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Multifunctional Flood Defense Structures

An Integrated Benefit Calculation Method

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Abbreviations

MFFDs: Multifunctional flood defense structures
CBA: Cost benefit analysis
NPV: Net present value

1.0 *Introduction*

The Netherlands is situated in the delta region of the Rhine, Meuse, Scheldt, and Ems rivers and has a long history of fighting the water element. Large parts have been developed alongside a river and in the most cases they lie below the sea level. As a result, the threat of a possible flood is always dominant. The economic development and population growth have increased the potential consequences of a flood event since more people and property are at risk of flooding. Moreover, the flood risk in urbanized areas is influenced by climate change. It is expected that the probability of flooding will increase due to the effects of climate change [1]. In addition, the rapid urban development, the consistent need for space and the increase in the number of people at risk in low-lying areas lead to the need for new dyke reinforcement technologies and new dyke designs. Therefore, instead of trying to enhance and enrich the already existing dykes by heightening up the walls or taking any other kind of measures; the new concept suggests the design of multifunctional flood defenses. The multifunctional dyke concept combines other functions with the primary flood protection function. In practice, incorporation of multiple functions requires over-dimensioning and may thereby help to create a robust dyke [2].

Nowadays, this design concept of multifunctional dyke has become increasingly popular among municipalities and private organizations since they want to implement solutions that will provide safety to the citizens but also be financially beneficial for them. Especially in urban areas, the opportunity of integrating housing, transport or infrastructure into a multifunctional flood defense is attractive in terms of efficient use of available space [3].

Although the benefits from the construction of MFFDs have been recognized by many authors and experts in the construction field, it is still difficult to take these benefits into account during the decision making process of a project and include them in a cost benefit analysis (CBA). This difficulty is mainly due to insufficent ways to calculate these benefits. In particular, there are no established methods that provide the calculation of these benenfits directly. As a result it is common that decision makers think that multifunctionality leads to extra construction costs without considering the benefits that could derive from such projects. Therefore, one of the challenges behind the construction of MFFDs is to identify the potential benefits from this design concept and incorporate their calculation in a CBA during the decision making process. The latter requires the use of methods, suitable for the calculation of these benefits. In this way, decision makers will be able to take into account not only the costs but also the potential benefits that could affect the project without rejecting alternatives due to “inaccurate information”.

The focus of this research is to present the potential benefits that could be the result from the implementation of MFFDs, identify methods within the literature that could be used in order to calculate these benefits and develop an integrated method to calculate the benefits from MFFDs. In particular, the next section (section 2) presents the goal of this research and the research questions that will support the accomplishment of this goal. The next section (section 3) presents an overview of the benefits found in the existing literature and underlines the literature gap regarding the method of benefit calculation for MFFDs while section 4 explains the research method that we followed. Next, we explain how we will mitigate this gap (section 5) by presenting the integrated method for the benefit calculation in MFFDs. By implementing this method into a real project (section 6), we will check if this calculation is feasible and we conclude to some useful results but also suggestions for further steps to this direction (section 7).

2.0 *Research Model*

Research goal

The goal of this research is to develop an integrated method to calculate the benefits, derived from the construction of MFFDs.

To achieve the research goal, the following research questions should be answered:

- What are the main potential benefits that derive from the construction of MFFDs?
- Which methods could be applicable to calculate the benefits?
- How these benefits can be calculated with an integrated method and consequently included in a CBA?

3.0 *Theoretical Points of Departure*

The literature review is the starting point of our research. First, we describe the different multifunctional design concepts and the kinds of functions that could accommodate. Then, a description of the benefits from MFFDs that have been already identified in previous studies follows. The section is concluded with methods that have been applied in other kinds of projects in order to calculate similar benefits but for different purposes.

3.1 Multifunctional Design concepts

There are several design concepts for multifunctional defenses that could accommodate some extra functions and consequently generate benefits. These concepts include the construction of a technical solution which provides the necessary flood protection and simultaneously provides space for other functions [4]. The table below presents these concepts with the possible functions that can be integrated [4]:

Multifunctional Design	Possible Integrated functions
Coffer dam	- Infrastructural functions - Recreational functions - Green functions - Nautical functions
L-wall	- Infrastructural functions - Living functions - Industrial functions - Business functions
Soil retaining wall	- Infrastructural functions - Living functions - Industrial functions - Business functions - Recreational functions - Green functions - Nautical functions - Agricultural functions
Over sizing inner and outer slope	- All the functions are possible
Step dyke	- Infrastructural functions - Recreational functions - Green functions - Nautical functions

Table 1: Multifunctional designs with possible integrated functions

The exploitation of these functions could bring significant revenues. The next section describes the benefits that could derive from these functions as a part of a CBA.

3.2 Benefits of MFFDs in CBA

CBA is an economic tool that is usually used for project evaluation. CBA is the examination of a decision in terms of its consequences or costs and benefits [5]. These costs and benefits are quantified as much as possible and expressed in monetary terms. Costs and benefits occur in different years within the time horizon of the CBA. To deal with this, they are presented as so-called net present values (NPV) [6].

The NPV is one of the most important and reliable indicator and should be used as the main reference economic performance signal for project appraisal [31]. This indicator calculates the difference between the required costs for the project and the expected benefits from its implementation. If the NPV>0, then we can proceed to the construction of the project but if the

NPV<0, then normally the project should be rejected. However, in some exceptional cases, a project with a negative NPV could be accepted if there are important non-monetized benefits (e.g. for biodiversity preservation projects, cultural heritage sites, landscape) [31]. MFFDs could belong to this category since many of the benefits cannot easily be counted in monetary values.

A CBA can be carried out to assess the profitability of a project by comparing the required costs for the project with the expected benefits. The basic principle of CBA requires that a project results in an increase of societal welfare, i.e. the societal benefits generated by the project should exceed the costs of it [7].

In the existing literature, there are several studies [8], [3], [4], [7], [9], [10] that point out the benefits that could be derived from the construction of MFFDs or from the multifunctionality in general. These benefits could be grouped to two main categories, the direct and the indirect benefits. The table below presents the overview of these benefits.

Benefits from MFFDs	
Indirect Benefits	**Direct Benefits**
1. Safety: Reduction of flood risk as a result of decreasing the probability of failure	1. Added value in the relevant area.
2. Cost Savings from avoiding flood damage	2. More available space, effective use of space
	3. Benefits from secondary functions (ways to realize the real estate).
	4. Cost saving through Constructional combination: use of the same building materials for both the dyke reinforcement and the construction of functions. Positive construction synergies, method: “making work with work”. Since more stakeholders are involved to MFFD projects, it is possible to share costs and benefit from this collaboration.
	5. New revenues from Operational Combination. Multiple use of space.
	6. Use of the same materials to upkeep both the dyke and the functions.
	7. Unbreachable dyke -> stronger dyke: fewer or none adjustments in the future.
	8. Recreational benefits

Table 2: Benefits from MFFDs

The *indirect benefit*s include the high level of safety and the costs that could be saved from damage avoidance. Multifunctional dykes are usually unbreachable and over-dimensioned. By constructing an unbreachable dyke the risk of total failure and subsequent total inundation is virtually zero and consequently the flood risk significantly reduced [10]. Therefore, an unbreachable dyke means a stronger dyke. This means that the dyke will need fewer or none adjustments in the future, which could reduce the maintenance costs [10]. In addition, by reducing the flood risk, we also avoid significant damage costs from a possible flood. There are several studies [11], [7], [12], [13] that analyze and calculate the benefits from avoiding flood since this benefit derives from any flood defense, either monofunctional or multifunctional. Therefore, in the terms of this research, we will not include these benefits in the integrated methods that we will develop.

On the contrary, we will focus on the *direct benefits* that could derive from the construction of MFFDs. These benefits can be considered as more commercial and financial since these benefits could affect the financial performance of a project. There are several researchers that have mentioned these benefits in previous studies [10], [2], [8]. Most of these benefits concern the extra space that becomes available which could be used effectively by accommodating various functions. In this way, the value of the area is increased while new ways to realize real estate are developed since multifunctional projects usually determine the new market price of land at the location and the change in the producer and consumer surplus as a result of the project. This happens because the multifunctional projects make extra space available for construction [9]. We estimate this effect by deriving the residual value of land in the project area from the expected value of the real estate to be constructed. This approach is also being used by municipalities in determining the rents for newly issued land.

Another *direct benefit* has to do with the phase of construction of MFFDs. In particular, we can have significant cost savings through the constructional combination [8]. This benefit can be considered twofold. On the one hand, the same building materials for both the dyke reinforcement and the construction of functions can be used and lead to cost savings. This method is also called “making work with work” [8] [4]. On the other hand, this kind of projects requires the participation of several stakeholders. This means that except from the water board or the municipalities, there could be also private or public investors that are interested in investing on extra commercial functions since this kind of development can generate benefits for them as well. Therefore, these stakeholders become shareholders by sharing the construction and maintenance costs for the project. Apart from the constructional combination, the operational combination could be also considered as a benefit. The multiple use of space serves multiple needs while the functions could enhance the reinforcement of the flood defense and the other way round, the flood defenses help to retain or increase the value of the functions, improving social cohesion [8]. In addition, the same materials could be used to upkeep both the dyke and the extra functions due to this operational combination [8].

The benefits from the exploitation of recreational functions could also be considered as *direct benefits*. The term 'recreation benefits' covers benefits arising from the enjoyment of landscape, wildlife and natural amenities as well as from the enjoyment of recreational activities. A multifunctional dyke can accommodate several recreational functions such as parks, boulevards or shopping buildings [4]. These functions will affect the value of the river or coast for recreational uses [12].

Most of these benefits are not included or fully included in CBA for potential multifunctional projects and consequently this design solution is often considered as expensive and unattractive. The economic challenges behind this opinion concern mainly the non-repetitive benefits that are delayed, dispersed, non-guaranteed and non-financial. These challenges hamper the willingness and the ability of private sector parties to invest in multifunctional projects [14]. Therefore, quite "traditional" solutions are prevalent [14].

Important to this research is to mitigate this gap by suggesting an integrated method to calculate the main benefits so that this calculation could be included in a CBA for MFFDs. We will pay special attention to the benefits that according to the literature are more frequent in MFFDs and have direct financial effect on the project. However, it is beyond the scope of this research to discuss the calculation of all the possible benefits. The benefits we consider in this research are: 1) benefits from the real estate realization, 2) benefits from the constructional combination, 3) recreational benefits and 4) benefits that derive from the added value in the relevant area. The next section presents methods for the calculation of benefits that have been identified in the literature and have been implemented in other kinds of projects.

3.3 Methods to calculate the benefits

There are several studies in different research fields that introduce methods to calculate similar benefits but in different kinds of projects (infrastructure, recreational, flood defense etc.). Therefore, these methods could also be suitable and become the basis for the calculation of the benefits from MFFDs. These methods are: the comparing rental value method, the travel cost method, the asset valuation method and the comparing alternatives method.

The *comparing rental value method* compares an object with another similar object. In the case of MFFDs, buildings or land are compared that could be used multifunctionally. In particular, Oderker et al. [4] present a CBA of different alternatives within a project, multifunctional or not, and they used the *comparing rental value* method to calculate and compare the benefits from rent or sale of the land among the alternatives. In addition Besseling et al. [9]

implemented this method in the infrastructure multifunctional project in the Amsterdam South Axis area to calculate the benefits from the rent of office and the sale of the dwellings that became available from the multifunctional land use.

The *travel cost method (TCM)* is a method that is mainly used to calculate recreational benefits. In this method, we collect data about the travel costs associated with accessing the amenity or recreational site. The travel cost method involves collecting data on the costs incurred by each individual in travelling to the recreational site or amenity. This method normally requires a survey on the field of the amenity. In particular, questionnaires are distributed to the visitors of the amenity; including questions about the price that each of them is willing to pay to visit this amenity. This 'price' paid by visitors is unique to each individual, and is calculated by summing the travel costs from each individuals original location to the amenity. By aggregating the observed travel costs associated with a number of individuals accessing the amenity a demand curve can be estimated, and as such a price can be obtained for the non-price amenity [15].

To calculate the value of the asset with this method, we use the following equation:

$V = (T*w) + (D*v) + Ca$

Where,

T = travel time in hours
w = average wage rate (€/hour)
D = distance (in km)
v = marginal vehicle operating costs
Ca = cost of Admission to asset

There are studies [16], [17], [18], [19], [20], [21] which used this method to calculate the recreational value of a natural coastal area or the recreational beach use. In particular, Voke et al. [17] used the TCM to associate financial values with non-marketed aspects of the marine environment while Rolfe et al. [21] used this method to calculate the benefits form a visit to a beach along the coastline adjacent to the Great Barrier Reef in Australia. Also, this method has been applied in studies that aimed to calculate the recreational benefits from parks or lakes [22], [23], [24], [25]. In particular, Turpie et al. [24] calculated the benefits of a change in river quality on the tourism value of Kruger National Park in South Africa while Fleming et al. [23] used the TCM to calculate the recreational value of lake McKenzie in Australia and the method yields recreational values of the Lake ranging from $13.7 M. to $31.8 M per annum, or from $104.30 to $242.84 per-person per-visit.

The *comparing alternatives method* has been used to calculate benefits coming from constructional combination. This method was applied by researchers that wanted to compare the costs and the benefits of several alternatives for the same project in order to conclude to the most beneficial one. For example, Rik Jonker et al. [8] claim that on MFFDs, to find out which solution is more cost-effective, two alternatives should be examined: The costs and the benefits from the simultaneous construction of the dyke and the functions (constructional combination) should be compared with the ones from the separate developments. Also, Besseling et al. [9] used the same comparing method to find out the benefits from the multifunctional land use and the simultaneous construction of all functions in the Amsterdam South Axis area.

The same researchers [9] used also the *asset valuation method* to calculate the residual value of the land. The asset valuation method uses changes in the value of assets to estimate the benefits or costs of a project. The size of a price increase can be used to estimate the benefit of a project, and similarly the size of a price decrease can be used to measure the costs of a project or negative externality. They explained that the residential value can be derived as a balance of the net revenues of the real estate development of the land and the costs that must be made to make the land ready for building. The net revenues of the real estate development equal in their turn the balance of the revenues from exploitation of the real estate and the development/building costs and the costs of maintenance. A normal return to the capital constitutes a part of the development/ building costs.

The benefits that are calculated with these methods refer to year 0. However, the benefits should be calculated for the whole life cycle of the function. Therefore, the benefits should be calculated for all the years of the life cycle and be converted in prevent values. In order to do that, we use the discounting technique which converts all costs and benefits that occur in different time periods to present values so that they can be compared [4]. The present value of benefits is calculated as follows [15]:

$$PV = \frac{F}{(1+r)^n}$$

Where,

PV = present value
F = future value of cost or benefit in monetary terms
r = the rate of discount
n = no. of periods under consideration (e.g. years)
For cases that the functions will last for multiple years, the formula that we use is the following:

$$PV = \sum \frac{F}{(1+r)^n}$$

In the next section, we will describe the research method that we followed in our research.

4.0 Research Method

In order to achieve the research goal, we conducted a case study. In particular, we used two different methods to collect the necessary data: 1) literature review and 2) documents from past projects. We decided to use this methodological triangulation and combine these methods of data gathering in order to ensure the validity of the research. In this way, we will check if the data of these different approaches match and we will be able to cross-check our findings [26]. The figure below presents the process that we followed.

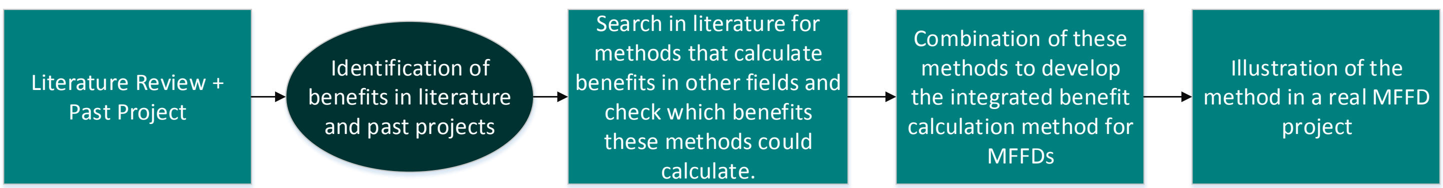

Figure 1: Research method

Literature review + Past projects ⟶ Identification of benefits

The first step in our research was to identify the benefits from MFFDs that have been recognized in the existing literature and in past projects. The focus of our research was mainly on benefits that could be translated in monetary values and consequently could affect the financial perspective of the project. Consequently, we didn't include benefits that are also derived from monofunctional flood defenses such as the avoided damage from a potential flood or the number of human lives that become safe due to flood defense. On the contrary, we identified several commercial benefits in the existing literature and in past projects and we wanted to check which of them were most frequent in these two sources.

Therefore, we examined four *past projects* from the Municipality of Rotterdam which included the implementation of multifunctional flood defense structures. We selected these cases in order to identify the benefits that were realized in these projects and add or verify the results from the literature review. The chosen past projects from the Municipality of Rotterdam were the following: the "Noordendijk Dordrecht", the "Boompjes", the "Stadionpark" and the "Brielse laan". We chose these cases because they cover a significant range of possible multifunctional solutions, different kinds of integration and they explain the need to balance the costs and the benefits behind these projects.

By using these cases we were able to identify the benefits that may derive from these projects since they do not only ensure the required flood protection but they also provide benefits from the exploitation of the space that becomes available. When we gathered all the benefits from these two sources, we made a list and we compared these benefits in order to find out the most frequent that our integrated method should focus on. Also, we wanted to include benefits that could affect directly the financial perspective of the project and could contribute to the final decision during the decision making process.

Benefit calculation methods in the existing literature → Develop the integrated benefit calculation method for MFFDs

After the identification of the benefits, we searched methods in the existing literature that could calculate these benefits separately and normally in other fields but could be applicable in the case of MFFDs. We found four different methods which could calculate four of the identified benefits. These methods were (1) the comparing rental value method, (2) the travel cost method, (3) the asset valuation method and (4) the comparing alternatives method and the benefits that these methods could calculate were (1) benefits from the real estate realization, (2) recreational benefits (3) benefits that derive from the added value in the relevant area and (4) benefits from the constructional combination.

The next step was to combine these methods in order to develop the integrated benefit calculation method for MFFDs. To integrate these methods we combined the necessary data for the calculation of each benefit such as the available land, the land prices, the travel costs or the possible cost savings and we used them as a basis in order to develop the overall method that could lead to an efficient calculation of the benefits from MFFDs. Since each of the benefits is unique, it was not feasible to use only one of these methods to calculate all the benefits at once. On the contrary, all these methods together will provide a complete first impression for the benefits that we could expect from the construction of MFFDs and will enhance the decision making process in the comparison between the costs and the benefits of the project. The integration process can be divided into three steps: (1) identify the required data and formulas for the calculation of each benefit, found in existing literature, (2) calculate all the benefits for year 0 and the PV of these benefits for the whole life cycle of the project, and (3) combine all the calculations for the integrated benefit calculation method to a final proforma.

Illustration of the method in a real MFFD project

The final step was the validation of the method. Therefore, we illustrated the method in a real MFFD case. In this way, we would be able to test if and how the method could work in reality and realize if the calculation of the benefits from MFFDs was feasible by using this method.

We chose the project "Wateregcentrum Hoek van Holland, Kaap de Goede Hoek". Some of the benefits that we calculated were realized in this project like the real estate benefits and some of them were not. However, none of these benefits have been calculated for this project in the past and therefore we suggest how we could calculate them by using the integrated benefit calculation method in order to include their calculation in a CBA.

The outcome of the research is presented in the next section where the suggested method for the calculation of the benefits from MFFDs is described while in section 6 an illustration example of this method in a case of MFFD project follows. Our results as well as their theoretical and practical implications are further discussed in section 7.

5.0 *Method to calculate the benefits in MFFDs*

The figure below presents the process of calculation and then we describe how the method works.

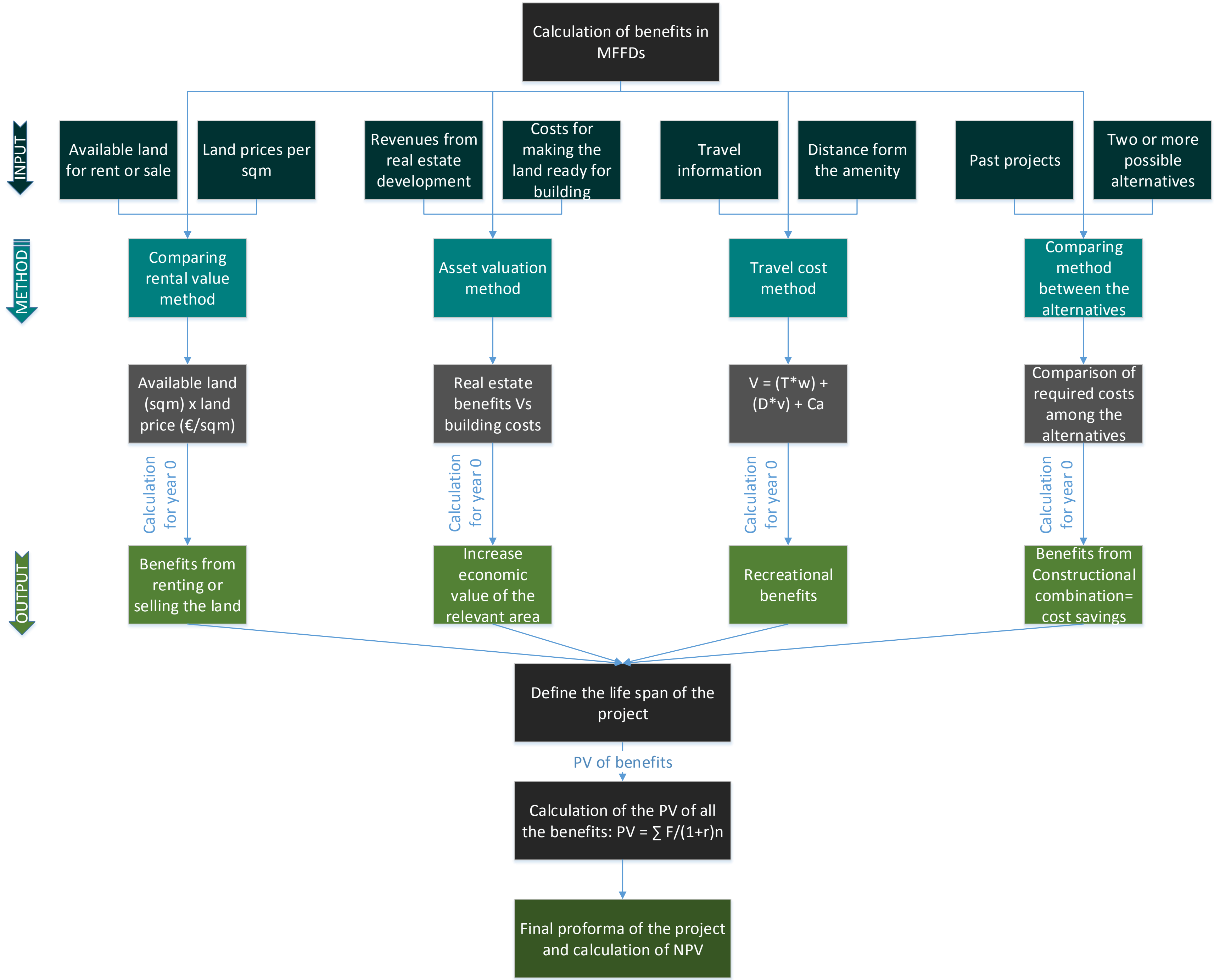

Figure 2: Integrated benefit calculation method for MFFDs

First, we should identify the required data for the calculation of each benefit. In particular, to apply the *comparing rental value method* and calculate the benefits from renting or selling the land that becomes available, we should know the extra space that becomes available due to the multifunctional construction. Also, we need the rent/sale prices of this land per m^2. Then we can calculate these benefits by multiplying the available land with the land prices. For the *asset valuation method,* we need first to calculate the revenues of the real estate development and the costs of making the land ready for building [9]. Then, we can calculate the increase in the economic value of the area as a balance between the real estate benefits and the building costs. To apply the TCM and calculate the recreational benefits from extra functions like parks or amenities on the top or next to the dyke, we should set travel zones around the amenity. Then, we should identify travel information such as fuel costs, travel time and visits per year as well as the distance between these travel zones and the amenity. The formula which calculates the recreational value of the amenity is the following:

$$V = (T*w) + (D*v) + Ca$$

Where,

T = travel time in hours
w = average wage rate (€/hour)
D = distance (in km)
v = marginal vehicle operating costs
Ca = cost of Admission to asset

For the *comparing alternatives method,* we should compare different alternatives based on the required costs and the expected benefits and calculate the benefits that could derive from the constructional combination. In particular, the potential benefits that we want to calculate with this method are the cost savings that we could have due to the constructional combination. Therefore, to apply this method, we need first to identify the alternatives. In the case of MFFDs we want to compare the required costs for the simultaneous construction of the dyke and the extra functions in comparison with their separate construction. Evidence from past multifunctional projects could also enhance this comparison. In this way, we will be able to identify if and how much money we can save from this constructional combination.

After the identification of the above necessary data and the use of the methods, we calculate each of these benefits for the year 0. Since all the benefits have been calculated for the year 0, we need to calculate the present value of these benefits for the whole life cycle of the project. Therefore, we should first define the lifespan of the dyke and the functions and convert the results into present values. We will do that by applying the following formula:

$$PV = \sum \frac{F}{(1+r)^n}$$

Where,

PV = present value
F = future value of cost or benefit in monetary terms
r = the rate of discount
n = no. of periods under consideration (e.g. years)

The calculation of the benefits leads to the final proforma of the project. The proforma is a cash flow of the benefits for the whole life cycle of the project. This proforma gathers together all the benefits that we could expect from the project and therefore can be a part of a CBA. The final step is to calculate the NPV to check if it is positive or negative. The NPV can be calculated by using the following equation:

NPV = Total discounted benefits – Total discounted costs

In the next section, we present an illustration example of the integrated benefit calculation method in a real MFFD project.

6.0 How this method could work in reality? Illustration of the benefit calculation method in a MFFD

To check how the integrated benefit calculation method could be used to calculate the benefits from MFFDs, we applied it in a real MFFD project. The project 'Waterwegcentrum (Waterway Centre) Hoek van Holland' gave rise to the idea of the 'step dyke' (figure 1). Through the use of vertical walls, diaphragm walls or sheet piling, no space-demanding embankments are needed with dyke reinforcement, so the available horizontal surface can be designed efficiently for urban use [8]. In combination with the use of flood defense, there will be space for urban functions.

Urban functions are even strengthened as new space is created, for example also with roads which have been better integrated and cause less nuisance to the citizens in the area. Moreover, the function of flood defense is further reinforced if the urban functions contribute towards the strength of the flood defenses. That is possible, for example, by creating a park on the bottom 'step of the ladder', which can absorb the initial flooding in a simple way [8]. Other than that, the multifunctionality in this project can be characterized as "structural integration" since the functions could be built on, in or under the flood defense structure, but does not directly retain water [27].

In addition, this project can also include tourism and recreational functions, housing, transport and public amenities in a coordinated way [28]. The project consists of an eastern and western planning area: The eastern planning area ("Waterwegcentrum Oost") includes the construction of 550 new houses as well as shops, hotel and catering facilities. In the western planning area (Kaap de Goede Hoek, westelijk deel), a new dune area will be created. On both sides of the dune, 165 dwellings will be constructed and some apartment buildings [29].

Figure 3: "Step Dyke"

The plan area covers about 80 hectares where dwellings will be built at low densities, bringing more life to the area and broadening the economic base for the shops and facilities in the village. Extending the railway line from Rotterdam right up to the beach will encourage more people to travel to the beach by public transport [28]. The most important tourist attractions and facilities include new shops in the village and on the beach, various museums and commercial tourist attractions, including hotels, cafes and restaurants [28]. All these functions will bring benefits to the area. In the next section, we present how some of these benefits, included in the project, could be calculated. In particular, we examine the benefits coming from the rent or sale of the available area, the benefits from the increase in the economic value of the relevant area, the recreational benefits that derive from a visit to the park on the top of the dyke or to the beach and finally the benefits coming from the constructional combination of the dyke reinforcement and the additional functions. We assume that the additional functions will last for 50 years and will be occupied for 50 years.

We will calculate these benefits for this project by using the integrated benefit calculation method that is described in the previous section.

- *Comparing rental value method* ➡ *Benefits from renting or selling the available space or the functions:*

The Municipality of Rotterdam offers 9 lots in the area of "Hoek van Holland Stationsweg" for building houses. These lots are presented in figure 2.

The sale prices as they are given from the Municipality of Rotterdam are presented in the table below:

Lot	Area in m^2	Price (€ per m^2)	Total purchase price(€)
A	772	475	366700
B	750	475	356250
C	745	475	353875
D	1085	450	488250
E	734	475	348650
I	711	475	337725
K	703	475	333925
L	978	480	469440
O	892	425	379100

Table 3: Prices of the available lots

Figure 4: Available lots from the Municipality of Rotterdam

Therefore, if all these lots are sold in year 0, the total benefits for the Municipality will be € 3,433,915. However, in our case, we will assume that half of these lots will be sold (lots A-E) and half of the lots (I-O) will be rent to private investors. We also assume that all the lots, which are for sale, will have been sold until the year 10. For the lots that will be rent to investors, the rental price should be identified. Several functions could be accommodated in this area such as hotels, restaurants or recreational centers in general. To identify the rental price, the comparing renting value method will be implemented. For this project, the rental value is compared by using the site www.Fundainbusiness.nl as a source for similar properties, land or dwellings. In this case of MFFDs, buildings are compared that could accommodate a hotel or restaurant.

For this situation, a rental price of €10.417/month for a hotel/restaurant in Zuid-Holland of approximately 1000 m^2 is applied. Here, there is one lot of this size, so the total benefits will be €125,004. For the lots that are smaller and around 700m^2-800m^2, a rental price of €4,957/month is applied. Here, there are two lots of this size, so the total rent benefits are €118,968. Finally, for the lot between 800m^2-950m^2, a rental price of €6,500 /month is applied. Then the benefits for the total year are €78,000.

Except from these lots, as we mentioned above, there are also dwellings available for sale that can be used for residential purposes. The price range is between €130,000 respectively €1,650,000 for an apartment with the surface area of 100 respectively 500 m^2 in the neighborhood of "Strand en Duin" [30]. Therefore, if we assume that all the 550 dwellings in the eastern area and the all the 165 in the western area will be sold in the average price of €500,000 then the total benefits will be €357,500,000 in year 0. However, in our case, we assume that 450 of the dwellings will be sold during the life cycle of the project gradually.

- *Asset Valuation method* ⟶ *Increase Economic value of the relevant area*

To apply this method we need to estimate the revenues of the real estate development and the costs of making the land ready for building [9]. This requires assumptions to be made concerning the developments at the land market. The project of "Kaap de Goede Hoek" includes the construction of 1200 dwellings in total for sale and the whole area is 12.000 m^2 for both the houses, hotels and the other facilities. On the one hand, we assume that the building costs are €1000/m^2. Then we have a total for the whole area of €12,000,000. Besides, we assume civil technical costs like excavation costs or preparation costs of the building site of €2,650,000 based on other multifunctional projects. Then the total costs will be €14,650,000. We assume that the maintenance costs will be 5% of the total investment costs.

On the other hand, the discounted benefits from the sale and rent of the available lots and the dwellings as they were calculated above are € 60,044,891.

The multifunctional use of land is expected to increase the productivity of companies at the location and thus the productivity of land in the area [9]. Therefore, we need to estimate the increase in the value of real estate in the project area and its direct proximity, which will result from the location quality improvement in the area [9]. For the purpose of this report, we rely on existing studies that have estimated the impact of multifunctional projects about the real estate value in the area. Based on expert opinions of large Dutch real estate agents, they expect a 10% value increase due to the implementation of multifunctional projects. Factors influencing the increased value are the location characteristics such as accessibility, availability and quality of facilities, economies of scale, and the quality of real estate.

Travel Cost Method (TCM) ⟶ *Recreational Benefits:*

To calculate the recreational benefits from the additional functions that can be integrated in the dyke such as a park or a visit to the beach we will use the travel cost method. As we explained in section 3, this method requires the conduct of a survey in the field of the amenity (park, beach, etc.). However, in the terms of this illustration example for simplicity reasons, we will be based on assumptions regarding the data that we need to apply this method.

Let's assume that we have four individuals that travel from 4 different locations. The table below presents these data:

Individual	Start point	Distance from the amenity(km)	Travel cost (€)	Visits/year
A	Rotterdam	31.6	20	10
B	Schiedam	25.8	15	15
C	Delft	22.2	12	25
D	The Hague	18.6	10	50

Table 4: Data needed for TCM

By using this data, we can develop the demand curve.

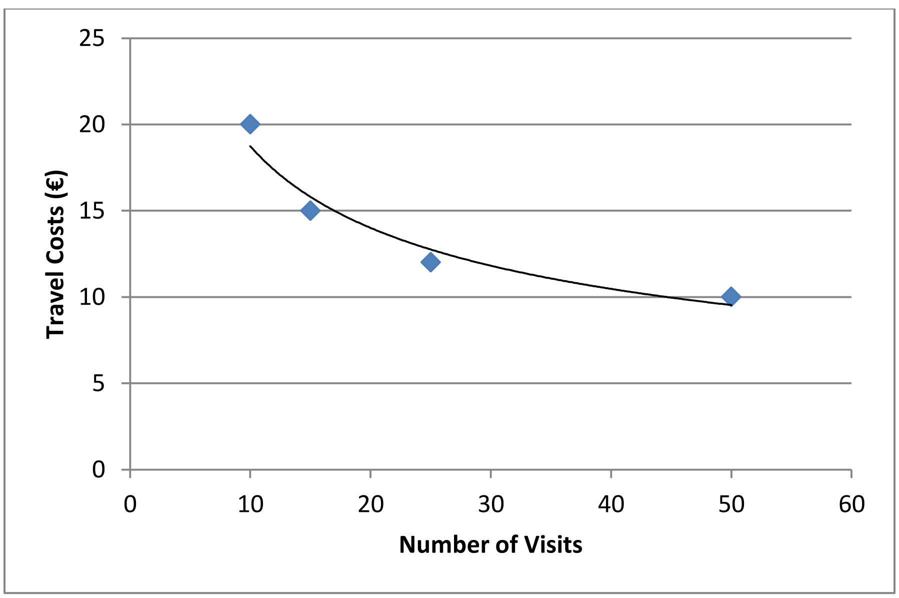

Figure 5: Demand Curve

In this curve we add data from other individuals in order to obtain the average price. The value of the asset can then been calculated if we multiply this average price with the total number of visitors.

For this project, the average price is €12.5 and the number of visitors on warm beach days is 60,000 to 70,000 for the whole beach area. If we assume that the visitors in the area which include the combination of the dyke and the functions will be 10,000, then the value of the asset is €125,000.

To calculate the value of a visit to the park on the top of the dyke, we can apply another application of the travel cost method, used by the researchers. This is the zonal travel cost method in which the researcher can designate zones around the amenity. For example, let's assume the park on the top of the dyke. We can set three zones around this asset. The zone A up to 10km, the zone B up to 20km and the zone C up to 30km. The picture below presents these travel zones.

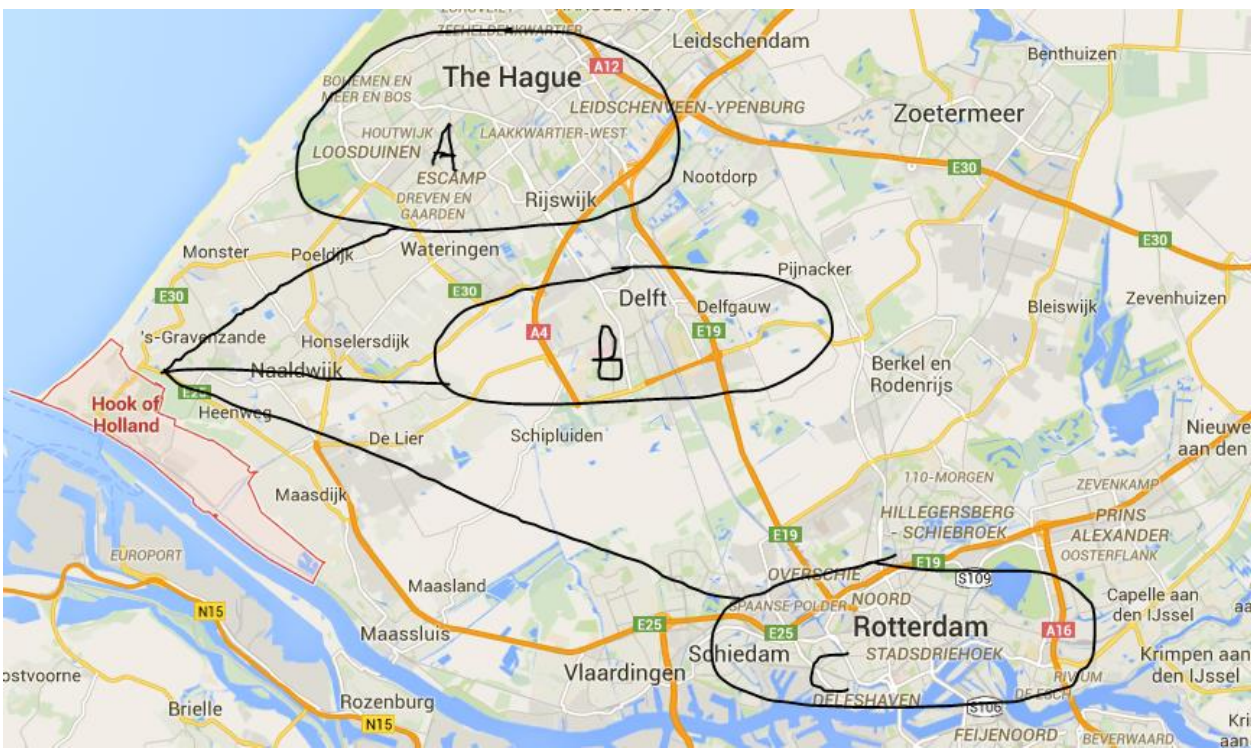

Figure 6: Travel zones

We also set a parking fee of €2.50. Finally, we need data about the annual visits. Let's assume that we have the following table regarding the park:

Zone	Travel Time (hours)	Travel Distance (km)	Admission Cost (€)	Visits per year
A	0.25	10	2.50	10000
B	0.55	20	2.50	8000
C	0.70	30	2.50	5000

Table 5: Data regarding the visit to the park

To calculate the value of the asset, we use the following equation:

V = (T*w) + (D*v) + Ca

We assume that the average wage rate is €15/ hour.
The marginal vehicle operating cost is 0.20cents/km

Therefore, the values of the asset for the zones A, B and C are presented in the table below:

Zone	Value	Average number of visits	Total value (value x number of visits) (€)
A	8.25	10000	82500
B	14.75	8000	118000
C	19	5000	95000

Table 6: Asset value for the zones A, B, C

The overall value of the park equal to,

V = €295,500

- *Comparing alternatives method* ⟶ *Constructional Combination*

To calculate this benefit, we compare the needed construction costs for the "traditional solution" with the costs for the multifunctional solution. Evidence from past projects that included the construction of MFFDs has shown that when this constructional combination exists between the reinforcement of a dyke and the development of functions there are significant cost savings. For example, in the project of Katwijk, the alternative that included the reinforcement of a dyke and the construction of a car park needed €24 million less money than the traditional approach due to this constructional combination. Another project that proves the benefits from this constructional combination is that of South-Western Ring Road in Gouda. This project included the construction of a road embankment that will also serve as a primary flood defense structure. The half a kilometer along which the road forms a combination with the dike requires an investment of around €800,000 while the costs of the separate construction of a new dike would be in the region of €5,000,000. This means that the constructional combination entails a saving of €4,200,000 or 84%.

Furthermore, in other projects that included multifunctional structures other than flood defenses, the multifunctionality led to a cost reduction between 20% and 25%. Therefore, we can assume that also in this project, if everything is built at the same time, we can save around 25-30% of the total investment costs. Management and maintenance costs are reduced due to the shared responsibility. Past projects have proved that the implementation of multifunctionality leads to 25% less management and maintenance costs in comparison with the reinforcement of a traditional dyke.

Normally, in projects that include the reinforcement of traditional dykes both national government and the water boards pay 50% of the construction costs. The maintenance costs are fully covered by the water board. The national government only contributes when a dyke fails the national assessment and becomes part of the Flood Risk Protection Program. Ellen et al., (2011) have mapped different problems regarding financing multifunctional dykes. For example additional costs for maintenance and construction costs can become a problem, especially taken into account the precondition that the design of a dyke must be 'robust, sober and effective' [10].

In this project, the shareholders who are mainly involved are the municipality of Rotterdam, the water board and the private investors who will buy and exploit the available area. Normally, the water board is responsible for maintaining the dykes but they can also contribute to increasing the spatial quality like in the project "Hondsbossche and Pettemer Sea defense" or the project of "Streefkerk" where the water board paid the €0.1 million of the additional costs since in return they will have a 100 times extra strong dyke. However, they did not contribute to the development of the housing area [10]. Therefore, we can assume that in this project, the water board will cover the maintenance costs; the municipality in cooperation with private investors will cover the costs for increasing the spatial quality and build the functions and the national government will pay for the reinforcement of the primary dyke.

All the above benefits are calculated for the year 0. Therefore, the next step in our method is to calculate the present value of these benefits for the whole life cycle of the project. This calculation leads to the final proforma (figure 8) of the project. The proforma is a cash flow of the benefits for the life time of the functions which in this case we assumed that this life cycle will be 50 years. The calculation sheet presents the first 10 years but all the present values have been calculated for the life time of 50 years. The proforma for 50 years is presented in the appendix.

In the next section, we will discuss the results of this research and we will make suggestions for further research that could lead the current research to a next level.

Figure 7: Proforma of the project

	Item	Year 0	1	2	3	4	5	6	7	8	9	10
	Sale the available land											
	Potential revenues											
	Lot A (772 sqm)		€ 366,700									
	Lot B (750 sqm)					€ 356,250						
	Lot C (745 sqm)						€ 353,875					
	Lot D (1085 sqm)				€ 488,250							
	Lot E (734 sqm)											€ 348,650
	Sale of 450 available dwellings		€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000
	Rent the available land											
	Lot I (711 sqm)		€ 59,484	€ 61,268.52	€ 63,106.58	€ 64,999.77	€ 66,949.77	€ 68,958.26	€ 71,027.01	€ 73,157.82	€ 75,352.55	€ 77,613.13
	Lot K (703 sqm)		€ 59,484	€ 61,268.52	€ 63,106.58	€ 64,999.77	€ 66,949.77	€ 68,958.26	€ 71,027.01	€ 73,157.82	€ 75,352.55	€ 77,613.13
	Lot L (978 sqm)		€ 125,004	€ 128,754.12	€ 132,616.74	€ 136,595.25	€ 140,693.10	€ 144,913.90	€ 149,261.31	€ 153,739.15	€ 158,351.33	€ 163,101.87
	Lot O (892 sqm)		€ 78,000	€ 80,340.00	€ 82,750.20	€ 85,232.71	€ 87,789.69	€ 90,423.38	€ 93,136.08	€ 95,930.16	€ 98,808.07	€ 101,772.31
	Total		€ 5,188,672	€ 4,831,631	€ 5,329,830	€ 5,208,077	€ 5,216,257	€ 4,873,254	€ 4,884,451	€ 4,895,985	€ 4,907,864	€ 5,268,750
(a)	Present Value (discount rate: 3%)	€ 60,044,891										
	Recreational Benefits											
	Value of visiting the park on the top of the dyke		€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000
	Value of visiting the beach alongside the dyke		€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500
	Total		€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500
(b)	Present Value (discount rate: 3%)	€ 4,795,951										
	Constructional Combination:											
	from using the same materials	20-25% cost reduction										
		25% less management and maintenance costs										
	Shared costs among the stakeholders											
	Water Board: maintenance costs	30% of the total Investment costs										
	Private Investors: increase the spatial quality and build the functions	50% of the total Investment costs										
	Municipality: increase the spatial quality and build the functions											
	National Government: reinforcement of the primary dyke	20% of the total Investment costs										
	Increase Economic value of the relevant area											
	Total Construction costs	€ 14,650,000										
(c)	Total Construction costs reduced by 20% due to the constructional combination	€ 11,720,000										
	Maintenance costs (5% of the total Invesment costs)		€ 586,000	€ 603,580.000	€ 621,687.400	€ 640,338.022	€ 659,548.163	€ 679,334.608	€ 699,714.646	€ 720,706.085	€ 742,327.268	€ 764,597.086
(d)	Present Value (discount rate: 3%)	€ 15,077,642										
(e) = (c)+ (d)	Total Costs	€ 26,797,642										
(f) = (a) + (b)	Total Discounted Benefits	€ 64,840,842										
(f) - (e)	NPV	€ 38,043,200										

7.0 Conclusions & Discussion

The construction of MFFDs is a design concept that together with flood protection can provide other commercial functions which enhance the urban development and could bring revenues for all the involved parties. There are several benefits, derived from the construction of MFFDs that have been identified in the existing literature such as real estate benefits, increase in the economic value of the area or cost savings during the construction.

Until now some of these benefits were not included or fully included in a CBA for MFFDs. The reason is mainly that the calculation is considered complicated since the most of these benefits are non-financial and are lying far to the future [14]. However, in our research we introduce a method that includes the integrated calculation of some of these benefits. By using and applying the integrated benefit calculation method in a real case, we realized that the calculation of these benefits is feasible and that it could be included in a CBA in order to support the ex-ante evaluation of a project.

The suggested method includes and calculates the benefits from the real estate realization, the benefits from the constructional combination, the recreational benefits and the benefits that derive from the added value in the relevant area. However, as we described in the theoretical section, there are also more direct benefits that could derive from the construction of MFFDs, which could also be included in the method. In addition, it is important to take both the direct and the indirect possible benefits into account during the decision making process in order to conclude to the best solution. Until now, the indirect benefits such as the calculation of the avoided damage due to the flood defense were mostly included in a CBA for MFFDs. Our research suggests a way to include also the calculation of direct benefits that could derive for the exploitation of the extra space that becomes available and the implementation of extra functions in the area. Therefore, the integrated benefit calculation method could be considered a first step to that direction.

Researchers also claim that usually the government finances only the cheapest solution to meet the required flood safety norm [2] since it is not always feasible to foresee the effects of MFFDs regarding its cost-efficiency. In addition, evidence from past projects has shown that sometimes the water board cannot realize the benefits of a MFFD project or they are reluctant to fund the construction part of the additional functions since their main responsibility is to guarantee flood protection by reinforcing the dyke. As a result, there is a tendency to prefer the traditional way of dyke reinforcement instead of the multifunctional solution. In our research, we introduced a method that could provide a first calculation of benefits that mainly refer to the future by providing an overview of the expected revenues today. Therefore, this method could be a tool for the decision makers who want to check the cost-efficiency of different alternatives within a project.

In the existing literature, there are methods to calculate these benefits separately and for different purposes. For instance, Besseling et al. implemented the comparing rental value method to calculate the rental benefits or Zhang et al. used the travel cost method to calculate the recreational benefits from a visit in a coast beach. However, up to now, there was little or none exploration of how the benefits from MFFDs can be calculated within a project and therefore it was difficult to include these benefits in a CBA during the decision making process. Oderker et al [4] and Veelen et al. [32] mention that special attention should be paid not only to the costs but also to the benefits within the construction of MFFDs in order to evaluate a MFFD. Therefore, our research suggests an integrated benefit calculation method that could be applicable in the case of MFFDs and limit this literature gap. This method uses the combination of existing methods in order to calculate the different benefits and provide an overall picture of the benefits that we should expect from the multifunctional solution. We decided to combine four different methods which we considered more suitable for the calculation of the benefits. However, it is possible that there will be more methods that could be also integrated and applied in the case of MFFDs.

The integrated benefit calculation method can not only be applied in a CBA for MFFDs, but it could also be used in general for the calculation of specific benefits. For example, recreational benefits could derive from different projects such as environmental or natural. Also, the real estate benefits and in particular the benefits from the rent or sale of the area are again benefits that we should take into account in almost all kind of projects that include the aspect of urban development. In addition, the way to calculate the increase in the value of the affected area is useful in many projects that include any kind of change even the construction of a road that would diminish the distance between a city and an amenity or in our case the construction of a multifunctional flood defense.

In addition, this method could also be used in other multifunctional projects that do not contain necessarily a flood defense but other functions such as a road and an underground parking area. Also, the method that we suggested can be applied in monofunctional projects that could generate these benefits and not only in multifunctional ones. For example, the method could be applied in infrastructure or recreational projects. Therefore, it could be applied in other countries and not only in countries that face a high risk of flood.

During this research, we identified several limitations regarding the benefit calculation of MFFDs. For example, some of the benefits are lying far to the future and therefore they could be considered as non-guaranteed since it is difficult to realize these benefits today. Therefore, public and private investors are reluctant to take that risk and invest their money on MFFDs. As a result, further research could conduct a risk assessment and examine the risks behind these decisions. Furthermore, it would be interested for further research to examine the fluctuations in the real estate market due to the addition of extra functions.

Another limitation was that it wasn't possible to calculate all the benefits. The main obstacle was that some of these benefits cannot easily be translated to monetary values. For example, the fact that the construction of MFFDs could lead to more effective use of space is a benefit that cannot be calculated in terms of money. In addition, the benefit of using the same materials to upkeep both the dyke and the extra functions could be calculated but this can be done only further in the life cycle of the project and not in advance. Therefore, we suggest that further research could be done in a different point during the life cycle of the project which will calculate these benefits and compare them with the solution of a traditional dyke.

Furthermore, there were also limitations regarding the different methods that we decided to combine in order to develop the integrated benefit calculation method. For example, the TCM that we used to calculate the recreational benefits requires a survey, in which questionnaires should be distributed to visitors asking them about the amount of money that they are willing to pay in order to visit an amenity. However, it may actually be quite difficult to measure the cost of accessing a site or amenity. This is because of the opportunity cost associated with the travel time. If the opportunity cost of all individuals is the same then the estimated price will be accurate. If, however, the opportunity cost of individuals accessing the site varies, which is more likely, then the measure will be inaccurate [15]. Another limitation regarding this method is that the estimation of willingness to pay used in the TCM is usually for the entire site access rather than specific features. The TCM only provides a price or value relating to the cost of accessing the amenity or recreational site and it does so for the whole site. It may, however, be the case that we wish to value a certain aspect of the site in our project appraisal [15]. For example, in the case of MFFDs we do not wish to value all the functions, but instead the park on the top of the dyke. Therefore, further research could conduct a real survey and calculate precisely the recreational benefits in a case of MFFDs.

Another important issue regarding the construction of MFFDs is the life span of the functions. The multifunctional projects include combination of functions that probably will not have the same life cycle. For example, a dyke could have a longer life time from a park or a shopping mall. In our research, we considered the same life span for all the functions. However, in reality this is not always happening. It is important to take into consideration the different life spans since this is a factor that can influence the total benefits over the years. Therefore, further research could focus on this point by examining each function separately with a different life time. Also, it would be interesting to examine how the revenues from one function could affect the others and which combination of functions could bring more benefits.

Furthermore, regarding the benefit of constructional combination, we assumed a total percentage of savings due to this benefit. However, further research could focus only on the phase of construction and estimate the exact amount of money that could be saved from the less needed quantities of materials in a simultaneous construction of the dyke and functions in comparison with the separate construction of them. In addition, further research could analyze the synergetic effects due to the integration of functions.

Finally, we presented the benefit from the share of costs between the involving parties. As we have already mentioned, this benefit requires the total agreement among the stakeholders regarding who will pay for what and of course who will reap the benefits. This agreement is difficult to be achieved from the beginning of a project since the participants have different interests and criteria in making funds available and have different time horizons in their goals [3]. Therefore, further research could be conducted for these communication requirements among the involving parties and focus on ways for better distribution of the costs and benefits among the stakeholders.

8.0 Acknowledgement

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		Year										
	Item	0	1	2	3	4	5	6	7	8	9	10
	Sale the available land											
	Potential revenues											
	Lot A (772 sqm)		€ 366,700									
	Lot B (750 sqm)					€ 356,250						
	Lot C (745 sqm)						€ 353,875					
	Lot D (1085 sqm)				€ 488,250							
	Lot E (734 sqm)											€ 348,650
	Sale of 450 available dwellings		€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000
	Rent the available land											
	Lot I (711 sqm)		€ 59,484	€ 61,268.52	€ 63,106.58	€ 64,999.77	€ 66,949.77	€ 68,958.26	€ 71,027.01	€ 73,157.82	€ 75,352.55	€ 77,613.13
	Lot K (703 sqm)		€ 59,484	€ 61,268.52	€ 63,106.58	€ 64,999.77	€ 66,949.77	€ 68,958.26	€ 71,027.01	€ 73,157.82	€ 75,352.55	€ 77,613.13
	Lot L (978 sqm)		€ 125,004	€ 128,754.12	€ 132,616.74	€ 136,595.25	€ 140,693.10	€ 144,913.90	€ 149,261.31	€ 153,739.15	€ 158,351.33	€ 163,101.87
	Lot O (892 sqm)		€ 78,000	€ 80,340.00	€ 82,750.20	€ 85,232.71	€ 87,789.69	€ 90,423.38	€ 93,136.08	€ 95,930.16	€ 98,808.07	€ 101,772.31
	Total		€ 5,188,672	€ 4,831,631	€ 5,329,830	€ 5,208,077	€ 5,216,257	€ 4,873,254	€ 4,884,451	€ 4,895,985	€ 4,907,864	€ 5,268,750
(a)	Present Value (discount rate: 3%)	€ 60,044,891										
	Recreational Benefits											
	Value of visiting the park on the top of the dyke		€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000
	Value of visiting the beach alongside the dyke		€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500
	Total		€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500
(b)	Present Value (discount rate: 3%)	€ 4,795,951										

	Constructional Combination:											
	from using the same materials	20-25% cost reduction										
		25% less management and maintenance costs										
	Shared costs among the stakeholders											
	Water Board: maintenance costs	30% of the total Investment costs										
	Private Investors: increase the spatial quality and build the functions	50% of the total Investment costs										
	Municipality: increase the spatial quality and build the functions											
	National Government: reinforcement of the primary dyke	20% of the total Investment costs										
	Increase Economic value of the relevant area											
	Total Construction costs	€ 14,650,000										
(c)	Total Construction costs reduced by 20% due to the constructional combination	€ 11,720,000										
	Maintenance costs (5% of the total Invesment costs)		€ 586,000	€ 603,580.000	€ 621,687.400	€ 640,338.022	€ 659,548.163	€ 679,334.608	€ 699,714.646	€ 720,706.085	€ 742,327.268	€ 764,597.086
(d)	Present Value (discount rate: 3%)	€ 15,077,642										
(e) = (c)+ (d)	Total Costs	€ 26,797,642										
(f) = (a) + (b)	Total Discounted Benefits	€ 64,840,842										
(f) - (e)	NPV	€ 38,043,200										

11	12	13	14	15	16	17	18	19	20	21	22
€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000
€ 79,941.52	€ 82,339.77	€ 84,809.96	€ 87,354.26	€ 89,974.89	€ 92,674.13	€ 95,454.36	€ 98,317.99	€ 101,267.53	€ 104,305.55	€ 107,434.72	€ 110,657.76
€ 79,941.52	€ 82,339.77	€ 84,809.96	€ 87,354.26	€ 89,974.89	€ 92,674.13	€ 95,454.36	€ 98,317.99	€ 101,267.53	€ 104,305.55	€ 107,434.72	€ 110,657.76
€ 167,994.92	€ 173,034.77	€ 178,225.81	€ 183,572.59	€ 189,079.77	€ 194,752.16	€ 200,594.72	€ 206,612.57	€ 212,810.94	€ 219,195.27	€ 225,771.13	€ 232,544.26
€ 104,825.48	€ 107,970.24	€ 111,209.35	€ 114,545.63	€ 117,982.00	€ 121,521.46	€ 125,167.10	€ 128,922.12	€ 132,789.78	€ 136,773.47	€ 140,876.68	€ 145,102.98
€ 4,932,703	€ 4,945,685	€ 4,959,055	€ 4,972,827	€ 4,987,012	€ 5,001,622	€ 5,016,671	€ 5,032,171	€ 5,048,136	€ 5,064,580	€ 5,081,517	€ 5,098,963
€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000
€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500
€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500

€ 787,534.998	€ 811,161.048	€ 835,495.880	€ 860,560.756	€ 886,377.579	€ 912,968.906	€ 940,357.973	€ 968,568.713	€ 997,625.774	€ 1,027,554.547	€ 1,058,381.184	€ 1,090,132.619

23	24	25	26	27	28	29	30	31	32
€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000
€ 113,977.50	€ 117,396.82	€ 120,918.72	€ 124,546.29	€ 128,282.67	€ 132,131.16	€ 136,095.09	€ 140,177.94	€ 144,383.28	€ 148,714.78
€ 113,977.50	€ 117,396.82	€ 120,918.72	€ 124,546.29	€ 128,282.67	€ 132,131.16	€ 136,095.09	€ 140,177.94	€ 144,383.28	€ 148,714.78
€ 239,520.59	€ 246,706.21	€ 254,107.39	€ 261,730.62	€ 269,582.53	€ 277,670.01	€ 286,000.11	€ 294,580.11	€ 303,417.52	€ 312,520.04
€ 149,456.07	€ 153,939.75	€ 158,557.94	€ 163,314.68	€ 168,214.12	€ 173,260.54	€ 178,458.36	€ 183,812.11	€ 189,326.47	€ 195,006.27
€ 5,116,932	€ 5,135,440	€ 5,154,503	€ 5,174,138	€ 5,194,362	€ 5,215,193	€ 5,236,649	€ 5,258,748	€ 5,281,511	€ 5,304,956
€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000
€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500
€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500

€ 1,122,836.598	€ 1,156,521.696	€ 1,191,217.346	€ 1,226,953.867	€ 1,263,762.483	€ 1,301,675.357	€ 1,340,725.618	€ 1,380,947.387	€ 1,422,375.808	€ 1,465,047.082

33	34	35	36	37	38	39	40	41	42	43
€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000
€ 153,176.22	€ 157,771.51	€ 162,504.65	€ 167,379.79	€ 172,401.19	€ 177,573.22	€ 182,900.42	€ 188,387.43	€ 194,039.06	€ 199,860.23	€ 205,856.03
€ 153,176.22	€ 157,771.51	€ 162,504.65	€ 167,379.79	€ 172,401.19	€ 177,573.22	€ 182,900.42	€ 188,387.43	€ 194,039.06	€ 199,860.23	€ 205,856.03
€ 321,895.64	€ 331,552.51	€ 341,499.09	€ 351,744.06	€ 362,296.38	€ 373,165.28	€ 384,360.23	€ 395,891.04	€ 407,767.77	€ 420,000.81	€ 432,600.83
€ 200,856.45	€ 206,882.15	€ 213,088.61	€ 219,481.27	€ 226,065.71	€ 232,847.68	€ 239,833.11	€ 247,028.10	€ 254,438.95	€ 262,072.12	€ 269,934.28
€ 5,329,105	€ 5,353,978	€ 5,379,597	€ 5,405,985	€ 5,433,164	€ 5,461,159	€ 5,489,994	€ 5,519,694	€ 5,550,285	€ 5,581,793	€ 5,614,247
€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000
€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500
€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500

€ 1,508,998.495	€ 1,554,268.450	€ 1,600,896.503	€ 1,648,923.398	€ 1,698,391.100	€ 1,749,342.833	€ 1,801,823.118	€ 1,855,877.812	€ 1,911,554.146	€ 1,968,900.770	€ 2,027,967.794

44	45	46	47	48	49	50
€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000	€ 4,500,000
€ 212,031.72	€ 218,392.67	€ 224,944.45	€ 231,692.78	€ 238,643.56	€ 245,802.87	€ 253,176.96
€ 212,031.72	€ 218,392.67	€ 224,944.45	€ 231,692.78	€ 238,643.56	€ 245,802.87	€ 253,176.96
€ 445,578.85	€ 458,946.22	€ 472,714.61	€ 486,896.04	€ 501,502.93	€ 516,548.01	€ 532,044.45
€ 278,032.31	€ 286,373.28	€ 294,964.48	€ 303,813.41	€ 312,927.81	€ 322,315.65	€ 331,985.12
€ 5,647,675	€ 5,682,105	€ 5,717,568	€ 5,754,095	€ 5,791,718	€ 5,830,469	€ 5,870,383
€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000	€ 125,000
€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500	€ 295,500
€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500	€ 420,500

€ 2,088,806.827	€ 2,151,471.032	€ 2,216,015.163	€ 2,282,495.618	€ 2,350,970.487	€ 2,421,499.601	€ 2,494,144.589