

Research Step 7: Final Version Bachelor Thesis
Sports Parks in the context of a healthy city and urban planning.

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Abstract

The health of the city's people is becoming increasingly prevalent in the policies and goals of cities which can be seen in the goals of the World Health Organisation to make cities "healthy cities". In making the city's citizens more healthy, sports are considered a big part of improving health. Sports parks are a logical way to incorporate more activity into citizen's lives. This study will look at how these sports parks should be implemented and how they should be designed so that the city becomes healthier. To do this, a research-by-design study was conducted in the neighbourhood of Meerstad, located in the Dutch city Groningen to answer the research question "In what ways can sports parks contribute to the design of healthy neighbourhoods?" This study found that several elements need to be taken into account when designing a sports park to make for a healthy neighbourhood: placement of the park, park aesthetics, feeling of safety of the visitor, sufficient equipment, weather resistance and relevant climate adaptation measures. By implementing these elements, it is expected that a sports park will perform well and that people will like to come to the park and exercise physical activity to improve their health.

1. Introduction

Designing neighbourhoods in a way that makes them healthier for the people to live in, is what urban planners are interested in nowadays (Forsyth, 2020). This “Healthy Cities approach”, as used as the term to describe principles related to this planning method, is used as an approach to “put health high on the political agenda of cities and to promote health at the local level” (World Health Organization, 2023). But how, and what aspects should be taken into account? Focusing more on physical health, regular physical activity has been shown to reduce morbidity and mortality as well as maintain a healthier body (Bedimo-Rung et al., 2005). With increasing obesity and overweight rates, the promotion of physical activity becomes even more important (Qiu et al., 2020). A question that comes up regarding this physical activity is how this can be implemented in healthy city principles and how these activities should be designed. Studies also show that physical activity is beneficial to improving quality of life, life satisfaction, and results in higher life expectancy (Arem et al., 2015; Mok et al., 2019). To accommodate this physical activity, sports parks and facilities can be used (Bedimo-Rung et al., 2005). Khan et al. (2012) also mention that to succeed in increasing physical activity, the implementation of these sports parks is necessary to make “sports for all a reality.” According to Jing et al. (2021), the urban spatial structure influences the chances of this physical activity. Thus the introduction of sports parks to a neighbourhood helps to improve the physical health of the citizens. Specific health benefits of engaging in the physical activity provided by sports parks are for example reduced chances of cardiovascular disease and diabetes (Khan et al., 2012). Leite et al. (2024) researched the influence of the proximity of sports parks on the occurrence of early deaths by heart attacks and found out that when distances to sports parks were halved, the odds of death decreased by 27%. Thus by implementing sports parks closer to the homes of citizens, their health will increase substantially. However, how these sports parks should be designed to incorporate healthy city principles into neighbourhoods remains a topic on which research isn’t focussed as much. The fact that sports parks help in improving health is clearly distinguished in the literature but the specific design of the parks to aid healthy neighbourhoods is not discussed. This research will therefore focus on how these sports parks should be designed and implemented to make neighbourhoods healthy for their citizens to live in. To study this, a case study will be performed on the Neighbourhood of Meerstad which is located in the city of Groningen in the Netherlands.

1.1 Research Problem

So as highlighted in the previous section, research shows that sports parks can help in making citizens have better physical health. But how should these sports parks and their facilities be implemented and what has to be considered when designing and placing them in the neighbourhoods to promote their use? This is where this research aims to find an answer on:

- In what ways can sports parks contribute to the design of healthy neighbourhoods?

To answer this central research question, several other secondary questions should first be answered, by combining these questions this research aims to answer the central question:

- Which design elements are needed to optimally design a sports park in a neighbourhood?

To answer these questions, a case study will be conducted on a neighbourhood in the city of Groningen in the Netherlands: Meerstad. Meerstad is a neighbourhood which has roughly 3.500 residents in 2023 (Allecijfers.nl, n.d.). The demographics of the neighbourhood show that the biggest age groups are between 25-45 (1.445 residents) and 0-14 (1.175 residents). The neighbourhood is a relatively new neighbourhood and many houses are built every year. This can also be seen in the rapid population growth. The population grew from around 1.000 inhabitants in 2018 to more than 3.500 in 2023 (Allecijfers.nl, n.d.). This neighbourhood will be further elaborated on in the theoretical framework section of this research.

1.2 Structure of Study

This study starts by looking at relevant literature and case studies in the theoretical framework. This theoretical framework will conclude with a conceptual model summarizing the findings. After the conceptual model, the methodology of the study will be discussed. Once the methodology is concluded the results of the study, in the form of the summarization of the ideation process and the final design, will be presented. At the end of this paper, a conclusion will be presented in which the main findings and the comparison of the design with other case studies will be shown.

2. Theoretical Framework

In this chapter, the relevant theories and cases regarding healthy cities and sports parks will be discussed. Therefore, the relevant concept from the literature will first be discussed, after which relevant case studies as well as the case for this study will be presented. At the end of this chapter, an overview of the findings will be made in the form of a conceptual model.

2.1 The healthy city/ neighbourhood concept

As mentioned in the introduction, a healthy city is an important concept to promote health at the local level. But how can a healthy city be defined? According to Forsyth (2020), a healthy city/place can be divided into six types: the basic healthy place in which a distinction can be made between healthy built environments and collaborative cities. The idea of basic healthy places is that a physical (built environment) and/or an institutional structure (collaborative) structure is made that is supportive of health (Forsyth, 2020). Two other types can be defined under a population-based lens: age-friendly/ all-age communities and child-friendly communities, which are more focused on population groups with health vulnerabilities and a wider relevance (Forsyth, 2020). The last two types can be defined under the health technology cities: healthcare industrial cities and smart health environments. The idea of these types is that innovative technology can be harnessed to create a healthy economy (Forsyth, 2020).

This study will focus on the first type of a healthy place: the healthy built environment. This means that the study will thus focus on how the built environment, with the implementation of sports parks, can provide healthy places for the neighbourhood.

An important part of a healthy city is thus its built environment (Forsyth, 2020). According to Joassart-Marcelli, Wolch and Salim (2011) and Jing et al. (2021), access to this built environment is also vital for physical activity engagement and positive health outcomes. An important issue with this, however, is that the knowledge of optimizing the design of parks for activities to make healthy neighbourhoods needs to be improved (Faskunger, 2013).

2.2 Health and Sports Parks

Health itself is defined by the WHO (n.d.) as a state of physical, mental and social well-being. As mentioned before, accomplishing a healthy status can for example be achieved via physical activity, since this is an instigator for better physical health (Bedimo-Rung et al., 2005). Not only is physical activity good for physical health, but it is also widely recognized to improve poor mental health conditions (Vella et al., 2023; Pedersen and Saltin, 2015) and it is also mentioned in the guidelines of the WHO as a treatment option for depression (World Health Organization, 2010). Next to that, Heckel et al. (2023) found out that regular physical activity at sports facilities and parks improves social well-being conditions. Concluding from this research, the addition of physical health facilities, in the form of sports parks, is shown to improve all three aspects of health as described by the WHO. It is also recognized in countries that the distribution of sports parks is important for public health (Yang et al., 2023). This is for example already been implemented in China, where there are plans to construct new sports parks all over China (Tan et al., 2017). Khan et al. (2012) also mention that to succeed in increasing physical activity, the implementation of these sports parks is

necessary to make “sports for all a reality.” Next to this, Khan et al. (2012) also mention that the benefits of engaging in physical activity in these sports parks reduce the chance of cardiovascular disease and diabetes. So, in making a neighbourhood healthy, the implementation of these sports parks is an essential part.

2.3 Placement of Sports Parks

Determining where a sports park should be placed in the neighbourhood is also of great importance to the health impacts that it can have. An important aspect of this is the accessibility of the sports park, thus if it is easily reachable for the people (Yang et al., 2023). They state that a sports park can work better if many people are easily able to go to it. To serve the most people in a certain radius, a central location is the best choice according to Yang et al. (2023). This means that a central location in a neighbourhood is a primary spot to put a sports park (Yang et al., 2023).

2.4 Design of Sports Parks

As seen before, sports parks greatly help in increasing health, and the distribution of these parks relates to the success of the park itself. But one thing that is still missing about this, is the question of how such sports parks should be designed. Bedimo-Rung et al., (2005) mention the fact that design elements are in fact important to the appeal of sports parks. They mention that some design characteristics are the size of the park, the layout, landscaping, balance of sun and shade, wind protection, topography, ease of access, visual appeal, and other design elements that may be important to the park's success. They do not state, however, what these characteristics should look like. They also state that further research should look into these elements.

Since then, other case studies have looked at factors influencing the satisfaction of residents with the parks (Shen et al., 2022; Luo and Wang, 2022). In their studies, they found out via questionnaires that there should be sufficient and varied sports facilities and also attractive greenery to make the parks more attractive for residents to visit. These studies, however, were focussed more on existing sports park usage and didn't come up with specific design elements that have to be taken into account when building new sports parks. To address this gap, this research aims to develop a design guideline that can be implemented at different locations to benefit future sports park implementations.

Another important dimension of the usage of public open spaces such as a sports park is the perceived safety (Türkseven Doğrusoy & Zengel, 2017). Türkseven Doğrusoy & Zengel (2017) found out in their studies that parks that are in central locations are perceived as safer. They also found out that the perceived safety of parks increases if the parks are smaller, easy to control, well-maintained and include various activities. This also corroborates with the research mentioned earlier that a central location and provision of good and plenty of equipment increase the success of a sports park.

2.5 Climate adaptation

In the construction of these parks, another important aspect also needs to be taken into consideration: climate change and adaptation (Derkzen et al., 2017). It is increasingly important to consider how to design the parks since sealed surfaces in cities are not ideal for tackling the problems of the changing climate (Derkzen et al., 2017). For example, One thing that must be taken into account is the urban heat island effect, in which urban areas have higher temperatures because of more impervious surfaces (Fahed et al., 2022). Another challenge is stormwater retention, specifically in case of heavy precipitation which is not allowed to penetrate the ground, resulting in flooding (Kotecha et al., 2024). These aspects have to be integrated into the design of projects in urban spaces (Fahed et al., 2022; Derkzen et al., 2017). Thus when designing new sports parks, it is essential to also look at how these parks can adapt to extreme weather conditions.

An example of how these parks can be adapted to the changing climate is the Water Sensitive Urban Design (WSUD) principle. In this principle, rainwater is stored as close as possible to where it falls and released slowly instead of removing it as quickly as possible (TU Delft, n.d.). WSUD also provides other benefits such as (TU Delft, n.d.):

- Allows water to infiltrate in the ground instead of being moved to surface water bodies.
- The runoff is also slowly transported instead of being released quickly in sewer and drainage systems which can cause overflow of these systems.
- Additional benefits from WSUD include filtering out pollutants, greening the city and mitigating the Urban Heat Island effect.

Another example considering climate adaptation is located in several places in the Netherlands and also in Groningen. It's part of the Municipalities plans for some neighbourhoods in the future which is mentioned in their 'New Space For Living' design guideline (Municipality of Groningen et al., 2021): the Wadi or Swale. A wadi is an abbreviation for "Water, Afvoer, Drainage en Infiltratie" which translates to water disposal, drainage and infiltration.

This means that when there is heavy rainfall, the wadi takes the water up and makes for a slow infiltration of the water into the ground and when the wadi is full, the water enters an overflow outlet which goes to a drainage pipe. A wadi is, just like the aforementioned water square, also an example of how WSUD can be used to have a smart disposal of water. Figure 5 shows a wadi in Groningen, Helpermaar.



Figure 1: Wadi in Helpermaar

2.6 Case Studies

Several already existing sports parks can be seen as best practices, these will now be highlighted starting with the Benthemplein in Rotterdam. The Benthemplein is a public space in a dense neighbourhood in Rotterdam providing sports facilities (basketball, football and a skatepark) but can also be used to store water from heavy rainfall. The square was completed in 2013 and is a good example of the Water Sensitive Urban Design mentioned above. In this case, the square is called a water square. It combines both the physical activity aspect as well as providing space for stormwater retention. As seen in Figure 1, it provides a seating area and also has plants and trees to help with stormwater retention and the provision of shadows. When there is heavy rainfall, the lower-laying basketball/football field and the skatepark can serve as retention for the water (Urbanisten.nl, n.d.). The square has an area of 5.500 m² and the capacity to store 1.800 m³ of water (Urbanisten.nl, n.d.).



Figure 2: Benthemplein. Photograph by Ossip van Duivenbode (Urbanisten.nl, n.d.)

Another example of designing sports parks can be found in Amsterdam. In the municipality's "Amsterdam Rainproof" plan, the municipality provides an example of rainproofing the city in combination with sports parks. They also make use of the water square design as mentioned before at the Benthemplein. They show a schematic of how such a water square works when rain has to be stored, this schematic can be seen in Figure 2.

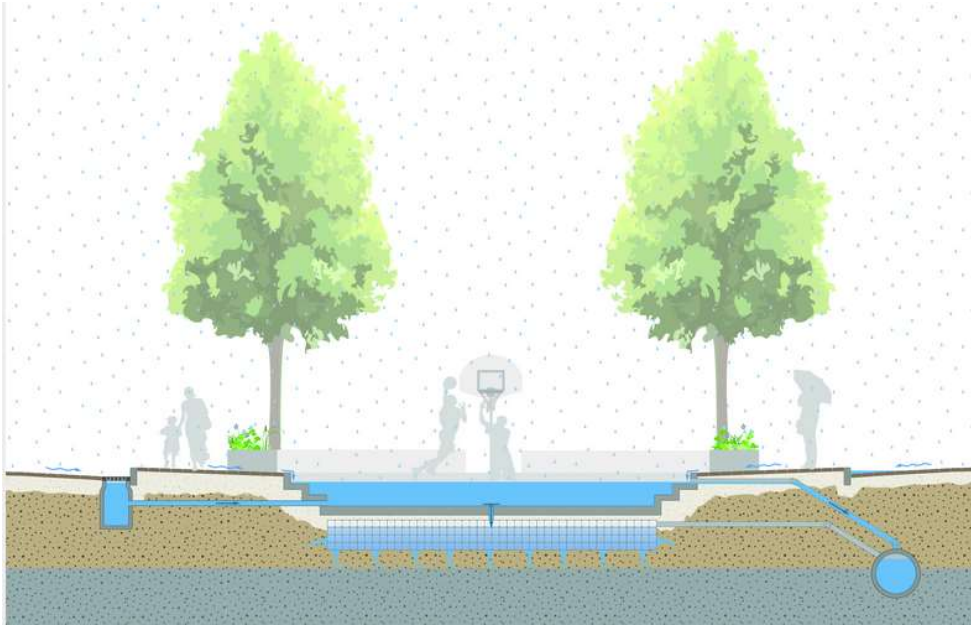


Figure 3: Water Square Schematic. Atelier Groenblauw (openresearch.amsterdam, 2021)

A different case study is located in Rio de Janeiro Brazil. In this case, colours are used to make the park more aesthetically pleasing as can be seen in Figures 3 and 4. As mentioned in the theoretical framework, the success of a sports park is also dependent on the visual pleasantness of the park. In this case, in Brazil, they adhered to that characteristic by using colours and different geometric shapes to give the park an extra edge and to make it stand out. The designers of this park noticed that painting enhances the sports experience so that people are more drawn to the park.



Figure 4: Colourful Basketball Field (Archdaily.com, n.d.)



Figure 5: Colourful Sports/Skatepark (Archdaily.com, n.d.)

2.7 Case

This research uses a case in which designs will be implemented. The case chosen for this study is a neighbourhood in the city of Groningen in the Netherlands: Meerstad. This neighbourhood is relatively new and many houses are built every year. This can also be seen in the rapid population growth. The population grew from around 1.000 inhabitants in 2018 to more than 3.500 in 2023 (Allecijfers.nl, n.d.). Most of the people that live in Meerstad fall in the age group of 25-44 and after that in the group of 0-14 (Allecijfers.nl, n.d.). Most of the people living in Meerstad are families with children. The area does have some playgrounds for kids scattered around but doesn't have many sports facilities next to a football centre. The neighbourhood is also still under construction in some places and therefore it leans itself to new designs of sports parks. For these reasons, this relatively new area has been chosen for the case study to implement a sports park. Figure 6 gives an image of how the neighbourhood of Meerstad is shaped.



Figure 6: Meerstad

2.8 Conceptual Model

To conclude the theoretical framework the conceptual model comes forward in the following figure;

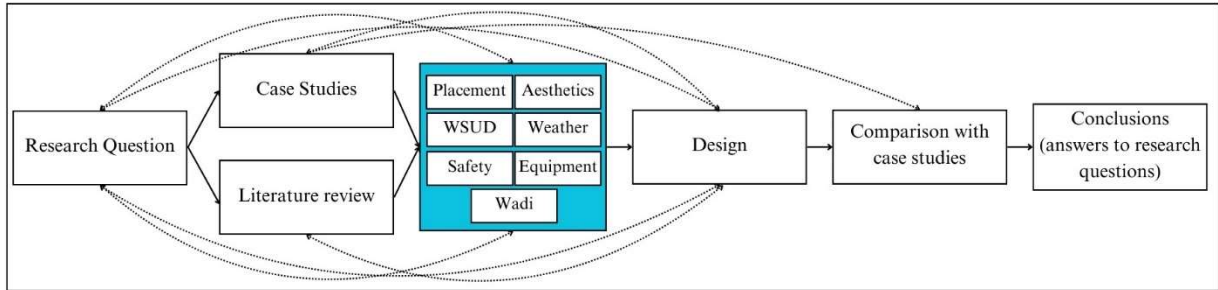


Figure 7: Conceptual Model (Made by the Author, 2024)

In this model, the most important aspects from the literature review and the case studies are placed in the blue square. These aspects are the main basis for the design. Next to these aspects, the research-by-design cycle is integrated into the model. The main elements of this cycle are feedback loops, illustrated by the arrows in the model, but also other elements not depicted in the conceptual model; divergence (broad view of the problem), convergence (specification of the problem) and iteration. These elements will be further elaborated in the methodology section of this research.

2.9 Expectations

Before the execution of the research itself, there are certain expectations: it is expected that this research will result in a guideline for sports park design so that this guideline can be used for future park implementations and also as a guideline that rates already existing sports parks on their usability. In this, it is expected that the important aspects mentioned by previous research and case studies in the theoretical framework and conceptual model will play a prominent role.

3. Methodology

3.1 Method

To come up with a design guideline for creating new sports parks in neighbourhoods, the research-by-design approach is a good way since the research comes up with several designs that can be used as input for the most important aspect of implementing a sports park in a neighbourhood. Therefore this research will use this research by design method to answer the questions posed in the research question. This is a methodology that uses specific designs to explore opportunities for improvement (de Queiroz Barbosa et al., 2014). Research by design is defined by de Queiroz Barbos et al. (2014) as: “the type of academic investigation through which design is explored as a method of inquiry, by the development of a project and also exploring the different materials by which a design is carried out – sketches, mapping, among others”.

The research-by-design method can be seen as a method that makes use of evaluation and reflection of the designs (Hauberg, 2014). The designs posed in the process go through several iterations resulting in the best designs (Goncikowski, 2023).

Research by design, however, remains a topic in which different approaches are taken (Psarra et al., 2021). Despite this, some fundamental aspects of the research-by-design process are recognized: convergence, divergence, iteration and feedback loops (Psarra et al., 2021); The divergence phase means that at first a broad view is taken in which multiple points of view are studied. In the convergence phase, a more specific topic is chosen on which the study builds. Through feedback loops, these two phases are walked through multiple times to come up with several iterations while ultimately coming to one conclusion. This research followed an approach of the converge, divergence, iteration and feedback loops and also used ideation to come up with the best designs. The feedback loops can also be seen in the conceptual model in Figure 7/8. Ideation is a structured approach to creative thinking, where the goal is to produce different and many viable ideas and concepts (Knight et al., 2019). By using ideation, many initial designs will first be developed after which they will be improved by talking to peers and supervisors about how the design could be bettered.

The elements incorporated in the design are based on the literature and the case studies mentioned in the theoretical background. Via several iterations and adjustments, this research aims to come forward with the best designs for the neighbourhood. This is also what the design cycle of this research encompasses: after (an) element(s) of the design was/were made, an evaluation was conducted based on the literature and research question. If the design was still in line with these, other elements were introduced. This happened continuously until a final design was presented.

3.2 Triangulation

This research used two sources of data; literature review and case studies. By conducting a literature review, the most important aspects of how a sports park should be designed were researched. The case studies were used to find best practices in designing sports parks and taking elements from these cases. In this research, the findings from both the literature review and the case studies were combined to take the elements from both into designing the park itself.

3.3 Programs

This research used the program Inkscape to make the designs of the sports parks visual in maps and schematics. In this software, it is possible to make models and draw designs. Next to this program, two other programs were used: Sketchup and Lumion. These two programs were used to make 3D models of the proposed final design to show the design in more detail. For this, a rough 3D model was first made in Sketchup based on the map with the design made in Inkscape. Once the rough model in Sketchup was completed, Lumion was used to provide a more realistic look of the designs.

With the execution of the research, the feedback loop that was most used in the process was a new loop between the design and the case studies/literature review. This is shown in the conceptual model below as the two bold lines. The other feedback loops between the design and research question and between the concepts and the research question were also used but were not the predominant loop. A reason for the predominant use of this loop is that during the design, there was a continuous search for improvements and therefore, literature and case studies were used to find these improvements.

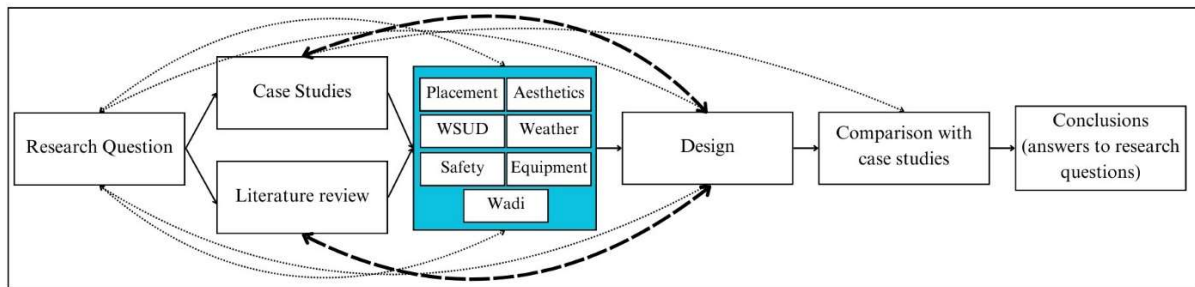


Figure 8: Conceptual Model (Made by the Author, 2024)

The designs that were made for the case are used as the data for this research. After the designs were presented in the result section, the design was evaluated via a comparison of similar cases in other cities/neighbourhoods. This forms the basis of the scientific contribution of this research.

3.4 Ethical considerations

Some of the main ethical considerations that are of relevance for this research are the use of the literature and the case studies used for the comparison. Since the research uses the comparison with case studies as the basis for the scientific contribution, the cases posed must be shown as accurately as possible. Other issues considering ethics can be the data storage during and after the research. To combat data storage issues like data breaches or accidentally leaking data to the internet, this research will store the data on local disks.

4. Results

In this section of the research, the design and the process behind the design will be discussed. For this, there will first be a short explanation of the chosen location and afterward, the process of the design will be explained in detail to show how the ideation process went and which approaches were used. After that, it will be shown how the process influenced the final design and what came out as the final design. There will also be further elaboration on how the final design can be implemented and the lessons learned from the design process will be discussed.

As mentioned in the theoretical framework, the reachability of a sports park is important for the success of it. To determine this, the area was investigated and scouted. In looking for the best place, there had to be enough space to place the sports park and it had to be in a central location so that most people in the neighbourhood could easily reach the park. In the map below, the chosen location is marked with a red dot (Figure 9). This location is roughly in the centre of Meerstad and also has enough empty space (the area is around 3 acres big) for the park to be placed there (as can be seen in Figure 10). Since the area is in the centre, it services most people in Meerstad so it is easily reachable for most of the residents.



Figure 9: Map with Designated Location (Made by the Author, 2024)



Figure 10: Designated Location (Taken by the Author, 2024)

Once the location was chosen, the design process could begin. In this process, several initial designs were made and continuously reiterated to finally come up with the final design. The process is summarized in the table below which shows which elements were used in which design. The process behind the choices made is shown in this section's subsections.

Design	Sufficient Sports Equipment	Colourful equipment/ fields	Greenery	Attention to Weather conditions	Attention for Safety	WSUD	Wadi's
1		X				X	
2		X					
3	X	X		X	X		
4	X	X	X	X	X	X	
5	X	X	X	X	X		
6 (Final)	X	X	X	X	X		X

Table 1: Elements Used in Designs (Made by the Author, 2024)

4.1 First design

The first design began with simply starting to draw up a design idea. In Figure 11 the first idea is depicted. In this design, the aspects coming from the literature of providing varied and sufficient sports equipment were the main drivers. Next to these aspects from the literature, the case studies of Rotterdam and Rio de Janeiro were taken as inspiration. In this first design, a basketball and football pitch combination was proposed while also providing space for fitness equipment. The basketball and football pitch is based on the WSUD principle of the water square in Rotterdam and Amsterdam: By providing both a sports field for people to play football or basketball on but also providing a basin for when floods occur, this pitch could serve two purposes at once. Next to this pitch, a field of artificial grass with fitness equipment was proposed so that people could also use these machines to work out, as a variety of possible activities is important for the success of the park. Artificial grass was chosen as the underground of this fitness area since that would mean less maintenance since a well-maintained park increases the attractiveness of the park and also the willingness of people to come to the park. Around both areas, trees are also placed to provide greenery and

several walking paths are in place to let people into the area from different points.



Figure 11: First Design (Made by the Author, 2024)

4.2 Second design

The second design was made with a similar approach of simply starting to draw out an idea. The second design is shown in Figure 12. This design also concentrated on the idea of providing varied and sufficient sports activities. In this design, however, an approach with a surrounding track for running was proposed. Within this track, a halfcourt for football and/or basketball is placed while also still providing a space for fitness equipment. In this design, there is less space for greenery and there are also fewer walking paths to access the park. This design does provide an extra activity but it does, however, provide less greenery and thus attractiveness to the park.



Figure 12: Second Design (Made by the Author, 2024)

4.3 Third and Fourth Designs

The third and fourth designs were designs that were inspired and made in a design workshop. In this workshop, after discussions with the supervisors, two new preliminary designs were made in which several new ideas that were not thought of before were implemented in the design. The main point that came forward in the discussions was that the designs that were already existing (designs 1 and 2) needed to be expanded more to make more use and better use of the space available. Next to this, the discussions made clear that some bolder design choices could help in making the park better. The designs are represented in the images below. In the third design (Figure 13), a fountain (blue circle in the middle) is placed in the middle of the park so that there is a central area where people can get around and it also gives a more aesthetically pleasing view of the sports park. Next to this, a football pitch is placed above the fountain and a halfcourt to the right of the fountain. There is also still space for fitness equipment on the left (the coloured circles). Next to these aspects, there is also more place for greenery in the form of hedgerows and more trees. The hedgerows are placed around the park to create a separate area distinguishing the park from its surroundings. The fourth design (Figure 14) uses canals accompanied by bridges, that go from the already existing lake of Meerstad, to make the area a more separate park. In this design, a fountain is placed at the entrance of the area. Next to this, a WSUD-based football and basketball pitch is placed similar to the second design. There is also a tennis court and fitness area. The biggest difference between this design and the second design is that there is an extra tennis court and that the trees are placed more strategically. The trees are placed differently to accommodate better for wind protection and also shade while not completely enclosing the fields so that the people can still have a sense of safety. These two aspects of wind protection/shade and a sense of safety came forward from the discussions in the workshop as important factors to

take into account with the design. After some further research these two factors were also mentioned in the literature to take into account and therefore they were used in this design.

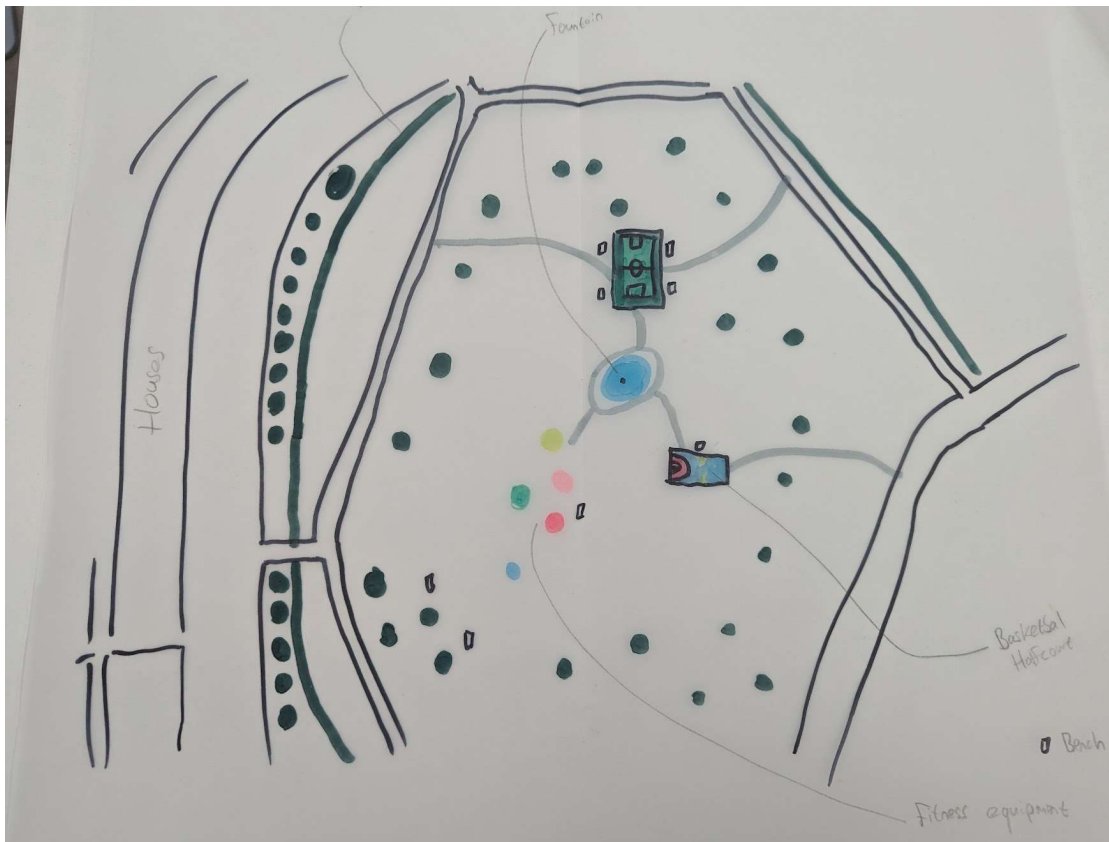


Figure 13: Third Design (Made by the Author, 2024)

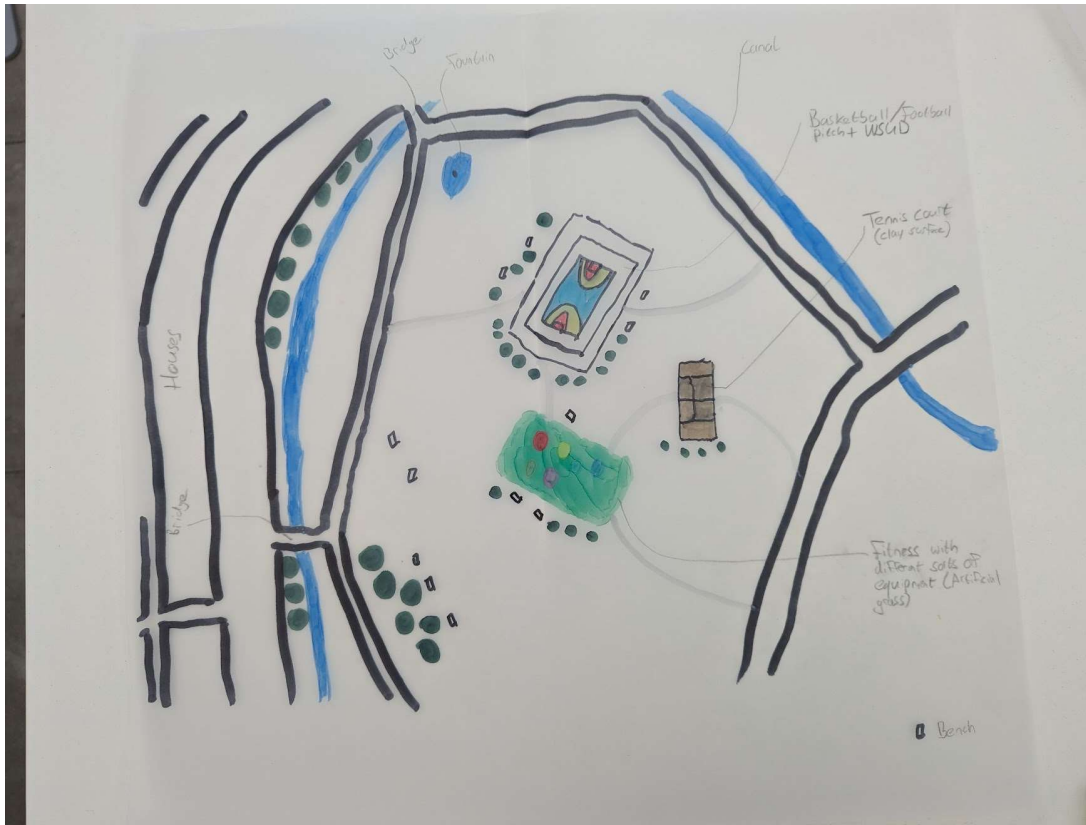


Figure 14: Fourth Design (Made by the Author, 2024)

4.4 Fifth design

After presenting the previously mentioned designs in a discussion session with several other researchers, some other insights came to light: The main insight was that a water square as proposed in the second and fourth designs was more meant for an urbanized area and since the Meerstad area already has a lake, it would not be necessary to put in such a measure since it would not work like the way it is meant to. Other elements, however, from the third and fourth designs were still used as the inspiration for the fifth design. As seen in Figure 15, the basketball/football pitch remains at the same spot but without the water square design. Next to this the fitness area and tennis court are still at the same spot as the fourth design as well. Another change is the water fountain in the middle of the park instead of at the entrance. Lastly, there are also some more trees placed in the park to provide more greenery.

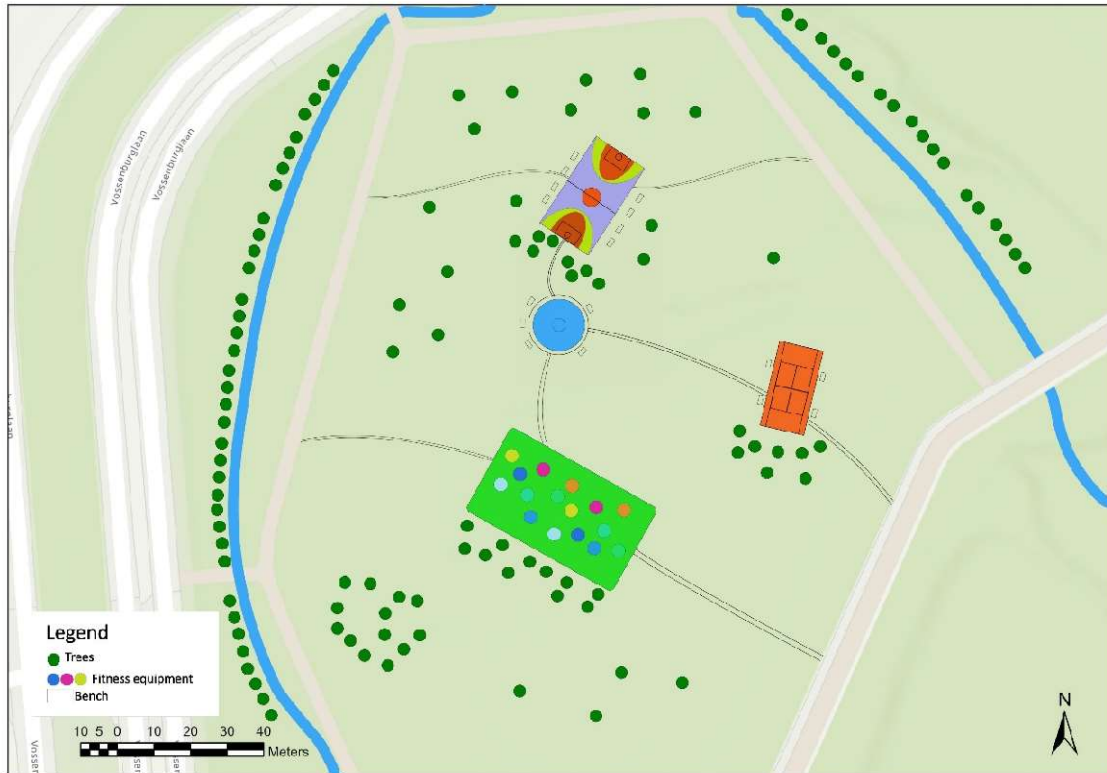


Figure 15: Fifth Design (Made by the Author, 2024)

4.5 Final Design

The final design presented here is a combination of all the lessons learned from the previous designs and is also an accumulation of the case studies and literature. The design was updated from the fifth design after a discussion with the supervisor on how to improve the park's design. In this design, a new element is added to give the sports park a dual purpose: the wadi or swale. By adding a wadi, this design will provide both a nice and biodiverse environment for the people to come to, as well as protection from heavy rainfall. Next to this addition, most of the elements of the fifth design are used. The map below (Figure 16) shows the final design in a schematic. Many of the design elements are taken from the fifth design, but next to that the wadi/swale areas are implemented at the four arms reaching a newly placed amphitheatre. This amphitheatre can be used as an additional public space in the park while also providing storage space for water following the WSUD principle. The wadis are all connected via a drainpipe and this amphitheatre so that they can take excess water from the other arms to decrease the load when there is extreme weather. The four arms of the wadis are also connected to the surrounding canals so that excess water can flow through to the canal and into the lake. It also increases people's willingness to come to the park since there is more greenery which is an indicator of how likely it is that people will come to the park. Next to this, more seating space, greenery and a new padel court are implemented in the design to make the park more attractive for residents to visit.

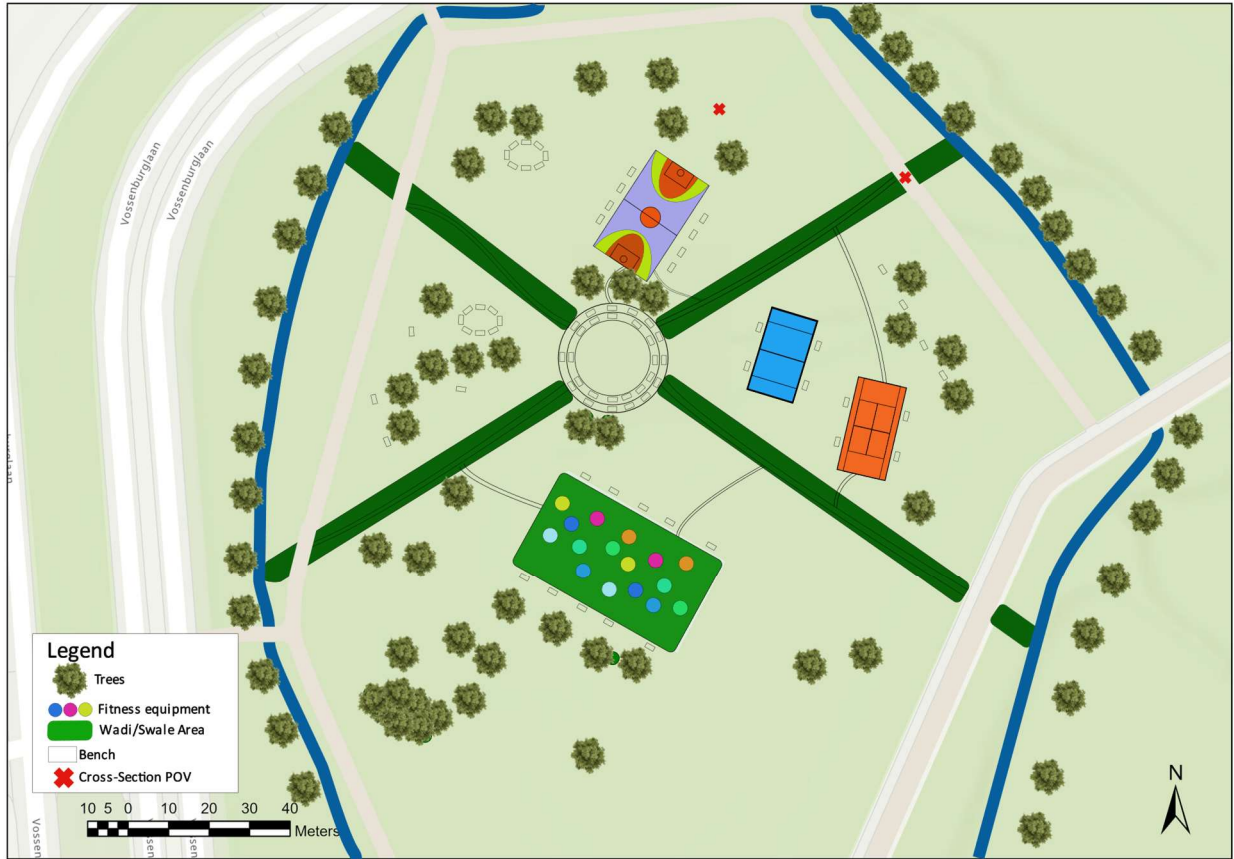


Figure 16: Final Design (Made by the Author, 2024)

In Figure 17, a cross-section of how a wadi operates is shown; when it has rained, the water is collected in the lower laying ground after which it goes through the ground and aggregate so that it gets filtered. After the filtering, the water seeps through the geotextile layer which only lets the water through. When there is too much water buildup, there is an overflow outlet that leads to a drainage pipe that can transport the excess water. In the case of the park in Meerstad, the water goes to the surrounding canal and through the canal to the lake.

Next to the cross-section of the wadi-operation, a cross-section is shown below in Figure 18 of how the wadis look in the park with the surrounding sports facilities. In this image, the wadis surrounding the basketball/football court and amphitheatre are displayed.

The places of both cross-sections are also marked in the map of the final design.

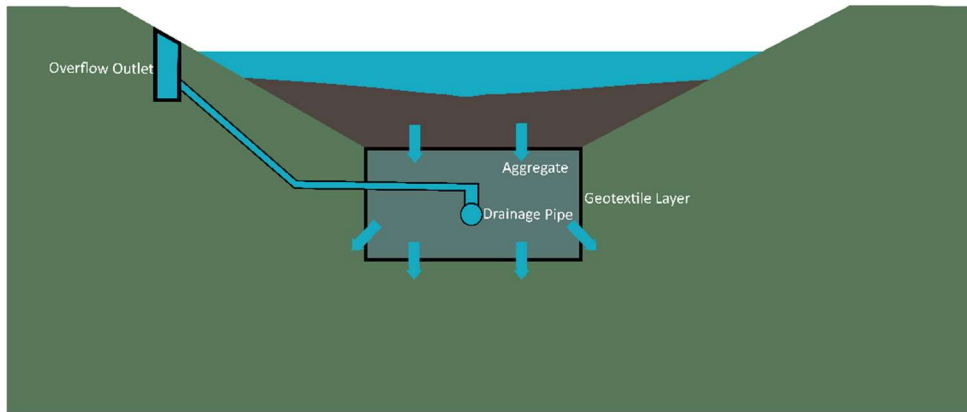


Figure 17: Wadi-operation (Made by the Author, 2024)



Figure 18: Wadi in the Sports Park (Made by the Author, 2024)

In Figures 19-26, the different sections of the parks are depicted in a 3D model. The wadi is also depicted and shows how it acts in two different situations: during a heavy rainfall (Figure 22) event in which the water is stored in the wadi and when the weather is clear (Figure 23). As mentioned in the theoretical framework, a wadi increases the biodiversity in the area, this will lead to better health. Next to that, the wadi also filters pollutants and provides nutrients for plants.

The different weather conditions are also shown for the amphitheatre (Figures 19-21). The amphitheatre has different levels in which the water can be stored: at the lowest level, the level can hold 83 m³ of water when filled (Figure 20). The second level reaches through to the ground level and can hold 174 m³ of water when filled (Figure 19). This means that the amphitheatre can hold a total amount of 257 m³ of water when filled. To make sure that the water can also flow away, drainage holes are implemented at the lowest level and connected to the drainage pipes in the wadis. These holes can be opened or closed when necessary.

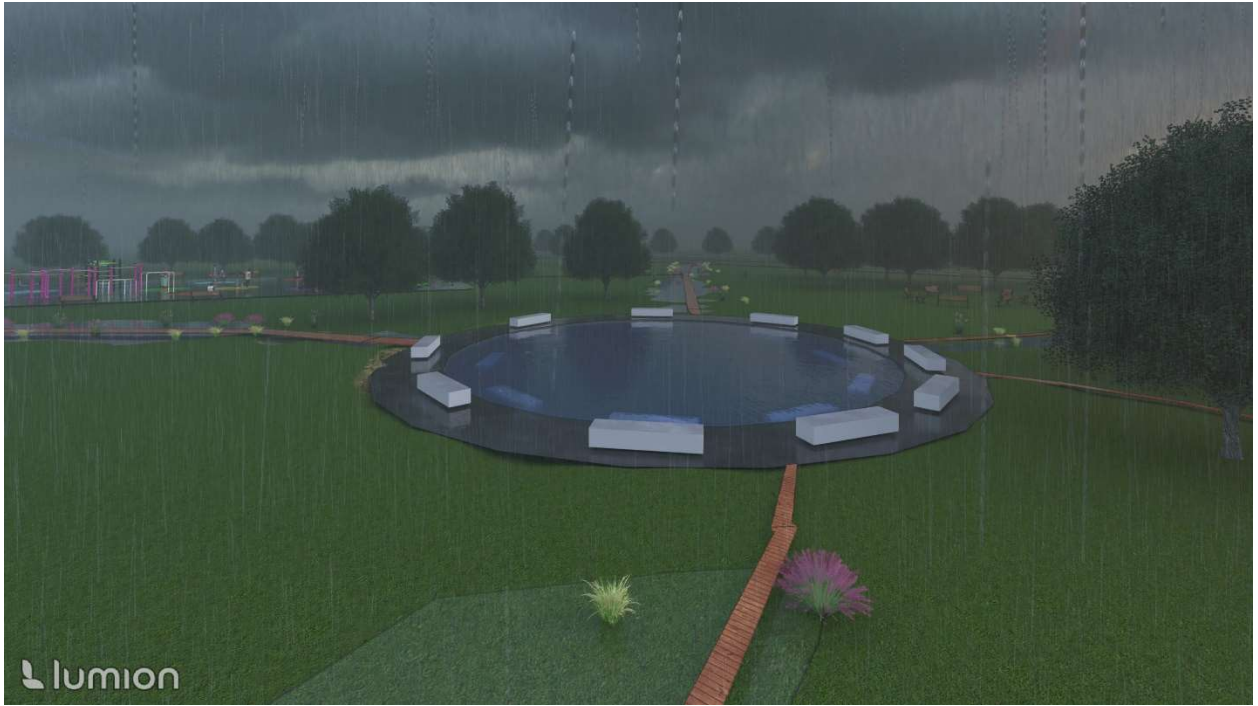


Figure 19: Amphitheatre Heavy Rain (Made by the Author, 2024)



Figure 20: Amphitheatre Rain (Made by the Author, 2024)



Figure 21: Amphitheatre Dry (Made by the Author, 2024)



Figure 22: Wadi Heavy Rain (Made by the Author, 2024)



Figure 23: Wadi Dry (Made by the Author, 2024)



Figure 24: Basketball/Football Court (Made by the Author, 2024)



Figure 25: Fitness Equipment (Made by the Author, 2024)



Figure 26: Tennis and Padel Court (Made by the Author, 2024)

5. Conclusion

This research had the goal of finding an answer to the research question: In what ways can sports parks contribute to the design of a healthy neighbourhood? To find out the answer to this question, a second question was proposed: Which design elements are needed to optimally design a sports park in a neighbourhood? In this research, several elements came forward through the literature review, case studies and the ideation process. These elements are the placement of the park, park aesthetics, feeling of safety of the visitor, sufficient equipment, weather resistance and climate adaptation measures such as WSUD and wadis. Comparing the final design of this research to other case studies, it shows that the final design is an enumeration of several case studies with the addition of elements found in the literature. When looking at the water square in Rotterdam for example, the location plays a big role; since the water square in Rotterdam is based in a more urbanized area, a water square makes more sense. When looking at Meerstad however, the neighbourhood is not as urbanized and not as dense with more greenery and space for greenery. Since there is more space for greenery and a lake close by, it doesn't make sense to implement the water square in Meerstad.

In the case of the multiple different coloured sports fields in Rio de Janeiro, the park designed in this research is more of a whole in the sense that it has several fields and places that are combined in one park whereas the fields in Rio de Janeiro are more scattered and don't make a park on themselves.

Finally, considering the wadi based in Helpermaar, the wadi is more to make the streets climate adaptive and doesn't make it a part of a bigger whole.

All in all, this research has combined several ideas from best practices, together with elements from the literature to come forward with a guidebook of sorts to look for how a sports park should be designed to contribute to a healthy neighbourhood.

For a sports park to contribute to a healthy neighbourhood, the design elements mentioned before need to be taken into account. If a sports park is designed it is, however, highly context-dependent in what ways the elements need to be implemented. Taking the Rotterdam and Meerstad case side to side, for example, some things are not feasible to implement at one location while it might be on the other (the water square design). Therefore it has to be noted that a good look at the context should be taken to look for what works best for the chosen location. Some of the elements, however, can be applied to most parks such as good accessibility to the park and park aesthetics. The best way to look at the context-dependent factors is to involve other people in the design, whether this be experts or people in the neighbourhood.

In this study, it has to be noted that due to the limited time, extensive conversations and consultations with residents of the neighbourhood were not taken into account. Further studies should look into this and how this could influence the elements that are needed to benefit the success of the sports park. When trying to make for a healthy neighbourhood, however, sports parks can, through their design for the specific context, help provide more physical activity and therefore healthier people and a healthy neighbourhood.

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