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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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.

Summary

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.

Summary

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

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.

Summary

- 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.

Summary

- 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.

Summary

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

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.

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.

VIII

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.

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.