. The moveable pitch also makes that the pitch condition isn't a deciding factor in the number of events that can possibly be organised within the stadium.

The number of FTE's and the general costs of maintenance of the stadium are adjusted to the available data and the size of the stadium, as is the function distribution within the stadium.

VII.VIII Results GelreDome

If we look at the results of the model run for the GelreDome, we can distinguish a few things. On a function allocation level we cannot see many strange results. The model stays within the boundaries that were set in the input and favours the more profitable functions over the less profitable ones as expected. The model does this to create the highest ROI as possible.

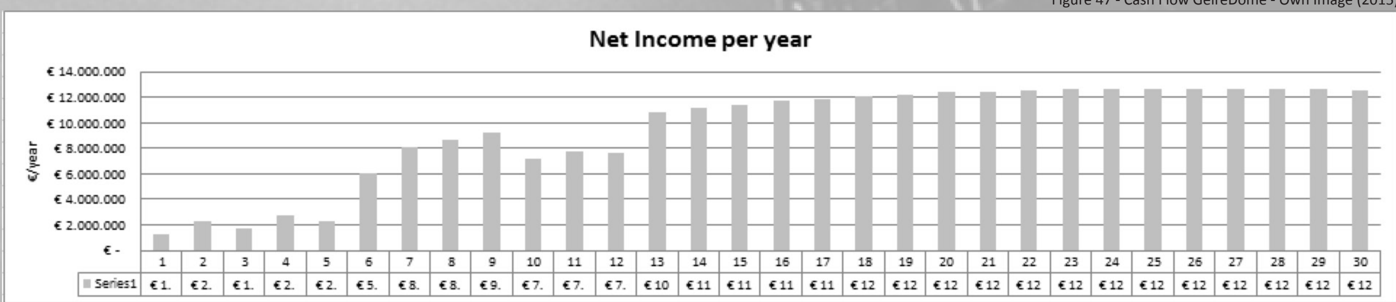
On a financial level the model the model looks to be representing reality well. The return on investment per year already starts with a positive the year after the initial investment. This is the result of the high number of events within the stadium. The graph of incomes then keeps on rising and reaches a high at a little over €12 million ROI per year, which is lower than the other two stadiums because of the differences in capacity. The planned renovation causes an interruption in the graph and is clearly visible.

The total IRR of the project is calculated at 6,7% as of now. This depicts that the stadium is a good investment and investors should be willing to get involved with the stadium. The current situation, in with a company is the sole owner of the stadium, already represents the created image in which private parties should become more interested in investing in sports stadiums, especially when they are as multifunctional as the GelreDome in Arnhem.

	IRR		Total Revenues	
Initial investment	€	-95.000.000		
Net income year 1	€	1.200.555	€	1.200.555
Net income year 2	€	2.326.907	€	2.326.907
Net income year 3	€	1.693.967	€	1.693.967
Net income year 4	€	2.745.569	€	2.745.569
Net income year 5	€	2.232.075	€	2.232.075
Net income year 6	€	5.998.498	€	5.998.498
Net income year 7	€	8.047.565	€	8.047.565
Net income year 8	€	8.642.282	€	8.642.282
Net income year 9	€	9.181.704	€	9.181.704
Net income year 10	€	7.200.247	€	7.200.247
Net income year 11	€	7.783.565	€	7.783.565
Net income year 12	€	7.583.462	€	7.583.462
Net income year 13	€	10.855.685	€	10.855.685
Net income year 14	€	11.168.780	€	11.168.780
Net income year 15	€	11.445.277	€	11.445.277
Net income year 16	€	11.687.666	€	11.687.666
Net income year 17	€	11.898.282	€	11.898.282
Net income year 18	€	12.079.320	€	12.079.320
Net income year 19	€	12.232.838	€	12.232.838
Net income year 20	€	12.360.769	€	12.360.769
Net income year 21	€	12.464.928	€	12.464.928
Net income year 22	€	12.547.015	€	12.547.015
Net income year 23	€	12.608.626	€	12.608.626
Net income year 24	€	12.651.261	€	12.651.261
Net income year 25	€	12.676.322	€	12.676.322
Net income year 26	€	12.685.127	€	12.685.127
Net income year 27	€	12.678.909	€	12.678.909
Net income year 28	€	12.658.826	€	12.658.826
Net income year 29	€	12.625.961	€	12.625.961
Net income year 30	€	12.581.331	€	12.581.331
Result		**6,7%**	**€**	**284.543.318**

Figure 46 - IRR GelreDome - Own Image (2015)

Figure 47 - Cash Flow GelreDome - Own Image (2015)



VII.IX Influence on Original Case

Now that two separate cases have been modelled and tested, it is possible to see in what way these cases have influenced the original case of the Kuip in Rotterdam. Alterations are made to the model input of this case based on the input of the other cases to make the main case input more realistic. Still some of the input of the model remains an estimation of the actual costs or actual numbers, but the other cases give a good indication of the magnitude of the figures that represent the case as realistic as possible.

The main alteration to the initial model is made in the values of events and the values of sponsorships. The event figures of the other stadiums, in combination with an estimation of the number of events a renovated stadium in Rotterdam would attract, made that the number of events has been adjusted. The number of concerts has dropped, but the number of other events like business events and fairs has risen due to the extra available information.

The sponsorship levels have also changed. The initial estimation of the sponsorship income proved to be to low. Where Vitesse can be seen as an average to above average club when it comes to sponsorship revenues, Ajax, Feyenoord and also PSV are of top quality. Of these three, Ajax has the highest income from sponsorships, and Feyenoord is in third place. The sponsorship budget is adjusted to these numbers and the Feyenoord budget is now approximately 80% of the Ajax budget. However, the way in which it is incorporated in the model differs from the model of the Amsterdam ArenA. The sponsorship revenues that are meant for the stadium are fully destined for Stadion Feijenoord, as where the revenues of the Amsterdam ArenA are only partially destined for the stadium itself, since the municipality of Amsterdam is the owner of the stadium.

Also, the number of employees and the maintenance costs of the stadium are adapted to the size of the stadium and the activity within the stadium. For Example, the GelreDome will have higher cleaning costs since more events are hosted. Other cost figures are also adapted using the information of the two other models.

Finally, the revenue decrease and the planned renovation in ten years are adapted in all three models. All three models now have costs in this area that is dependent on the size of the stadium and the development costs, which rules out any hindrance and discrepancies in the comparison process that will follow next.

Figure 48 - Stadion Feijenoord - S. Dijkshoorn (2014)

VII.X Results the Kuip

If we look at the results of the model run for the Kuip, we can distinguish a few things. On the level of the function allocation the model does what it is supposed to do and it assigns all the functions within the set boundaries. It prefers to allocate the most profitable functions and these functions are often represented as much as possible. This is in line with the purpose of the model in achieving a maximised ROI.

Out of the three models, this model run should be the most interesting one, as it should represent the situation that caused the collaboration between the FFC and BAM to end. Looking at the financial cashflow over thirty years, the first five years are displayed as years without revenues, and even a loss in the third year of over €6 million. This is in line with one of the reasons the collaboration did not work out between the FFC and BAM. The FFC demanded a high ROI in the first few years to be able to attract high profile players for the club to ensure quality results of the team on an international level. The model does not represent this demand.

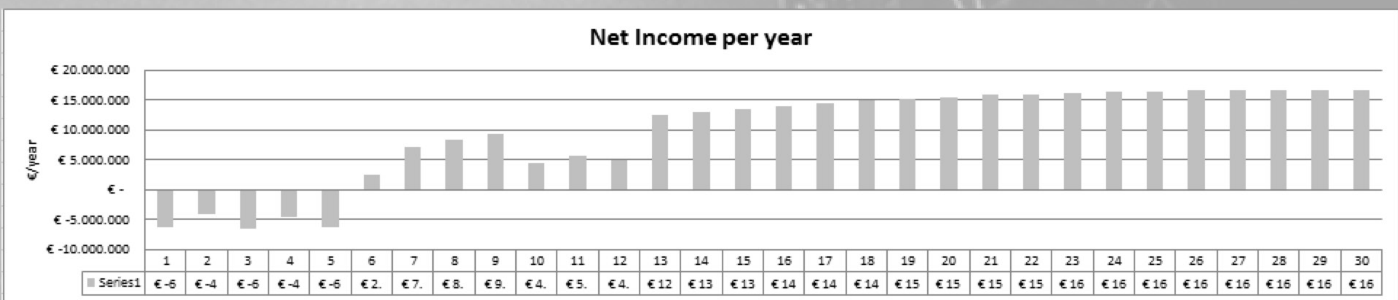
The graph of incomes then keeps on rising and reaches a high at a little over €16 million ROI per year, which is lower than the Amsterdam ArenA, despite the greater capacity. A number of reasons for this abnormality can be explained and will be in the following paragraphs. Also, the planned renovation causes an interruption in the graph and is clearly visible.

The total IRR of the project is calculated at 1,7% as of now. This IRR is too low for most investment proposals, despite the fact that a positive IRR represents a positive Net Present Value of the project (see chapter VI). Developers aim for an IRR of 4% or higher to mark a project as attractive for an investment. Although the result of the model run can be summarized in a negative investment advice, it does however represent reality well. The gap between an infeasible and a feasible project can be bridged in a number of ways, and an analysis of the possible explanation of the results will follow in the next paragraphs.

	IRR		Total Revenues	
Initial investment	€	-200.000.000		
Net income year 1	€	-6.270.515	€	-6.270.515
Net income year 2	€	-4.223.021	€	-4.223.021
Net income year 3	€	-6.503.588	€	-6.503.588
Net income year 4	€	-4.507.211	€	-4.507.211
Net income year 5	€	-6.362.294	€	-6.362.294
Net income year 6	€	2.539.654	€	2.539.654
Net income year 7	€	7.201.653	€	7.201.653
Net income year 8	€	8.277.645	€	8.277.645
Net income year 9	€	9.261.919	€	9.261.919
Net income year 10	€	4.398.897	€	4.398.897
Net income year 11	€	5.552.720	€	5.552.720
Net income year 12	€	4.908.685	€	4.908.685
Net income year 13	€	12.394.765	€	12.394.765
Net income year 14	€	13.002.254	€	13.002.254
Net income year 15	€	13.548.540	€	13.548.540
Net income year 16	€	14.037.688	€	14.037.688
Net income year 17	€	14.473.520	€	14.473.520
Net income year 18	€	14.859.622	€	14.859.622
Net income year 19	€	15.199.364	€	15.199.364
Net income year 20	€	15.495.911	€	15.495.911
Net income year 21	€	15.752.233	€	15.752.233
Net income year 22	€	15.971.118	€	15.971.118
Net income year 23	€	16.155.186	€	16.155.186
Net income year 24	€	16.306.891	€	16.306.891
Net income year 25	€	16.428.540	€	16.428.540
Net income year 26	€	16.522.296	€	16.522.296
Net income year 27	€	16.590.187	€	16.590.187
Net income year 28	€	16.634.117	€	16.634.117
Net income year 29	€	16.655.869	€	16.655.869
Net income year 30	€	16.657.116	€	16.657.116
Result		**1,7%**	€	**290.959.761**

Figure 49 - IRR Stadion Feijenoord - Own Image (2015)

Figure 50 - Cash Flow Stadion Feijenoord - Own Image (2015)



VII.XI Result Analysis

Now that the three model outcomes have been discussed, it is time to refocus on the original case of the Feyenoord stadium. The results show that the IRR of the project of 1,7% is below the desired IRR of the stakeholders, who often expect a minimal IRR of 4%. This is where one of the qualities of the model approach can be utilised to benefit the research process of these results. As of now, a solution space is defined and an objective function identifies one of the corners of this solution space. However, the IRR is not high enough, so the solution space must be made larger.

The next paragraphs will research to what extend the solution space that is created by the constraints should be broadened to be able to find a solution that complies with the IRR demands as well. In order to do so, the constraints that will be broadened must be identified, and an assessment must be made to define the extent to which the constraints can be broadened.

Constraint definition

The constraints that will be considered for alteration and broadening can be divided into two groups;

1) Constraints that have a positive influence on the IRR
2) Constraints that have a negative influence on the IRR

Positive constraints are the input variables that increase IRR when they have a higher value, whereas negative constraints have a positive influence on the IRR when the have a lower value. Out of all the constraints in the input sheet, a selection of constraints is made that will be adjusted to raise the IRR. These constraints and the intensity of the alterations will be discussed below. The new constraint value is discussed and the influence of the constraint on the IRR is represented by a dual value of the constraint on the IRR if changed to the new value.

Positive constraints:

Capacity

Table 11 - Capacity - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
Capacity	72.000	76.000	+1,7%

The most logical adjustment would be to enlarge the maximum capacity of the stadium. Since there was a discussion in the early phases of the project about capacity and a capacity of 76.000 has been considered seriously, this is the number of seats that will be used as a realistic new constraint.

Stadium Financing

Table 12 - Stadium Financing - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
Construction Costs	€200.000.000	€185.000.000	+2,1%

The stadium renovation costs are naturally a component that can be lowered in order to come up with a more feasible outcome of the model. The original negatiations broke down over a sum of €15 million, so the stadium costs have been lowered by that exact amount to €185 to see the effects.

Revenue Increase

Table 13 - Revenue Increase - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
Revenue Increase	1,0%	2,0%	+3,6%

Revenue increase has been set to 1% in the original model, a safe percentage that reflects the difficult economic situation in The Netherlands and the rest of Europe. Raising this percentage to 2% is optimistic, but not unrealistic

Ticketing

Table 14 - Ticketing - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
Ticketing Category 1-4	€20-€60	€20-€70	+1,8%

The ticketing in the four categories now range from €20 in category 1 to €60 in category 4. These figures will be adjusted to the level of the Amsterdam ArenA, since it is a competitor in this business sector, raising the ticket prices to €20 in category 1 to €70 in category 4, with higher prices in the middle categories.

Number of Business Seats/Suites/Sky Boxes

Table 15 - Business Seats/Suites/Sky Boxes - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
No. of Business Seats	6200 (max)	7500 (max)	+0,2%
No. of Suites & Sky Boxes	88 (max combined)	100 (max combined)	+0,6%

The number of VIP seats in the stadium are now determined by the BAM design, which calculated with 6200 business seats and a total combined number of 88 Suites and Sky Boxes. These numbers will also be altered in the input of the model to a maximum of 7500 business seats, and a combined number of 100 Suites and Sky Boxes. Especially business seats tend to have a maximum of 10% of the stadiums' capacity.

Number of Concerts

Table 16 - Concerts - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
No. of Concerts	6 (max)	10 (max)	+0,9%

A good estimation of the number of concerts is made, keeping in mind the historical number of concerts, type of stadium, location, acoustics and competition of other stadiums. For the sake of the improved IRR the maximum number of concerts will be increased from 6 to 10.

Number of Corporate Events/Fairs & Exhibitions

Table 17 - Corporate Events/Fairs & Exhibitions - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
Corporate Events	50	65	+0,4%
Fairs & Exhibitions	4	8	+0,3%

With the same reasoning as the number of concerts in mind, the number of events and fairs & exhibitions have been defined at a maximum of 50 and 4. These figures will also be altered to a maximum of 65 and 8 events per year.

Sponsorship Revenues

Table 18 - Sponsorship Revenues - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
Sponsorhip	€4.000.000	€6.500.000	+0,9%

The sponsorship revenues are set at €4 million per year. This is significantly less than in the other two stadiums, but a larger percentage of this source of income is destined for the investor. This figure will be adjusted to €6,5 million, which is opportunistic, but is also very achievable if a willing sponsor is found.

Number of FTE's

Table 19 - FTE's - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
FTE's	110	80	+0,4%

The number of FTE's in the stadium as of now is 110. In order to cut costs, the number of FTE's can be cut. In this scenario the number of employees in the stadium is cut to 80, which should be enough to leave the stadium in an operating status.

Negative constraints:

Cost Increase

Table 20 - Cost Increase - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
Cost Increase	3,0%	2,4%	+0,4%

The cost increase percentage is now set at 3%. Lowering this percentage will increase the IRR of the stadium project. A realistic estimation of the lowered value of this constraint is 2,4%, which is not significantly lower, but should make a difference in the total IRR.

Operating Costs

Table 21 - Operating Costs - Own Image (2015)

Constraint	Original value	New Value	IRR dual value
Operating Costs	€21.500.000 (min)	€18.275.000 (min)	+0,9%

The constraints that form the total operating costs now add up to a total minimum of €21,5 million per year. Alterations to the model have been made to lower costs with a maximum of 15%, which adds up to €18,275 million per year.

New model run

Running the new model with the adjusted constraints should define a greater solution space and should calculate a higher IRR for the project. Running the model with this adjusted input, the outcome is greatly increased compared to the first 1,7% with a newly calculated IRR of 8,8%. We have to bear in mind that this model run is very optimistic and maximizes a number of variables to a value that probably won't be achieved in real life. The positive lesson from this model run is that the model is able to find a solution that meets the requirement of a minimal IRR of 4%. The next step is to tone down some of the extreme constraints to come to a set of constraints that is feasible in terms of achieved IRR and feasible in terms of realism.

Out of the adjusted constraints, the constraints with the highest 'IRR dual value' (the influence of that constraint on the IRR) have the best opportunity to change the outcome of the calculations. However, the constraints with this power are also the constraints that are most unrealistic. A well-deliberated choice has to be made on the constraints that will be altered and to what extend. By altering the constraints one by one, the model outcome is forced towards the desired 4% IRR. The solution space is made big enough to achieve this IRR, but is not made any bigger to restrain the model in terms of realism as well.

After altering some of the constraints slightly, the desired 4% IRR was reached. The changes that were made to the input sheet of the model obviously could have been made in a different way, resulting in the same IRR. The changes made are displayed in the table below.

Constraint	Old Value	New Value
Capacity	72.000	74.000
Construction Costs	€200.000.000	€195.000.000
Revenue increase	1,0%	1,3%
Ticketing Category 1	€60 (max)	€70 (max)
No. of Business Seats	6200 (max)	6700 (max)
No. of Suites and Sky Boxes	88 (max combined)	91 (max combined)
No. of Concerts	6 (max)	8 (max)
Corporate Events	50	55
Fairs & Exhibitions	4	6
Sponsorship	€4.000.000	€4.000.000
FTE's	110	100
Cost Increase	3,0%	2,6%
Operating Costs	€21.500.000 (min)	€19.000.000 (min)
IRR	1,7%	4,0%

Table 22 - Overall Model Alterations - Own Image (2015)

When looking at the table, the alterations that were made to the model to achieve the desired IRR don't seem to be very rigorous. However, keeping in mind the fact that no safety margins have been put into place in this model, it is still optimistic. Knowing that relatively small alterations can have such a great impact on the end result of the model is something that is exploited in the table, but can become an issue if the effect is turned around. Small setbacks in the design and construction process of the stadium renovation can also drop the ROI and IRR of the project dramatically as shown in the model runs. The sensitivity of the model is therefore an opportunity to tweak the model to force it in the desired direction, but is also a dangerous characteristic of the model.

VII.XII Agreed Situation Analysis

The results of the previous paragraph show that, under certain assumptions, a feasible stadium design for the stadium could have been made. The extend to which these assumptions are realistic are up to debate and will also be discussed in the conclusion and reflection on this research. However, one question remains to be answered. If the model with the data from the stadium design shows that the design proves to be lacking in terms of IRR, but also in other demands that were set for the cash flow structure of the project, how did an agreement exist between the involved stakeholders in the first place? The involved stakeholders were the FFC and BAM. After a selection round with other competitors the BAM design was chosen based on the experience, financial feasibility and overall design after the proposed stadium renovations. At this point in time, the expectations BAM had created for the design and the profitability of the stadium were positive enough to be awarded the provisional project. In other words, the proposed IRR of the project should have been bigger than the stated 4%. After further development of the design, the stadium proved to be less feasible and the IRR dropped to a level that was not satisfactionary anymore for the FFC. Therefore, it is very interesting to see which alterations to the design were made that made that the project became infeasible.

This paragraph will try to recreate the proposed design that was accepted by both stakeholders by altering the input of the model in different areas. These areas are defined based on knowledge on the project. For instance, the entire structure of the initial stadium design proved to be too large. The highest tiers of the stadium were 'hanging' outside the predefined envelope in which the structure should have been designed. This meant that the entire structure had to be altered, leading to a smaller stadium with less square meters that could have been profitable. This is only one of a few causes for the fact that the final design proved to be less feasible than the initial design.
A second major influence, that is partially related to the first influence, is the size of the commercial area in the stadium. The final design had more than 20.000 square meters less commercial area than promised in the initial design. This also had an effect on the number of F&B sales point in the stadium, since capacity of the F&B areas in the stadium increased.
The final major influence on the feasibility was the estimations on the economy. The design made assumptions on the market that were on the rather positive side, instead of a more realistic one. The revenues were estimated on the high side of the normal bandwidth for variables like revenue increases. The model has also been adapted for this positive view on future cash flows.

The table below shows the alterations that were made to the model to recreate the initial bid that BAM made for the project, based on the above stated information. If the model is realistic, the calculated result of these alterations should make the IRR of the project rise from the projected 1,7% to a percentage of over 4%.

Constraint	Old Value	New Value
Square Meters Ground Floor	18.000	30.000
Square Meters 1st Floor	9.500	12.000
Square Meters 2nd Floor	9.000	12.000
Square Meters 3rd Floor	6.250	8.000
Square Meters 4th Floor	12.000	14.000
Square Meters 5th Floor	11.000	14.000
Max. Square Meters Commercial Ground Floor	2.600	5.000
Max. Square Meters Commercial 1st Floor	3.000	5.000
Max. Square Meters F&B 1st Floor	1.800	3.000
Max. Square Meters F&B 4th Floor	1.600	2500
Max. Square Meters F&B 5th Floor	1.600	2.500
Revenue Increase	1,0%	1,5%
IRR	1,7%	4,1%

Table 22 - Model ALterations Initial Design- Own Image (2015)

Table 22 shows that the IRR would rise dramatically because of these alterations. The initial 1,7% rises to an acceptable 4,1% due to alterations in the size of the stadium, the size of the commercial area in the stadium and a more positive view on future cash flows. It is assumable that the original design consisted out of more of these positive outlooks on the future, making the project even more interesting for investors by raising the IRR with their promises. This analysis is merely an indication of the alterations that could have been made to te stadium that make that it is not feasible anymore. It does show that any project is highly sensitive for a combination of small alterations on a higher scale.

The discussed alterations did not only impact the stadium on a financial level, but also impacted the atmosphere of the new stadium. One of the main concerns of the Feyenoord fans was for the typical atmosphere of the stadium to remain. The large stadium structure and the fanatic fans within the stadium should intimidate opponents of the club. This aspect is very hard to capture in any model, but according to the fans, the developed design lacked any atmosphere within the stadium because of the smaller structure and cost saving design solutions that had to be put into place to make the project more feasible. One of the most visible examples of this is the structure of the new tier in the design, which was invisible in the initial design and was very visible in the second design, causing obstructions for the view of some of the the spectators.

Figure 51 - Gameday Atmosphere Stadion Feijenoord - Twicsy (2010)

VII.XIII Monte Carlo Simulation

In addition to the general results that have been presented, an analysis of these results will follow in this next paragraph. A Monte Carlo (MC) Simulation, in combination with the Crystal Ball tool, is used for this analysis. Monte Carlo simulation is a quantitative risk analysis technique in which uncertain inputs in a model (in this case an Excel spreadsheet) are represented by probability distributions instead of by one value such as the most likely value. A number of most likely values for certain constraints have been put into the initial model.

By letting the computer recalculate the model over and over again (for this research 250 times) and each time using randomly selected sets of values from the input variables according to their probability distributions. The results of a MC simulation are a frequency and cumulative distribution of all outcomes rather than the one predicted outcome you get from a deterministic model; that is, the range of possible outcomes that could occur and the likelihood of any outcome occurring. In this case, the main outcome of the model is the IRR that is calculated. By applying a range to certain deterministic values in the input sheet, the range of the IRR outcome can be calculated and the likelihood of the IRR results.

The most important advantages of Monte Carlo include:

- The probability distributions within the model can be easily and flexibly used, without the need to approximate them
- Correlations and other relations and dependencies (such as “if” statements) can be modeled without difficulty
- The level of mathematics required is quite basic
- Software like Crystal Ball can automate the tasks involved in simulation
- The behavior of and changes to the model can be investigated with great ease and speed

Crystal Ball, an add-in of Microsoft Excel, provides an easy, efficient and flexible tool to perform Monte Carlo Simulations with the following steps:

- Describe the model in words and diagrams
- Write the data in Excel and construct the model, including distributions in Excel, to match your diagrams;
- Nominate in Crystal Ball which cells are outputs you are interested in and run the model
- Review the results in the Crystal Ball forecast windows, overlay chart window, trend chart window, sensitivity chart window, report format or raw output data option.

A set of values, which until this point were of a deterministic nature, has to be chosen. In this case, the set of values will represent the uncontrollable variables that were part of the initial calculations. These variables together form a major part of the risk component that investors take into account when determining their desired or minimal IRR values. The set of values have an expected value, a pessimistic and an optimistic value, which are used for determining the range within which the MC Simulation will choose it’s different sets.

The set of uncontrollable variables (Table 23) that have been incorporated into the input sheet of the model, and therefore will be used for this analysis, are:

Value	Most likely value	Range/Bandwith
Average attendancy	70%	65%-85%
Revenue increase	1,3%	1,0%-1,5%
Cost Increase	2,6%	2,0%-2,8%
Interest Rate	3,0%	2,2%-3,4%
Initial investment	€195.000.000	€190.000.000-€215.000.000

Table 23 - Uncontrollable Variables in MC Simulation- Own Image (2015)

Results Monte Carlo Simulation

A stated, the MC Simulation simulates the model 250 times, whilst using a different set of values, chosen within the given bandwidths, resulting in 250 different outcomes of the model runs. These runs are displayed using a beta pert graph. The advantage of the beta pert graph over a normal distribution is the fact that it actually intersects the x-axis and can also be asymmetrical. A symmetrical result of the model runs will result in a beta pert graph that closely resembles the normal distribution. Because of the fact that the bandwidths are also chosen with some subjectivity, the chosen set of values overruns the boundaries of the bandwidths on rare occasions to simulate these outcomes as well.

The result of the MC Simulation with the presented set of values can be seen in the figure below.

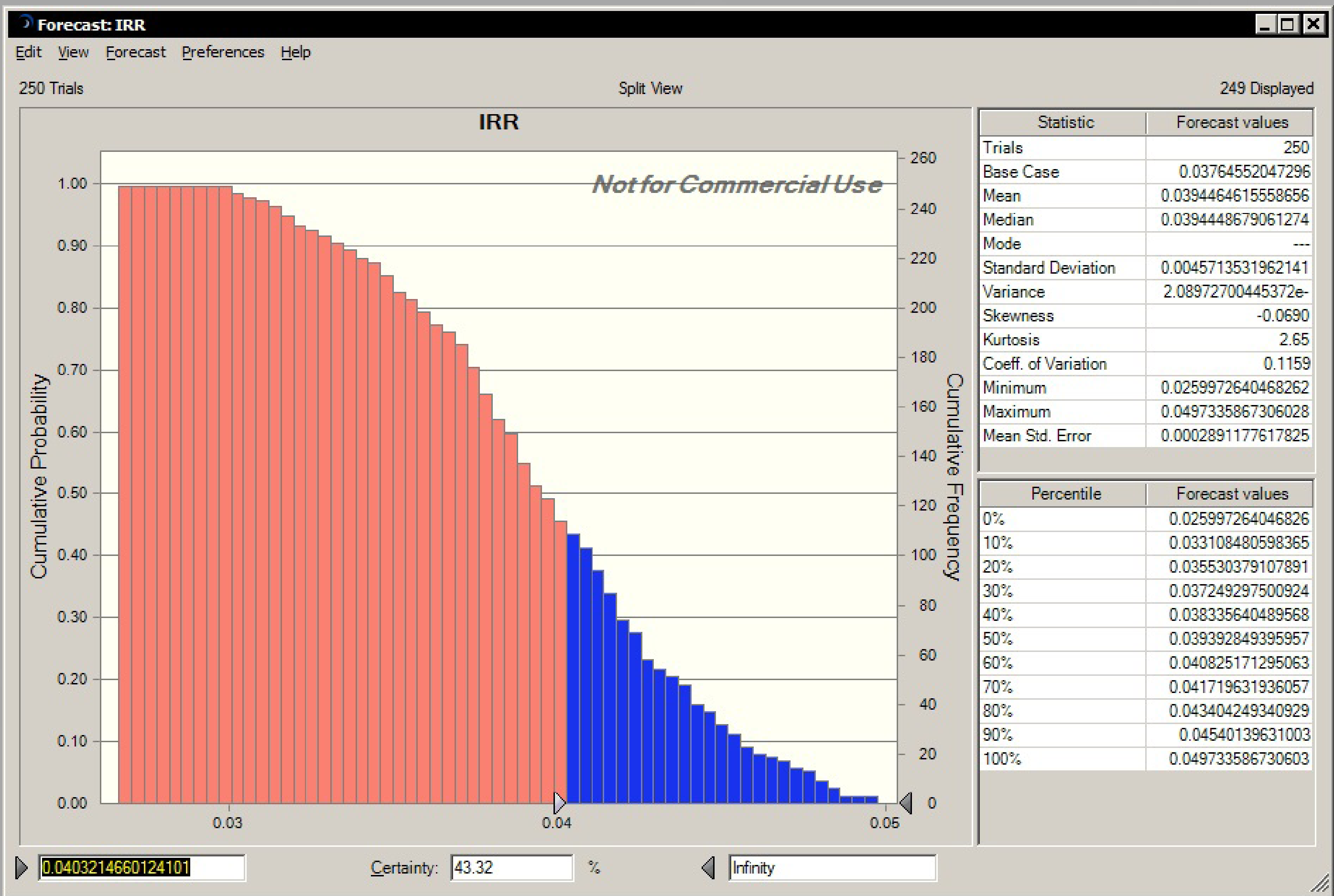
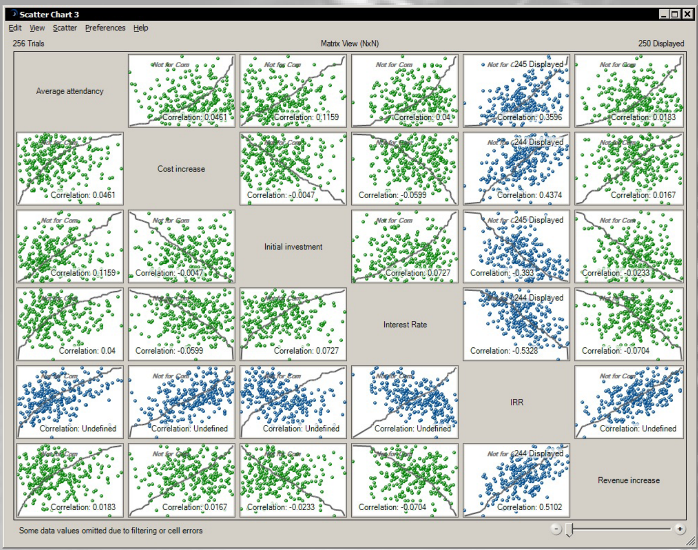


Figure 52 - Forecast of the MC Simulation - Own Image (2015)

The Forecast of figure 52 shows the outcomes of the 250 model runs. The 4% barrier is diplayed by the change in color of the graph. From the adjacent numbers we can distinguish that 40% of the runs project an IRR above 4% and 60 % of the runs project an IRR below 4%. Also, in none of the runs, the IRR drops below 0%. In figure 53, a part of the Excel sheet that shows the generated combination of values is presented (Collumn 2 to 6), with in green an outcome above 4%, and in red outcomes below 4%. The '2' in the last collumn shows that the result is feasible .

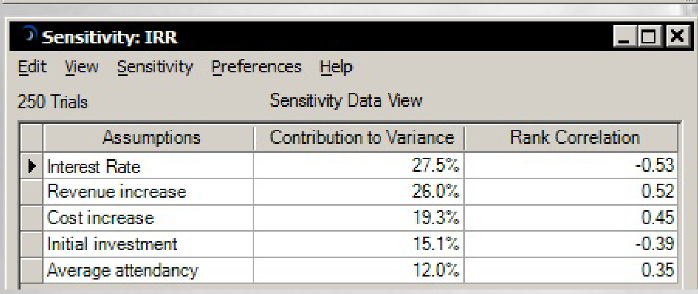
214	.	76,73%	1,19%	2,39%	2,86%	190799928	4,15%
215	213	71,53%	1,20%	2,41%	3,17%	192974627	3,51%
216	214	78,97%	1,33%	2,65%	2,78%	192160688	4,95%
217	215	67,90%	1,16%	2,50%	2,49%	190366584	4,15%
218	216	69,74%	1,27%	2,54%	3,22%	194050670	3,65%
219	217	74,06%	1,25%	2,40%	2,82%	191470710	4,17%
220	218	69,46%	1,46%	2,52%	2,50%	192960240	4,82%

Figure 53 - Forecast of the MC Simulation - Own Image (2015)



In addition to the general results, the MC Simulation also provides an analysis of these results on different subjects. The first of these is the correlation of the different values. The closer the dots are to the displayed line, the more correlation between the two values exist. As can be seen in image 54, no clear correlation between the chosen values exists. This is in line with the hypothesis, since none of the values have been given a designated dependancy or link.

Figure 54 - Correlation of the MC Simulation - Own Image (2015)



Assumptions	Contribution to Variance	Rank Correlation
Interest Rate	27.5%	-0.53
Revenue increase	26.0%	0.52
Cost increase	19.3%	0.45
Initial investment	15.1%	-0.39
Average attendancy	12.0%	0.35

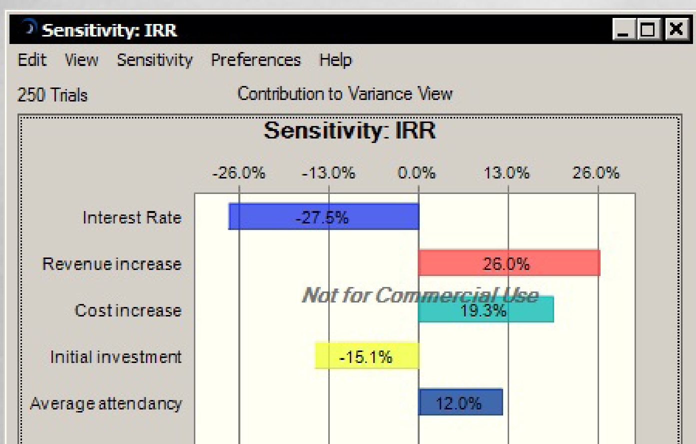
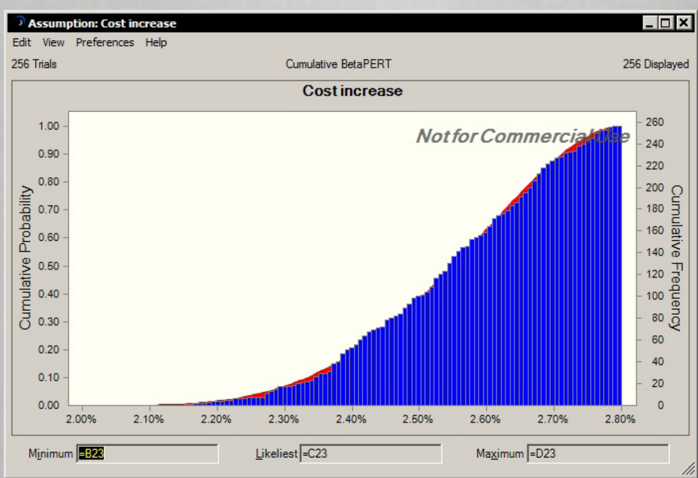


Figure 55 and 56 display the sensitivity of the five values in numbers and in a graphical way. Here we can see that the IRR is mostly influenced by the interest rate and revenue increase. The cost increase and initial investment have a medium amount of influence and the IRR is least influenced by the attendancy figures. Because of the financial dependancy of the IRR, it can be seen as logical that this value is mostly influenced by the financial values like the interest rate, cost increase and revenue increase. However, the other two values also have a strong financial influence on the IRR and especially the attendancy figures were thought to have a greater impact on the IRR.

Figure 55 - Sensitivity of the MC Simulation in numbers- Own Image (2015)
Figure 56 - Sensitivity of the MC Simulation graphical - Own Image (2015)



Finally, Figure 57 shows the extend to which the results comply with the chosen Beta Pert distribution. The blue graphs show the results of the run, where the red line represents a 'perfect' Beta Pert curve. As can be seen, the two results are very much alike and the fitted Beta Pert matches the results of the simulation almost perfectly.

All in all, the sensitivity of the model to these external and uncontrollable variables is less influential than it was initially thought to be. We can conclude that the model is more sensitive to the controlable variables than the uncontrollable ones.

Figure 57 - Cumulative Beta Pert of the Cost Increase - Own Image (2015)

Conclusion

The conclusions on the research are based on the main research question of this thesis, being:

"How can a decision support model contribute in enlarging the return on investment, based on the lay-out of flexible and multifunctional sports stadium projects, in order to increase feasibility?"

The conclusions that have to answer this question are twofold and are therefore discussed on two levels. First of all, a main conclusion on the model will tell if a model is created that is able to display reality as realistic as possible. Furthermore, the case-specific results will be discussed and will provide the conclusions on the main research question and the case study itself.

VIII.I General Conclusion

The general conclusions cover the aspect of the research itself, the motivation on this typical research and the hypothesized outcomes.

The first aspect to address on this matter is the fact that a model had not been created yet for this purpose. In the field of decision modelling, some decision support models have been created for housing and urban planning design problems. However, the fact that stadiums are such a specific type of real estate that exists in an ever-changing process of optimization makes it impossible to develop a tool that is suitable for all cases.

This is also the reason that the focus of the tool has not been on designing a stadium itself, but to come up with a tool that is able to help decision making on multiple moments during the design process.
The first of these moments is the initiation phase of the project. The tool will be able to incorporate demands from all involved stakeholders in the project and define if there is an actual solution space for the design that is to be made. This will prevent lengthy discussions, meetings, initial designs and other preparation activities. The power of the tool lies in the fact that it is able to define a solution space as well as identifying the reasons for a solution space. This makes that it is able to identify the constraints and stakeholders that are defining the solution space.
The second point in time the model can be used is at the end of the design process, since the tool has reflection capabilities as well. Whereas the tool will not be used for the designing itself, it is able to reflect on the financial decisions of the design that is made. The tool will be able to analyse if the design is indeed the best design for the stadium financially and will also be able to showcase and understand the reasons for deviating from the financially best design. If the chosen design and the design the model suggests differ, this will be a reason for renegotiating the design or changing the model constraints in order to match both design solutions.

Another aspect that seems logical but is essential is that a working model is created. The model is developed to represent reality in the best possible way, incorporating as much of the problems and demands that the real world project encounters, making it the optimal simulation of the stadium cash flows. Going into depth even more with the capabilities of the model itself would mean a better representation of reality, but the present level of detail is chosen for on purpose. First of all due to time constraints, but most of all due to the fact that, while it is possible, adding more detail that has little impact on the end result of the model will only mean that the model runs are more time consuming whilst not benefitting the end results in a similar way.

This brings us to the next part of the conclusion. The model has an inductive nature. It is created and tailor made for one specific case. However, with the knowledge gathered in the creation process and the process of tweaking the model itself, it is possible to adapt the model to future projects. Some alterations must be made to make the model usable for a different project, but the main structure of the model will remain to exist. This fact that it is an easily transferable process underlines the value that it can have in the future for other stadium projects as well. This is also proven by the altered approach to the research that included the addition of two new stadiums, making it a case study on three stadiums instead of one. The advantage of the original model is the fact that is developed for a large stadium, making it relatively easy to adapt the model for smaller stadiums. Adapting the model for larger stadiums is a possibility, but would take more time in the alteration process.

VIII.II Case Specific Conclusion

The case specific conclusions are the conclusions based on the final results of the model runs of the three cases, the analysis of the results and the input of stakeholders in the stadium design process.

Model runs

The main conclusion that can be made upon the initial results of the model runs is the fact that the model displays reality as desired. Without forcing the model in a certain direction, all the model outcomes depict reality well with the available information. The hypothesis of the three model runs was for the ArenA and the GelreDome to result in two good investment opportunities, with the GelreDome as most interesting one. This because the stadium is also an entertainment centre, with a retractable roof, moving pitch and is in all aspects the most multifunctional of the three. The original case of the Feyenoord stadium shows a low IRR of only 1,7% and is not a viable investment for any private investor. This is also in line with reality, since negotiations on this stadium design eventually broke down.

The research has succeeded in the creation of a tool that did not exist until now. Design decisions are often made in a formal setting where discussions between stakeholders, in combination with a certain power distribution, determine the design process and decision. Although decision support systems exist for residential and commercial real estate, a decision support system for stadium development had not been created yet. Therefore, it adds a new aspect to the negotiation and design process of stadiums as it dramatically increases transparency and can be used to speed up the analysis of certain design solutions.

Decision support systems as this model increases transparency of the entire process. Whereas too much transparency can also work in a negative manner for some stakeholders. For example, high profit margins for a certain stakeholder that used to be invisible for the other ones, now becomes clearly visible in the model. In order to nullify such aversions to this approach, it is made possible to set constraints to the model that aren’t visible for other stakeholders. Each stakeholder could use his own input sheet with only the constraints that are of their interest.

The model now projects the cash flows 30 years into the future. We can conclude that this a realistic amount of time to rightfully see the cash flows develop over the years and incorporate new investments over time. Setting the horizon too far ahead is also not realistic, since modern technology evolves quickly and it is not realistic to assume conditions stay the same over such a long period of time.

Model Run Analysis

The main conclusion that can be drawn from analysing the model and it’s mechanics is the sensitivity of the model itself. It was surprising to see how small alterations to certain input variables could have a big effect on the result of the model run. Analysing this sensitivity and the realism of such sensitivity in a model is one of the subjects that must be investigated further, since it is not clear yet if this represents the real situation in the best possible way.

Where the sensitivity of the model to the controllable variables is high, the sensitivity to the uncontrollable variables is not defining. The Monte Carlo Simulation that has been carried out after the model runs shows that the sensitivity of the model to external and uncontrollable factors is noticeable, but not determining for the decision making process. The results of the simulation show that the IRR fluctates between 0% and around 5% IRR depending on the chosen set of variables. This implies that these uncontrollable influences, that add up to a major part of the risk component in the design and construction process, will not cause the project to become infeasible in the worst case scenario. The revenues will be marginal and some investors might not want to take on the risks since better investment opportunities occur, but the reassurance that the IRR will remain positive is a positive reassurance.

In the three model runs, two expected results surfaced. The ArenA and the GelreDome proved to be feasible and interesting investments for a private investor if no alterations are made to these two stadiums. If alterations will be made to them, they would be even more interesting for investors, marking the potential of such investment opportunities.
However, the Kuip project didn’t prove to be very feasible, despite the positive IRR of the model run. Also, the FFC demanded a certain cash flow structure where high revenues in the first years after completion would contribute to the financial position of the club and player budget to ensure competitiveness in the coming years. The model run however predicts a negative cash flow in the first few years, giving investors reasons for extra contemplation before investing.

Conclusion

The outcomes of the model runs of the Feyenoord stadium are analysed and the solution space for the model is made bigger by widening some of the constraints in the model. Suitable constraints are identified and a realistic reasoning to the extend of the widening is provided. After running the model with these alterations the IRR is raised from 1,7% to 8,8%. In order to reach the minimal required IRR of 4,0%, some of the widened constraints are narrowed again and therefore the solution space is adjusted to facilitate the desired IRR. The desired IRR of 4,0% is reached with a slight increase in some of the model variables. The real discussion on these results is if the widened constraints are realistic and how safety margins for the project are built in. Slight alterations have a large impact and the sensitivity of the model shows that relatively small issues in the design and construction process could lead to a stadium that is much less feasible than initially projected.

The model itself also has certain limitations and needs continued tweaking and development in order to be more accurate and serve the purpose of the model in a better way. One of the main limitations of the model is the way in which it displays ownership of the stadium. This is not clear yet and the ownership situation is now represented in the percentages of the revenues that will go towards the stadium owner. Extra information that enables the model to quickly adapt to new ownership situations might help in this case. Furthermore, the model as it is now, has some limitations in the size of the model. Not only is the model limited to a stadium with a certain amount of floor, but the model also has limitations in terms of the number of constraints. The What'sBest! plugin has a maximum number of constraints and variables with which it can operate and the plugin might struggle with more extensive models. Finally, the model greatly depends on the available information. A transparent process is not something that all stakeholders are comfortable with, so a lack of information and cooperation can make the model inaccurate and therefore not useable.

Conclusion

VIII

Reflection

Concluding the report, a reflection is provided in this chapter to address the different issues that were encountered, and to provide some general remarks on the research as a whole. Also, further research opportunities and limitations are discussed.

Research Reflection

- The overall structure of the model has also been something that caused some struggles. Because of the abundance of variables, constraints, input and output, a clear overview of the structure of the model went missing sometimes. The model itself therefore had to be rebuilt several times. This proved beneficial to the model and provided new insights in the calculations and the model structure.

- The main issue that I have encountered is deciding on the mechanics of the model itself. The way of calculating certain revenues can be done in multiple ways. I have now chosen for the way where the stadium owner receives a percent age of the revenues from the different types of revenues that are generated within his stadium. By doing so, I can always adapt easily to changes when they occur, simply by increasing or decreasing this percentage. I can also circumvent certain abstract financing structures buy altering the percentage to a number that corresponds with the results of these techniques. This is a suitable structure for now. However, I would like to see that the model incorporates the different calculation methods that are used in the process altogether in the model itself. This in order to create the most realistic model as possible.

- Adding to the previous point of reflection, decisions had to be made on the mechanics as a whole. The created model could have been constructed in many ways, but I have chosen for the way it is built up now. Ive deliberately chosen not to let the model produce floorplans of the design solutions. This is a load of extra work and the decision was made to focus more on the accuracy of the model initially, and to discover the added value of such a mechanic later. Such a mechanic, that visualises the results somewhat better could have been useful and is something that can very well be added to the model in other researches. Another deliberate choice was made for the model to not make use of the geometry of the stadium. This is not a point of focus of the research and makes that the model can be altered for any stadium, despite differences in geometry. THe strategy has always had a focus on the pure financial side of the main research question and all decisions on the model mechanics have been made in order to facilitate that sole purpose. Further research can add, substract or improve certain functions of the model, but within the set time limit of this research all decisions have been made to display reality as well as possible.

- One of the more difficult and important decisions I had to make during the research itself, was to set the Minimal Internal Rate of Return (MIRR) for stadium projects. As explained in Chapter VI, every company uses a different MIRR for investments. THis is dependant on many factors, ranging from economic factors the current market, risks and personal preferences. After a small research on the used MIRR in common housing projects and the assumption that stadium project investments carry more benefits when investing as reputation and extra sponsor revenues, a MIRR that is lower than common housing projects was chosen. This is still a debatable decision, and should therefore be discussed in this reflection. Altering this percentage has a great impact on the research and it's outcomes.

- Reflecting on the results of the research I can say that I am satisfied. Without forcing the model to display certain results, the model displayed the results that were hypothesized. This shows that the model depicts reality to a certain extend, which is one of the main goals of the research. It takes into account all variables in the design process, the stakeholders' wishes, and also generates a global layout of the stadium that will generate the highest possible revenue or the stadium owner.

- The solution space was enlarged and made smaller to direct the results towards the desired 4% IRR. The realism of the adaptions that had to be made to come to this result is something that can be debated. Most of the alterations can be validated by the other two cases, or by real time events that influenced the stadium design. For example, the construction cost debate encompassed €15 million, so this range was chosen for the alterations. This is however a crucial debate in the research. The results of the model show that it is possible to design a feasible and desired end product, but the realism of the adaptions in this case can be validated in my opinion. In other projects, it is very much the case of which stakeholders are involved, what their positions are and what the expect out of the project to provide a more substantiated opinion on this matter.

Reflection

- The desirability of the provided transparency is also a good point for reflection and discussion. We have concluded that transparency is created and that some stakeholders might not desire this transparency in the negotiation process. The question arises if this threatens the future of the use of the model when there will almost certainly be a stakeholder that is involved in the project that might not appreciate the transparency aspect of the approach. In my opinion, it is important that at least the main stakeholders favour the approach. By doing so, they force all the other stakeholders to cooperate with the chosen negotiation strategy, even if it is a transparent one. The investor itself is the one benefitting from the approach and should not have major issues against implementing the approach. Municipalities are government bodies and also benefit from the transparency. The last main stakeholder in the process, the sports club, might have some arguments ahainst using the approach. However, the benefits of the approach weigh out the downsides in my opinion. Without the model and it's outcomes, the club might enter in a contract that is far less beneficial than projected in the first place, forming a risk for the club and all other involved stakeholders.

- The addition of the Monte carlo Simulation, a part of the report that was added at the last moment, has proven to be a very valuable one. The analysis of the model runs shows how the model behaves under certain circumstances and expounds the results. Especially the sensitivity of the model to the uncontrollable variables sheds a light on how big of a role they play in the decision making process of any investor on investing in such an expensive real estate project.

- Finally, reflecting on the research as a whole, I think the research sheds a light on an area in the field of Real Estate that is important but undervalued. Stadium design can have a huge impact on urban area development and on social cohesion, but until now decision support model haven't been produced and used within this branch of Real Estate. In hard economic times, the perspective of the stadium owner and investor is also refreshing, and demands the design to be as profitable as possible, a demand that is critical to the chance of a successful operation of any Real Estate object.

Personal Reflection

- The main issue that I have encountered is the hard way of obtaining information. The project of the stadium that I have chosen for this research was in a stalemate between developer and stadium owner at the time of the initiation of this process. This had some consequences for the research since both main stakeholders were occupied and didn't have time for a graduation student at the time. Corresponding would take multiple days at a time, delaying some of the development process that could have been done

.- Issues with the modelling software were limited throughout the project. Some of the mechanics were to be learned by trial and error, but most of the theory behind working with What'sBest! was adapted quickly. The thing I personally struggled the most with, was the compatibility of the plugin. The plugin is only available on Windows operating systems, forcing users of other operating systems to circumvent this issue to be able to work with the software. Also, the implementation of the dual value took some extra time.

- I do have to say that the complete freedom that is given to you for a graduation research can be a bit scary sometimes. You are given the freedom of the topic, the research questions, the type of research and the way you conduct your research. The only thing that you will be judged on is academic relevance and academic level, which can be vary vague guidelines for students. Having no professor that will stimulate and motivate you, something you are used to throughout your academic career is a weird situation to experience, but very liberating at the same time. Your independency is put to the test during the entire process, and self-discipline is a characteristic you will have to relay on to complete such a research.

- Further research is to be done on this topic as well. It is not possible to make the perfect model in a matter of months, based on one case and in a research performed by a single person. The perfect model, if possible, will be the result of influences form all possible directions, all possible stakeholders and from years of tweaking and developing the model. What I have done is merely the framework for how such a model could function in the future. My model does what it is designed for, but some of the aspects could be investigated further and might need an entirely new approach to represent reality in a better way. All of this to create a transparent insight into stadium design and negotiations from different perspectives.

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